INTERSPECIFIC HYBRIDIZATION

IN *LEUCAENA* BENTHAM

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ABSTRACT

Thirteen *Leucaena* species and subspecies were studied from 1982-1987. Their valid species status was previously determined from chromosome numbers, geographical distributions, ecology and morphology. Present studies include self-incompatibility, interspecific hybridization, and morphological analyses of F1 interspecific hybrids.

Self-incompatibility (SI) was tested by hand pollinating 184 flower heads (2,805 florets). Two tetraploid species (4x=104) were self-fertile of the three tetraploid and eight diploid species selfed. Selfed progenies of *L. esculenta* (2x=52) were discovered. *L. retusa* (2x=56) was weakly self-fertile. Possible selfed progenies of four other diploid species were grown. None of the species hybrids grown were self-compatible except those derived from mating self-compatible species.

A refined emasculation technique helped in hand pollinating 1420 inter- and sub-specific crosses (22,193 florets), thereby testing 135 of the 156 (86.5 %) species combinations in a 13 x 13 diallel. The genus was largely interfertile as 55 of the 64 species combinations (64/135 or 47.4 %) producing viable-appearing seed were grown and verified. *In vitro* techniques were used to grow two species hybrids from semi-abortive seeds. With reciprocal crosses combined, 73 of the possible 78 (93.6 %) combinations in the diallel were tested, and 47 (64.4 %) produced viable-

appearing seed. Fourteen species combinations (14/135 or 10.4 %) produced abortive seeds.

Two tetraploid hybrids resulted from the mating of a diploid (2x=56) x tetraploid (4x=104) mating. These tetraploid hybrids probably resulted from the union of a normal pollen of a tetraploid species (n=52) with an unreduced egg of a diploid species (2n=56), resulting in novel 4x=108-chromosome species hybrids.

Growth rates rates of 50 species hybrids were determined. The fastest mean growth rate was 4.3 m/yr by L. diversifolia x L. pallida (4x=104). Seven hybrids had mean growth rates greater than 3 m/yr, and 23 hybrids had mean growth rates greater than 2 m/yr. Thirty hybrids had at least one tree which increased in height faster than 3 m/yr. The fastest growth rate of any tree was 6.2 m/yr by L. diversifolia x L. collinsii (2x=54).

Psyllid resistance to Heteropsylla cubana Crawford in the interspecific F1 hybrids was better than most L. leucocephala. Five hybrids had no observable damage from psyllids. One appeared to be heterotic for psyllid resistance, and one appeared to have poorer resistance than either parent. Glands were observed on pinnae rachises of L. esculenta leaves, and appear to be producing mucilage which was implicated in psyllid resistance.

Forty-one species hybrids reached sexual maturity, but 14 (34.1 %) failed to produce any viable seeds from open-pollination. Mean viable seed per pod production of the 27 hybrids setting pods was 37.4 %.

Yellow and red floral color, gland shape and number per leaf, floral bract shape, and inflorescence diameter were useful markers for identifying species hybrids. All appeared to be inherited additively in the F1, and all appeared to exhibit dosage effects except for gland and bract shape. Red flower color was recessive to yellow in matings of yellow x red flowers.

Numbers of leaflets per pinna and pinnae per leaf and leaflet lengths and widths in 50 interspecific hybrids and their parents were counted or measured. Parental and F1 hybrid data for leaf characteristics were linearized when plotted as the natural log of the data. Dosage effects occurred in triploid hybrids. Most (148/200 or 74 %) predicted hybrid leaf traits were predicted within 20 % of actual hybrid measurements; predictability would have been higher if data were used only from healthy mature trees. Only *L. retusa* x *L. collinsii* had leaflets which were not intermediate in size between than of the parental species. Leaf trait analysis was helpful in determination of parents of an open-pollinated species hybrid.

Meiotic chromosomes were studied in two species hybrids and one species. *L. collinsii* K450 had 28 II, *L. retusa* K280 x *L. collinsii* K450 had 4 II + 48 I and *L. diversifolia* ssp. *trichandra* K399 x *L. collinsii* had 26 II + 2 I.

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CHAPTER 1. INTRODUCTION

The genus Leucaena, composed of at least twelve species of nitrogen-fixing trees and shrubs, is endemic to semi-arid regions from Texas south to Peru at elevations up to 2500 meters. The species are delineated by their ecological adaptations, chromosome numbers, geographical distributions and morphology.

Leucaenas adapt easily to both small-farm and large-scale agroforestry, providing forage, pulpwood, poles, fuelwood, charcoal, green manure, food (leaves, seeds) and shade. They coppice readily, thus reducing the need to replant from seed. Many species are large trees.

L. leucocephala (Lam.) de Wit, the only species used on a commercial basis thus far, is already pantropical having been originally dispersed by Spanish ships in the 16th century. Among its many common names are "leucaena", "koa haole", "guaje", "ipil-ipil", "lamtoro", "subabul" and "yin-ho huan". The shrubby "common" or "Hawaiian" subspecies has weedy characteristics, but is useful in tropical pastures where it withstands heavy grazing. The arboreal "Salvador" giant type and the "Peru" giant types are preferred, however.

L. leucocephala is recognized as a fast-growing tree with typical wood yields of 20-50 m^3/ha/yr (Brewbaker et al., 1982). Experimental yields of 50-80 m^3/ha/yr were often reached in Hawaii (Van Den Beldt and Brewbaker, 1980).

Forage yields ranged from 15-30 dry t/ha/yr when given adequate moisture (Brewbaker and Hutton, 1979).

The genus *Leucaena* has been the subject of several extensive reviews (Oakes, 1968, Brewbaker and Hutton, 1979, NAS, 1977 and 1984b, IDRC, 1983, Pound and Martinez C., 1983, and Brewbaker, 1987a) and a three-volume bibliography by Oakes (1982, 1983, 1984). An annual publication on leucaena, "Leucaena Research Reports", is published by The Nitrogen Fixing Tree Association (NFTA), P.O. Box 680, Waimanalo, Hawaii 96795.

L. leucocephala's adaptability may be increased through interspecific hybridization. Extending *L. leucocephala*'s adaptability is needed for "waterlogged soils, high altitudes or temperate latitudes, aluminum-rich soils, or pest-prone areas" (NAS, 1977). Various leaf and seed compounds, including tannins, galactomannans, and mimosine, also limit the use of *L. leucocephala* as fodder, especially for nonruminants.

Most *L. leucocephala* accessions are highly susceptible to the psyllid *Heteropsylla cubana* Crawford. Believed to be native to Latin America, the psyllid spread to Florida in 1982 (Othman and Prine, 1984) and Hawaii in 1984 (Sorensson and Brewbaker, 1984) and quickly throughout the Pacific Basin, causing extensive damage. Damage to *L. leucocephala* from the psyllid has greatly increased interest in other *Leucaena* species and in species hybrids.

Superior qualities of interspecific hybrids were recognized in the 1940s. Dutch foresters in Indonesia preferred L. pulverulenta x L. leucocephala (3x=78) species hybrids in high-elevation coffee and tea plantations because they were less seedy and more cold-tolerant than L. leucocephala. Hybrid seed was picked from L. pulverulenta interplanted among L. leucocephala.

Several researchers have attested to the excellence of certain Leucaena interspecific hybrids. Bray's (1983) best L. pulverulenta x L. leucocephala hybrids produced 50 % more edible dry matter (leaves and young shoots) than the L. leucocephala K500 control, and up to 100 % more wood over a two-year period. Like certain walnut (Juglans spp.) interspecific hybrids which showed overdominance for cold tolerance (Yablokov, 1960), Energy Development/International (Kirmse, 1985) found that the winter survival of F2 trees of L. diversifolia K156 x L. leucocephala K8 (56.3 %) was six and nine times higher than that of the parents, respectively.

Gains through heterosis of Leucaena interspecific hybrids per se is not the sole goal from hybridization. Righter (1946) noted that genetic uniformity in tree crops was not always desirable because trees experienced a heterogeneous environment through time. Since the commercial species, L. leucocephala, is a relatively uniform self-pollinating species, hybridization could result in wider plant adaptability since genetic heterozygosity will be greater.

Prior to the initiation of the current study, Gonzalez (1966), Booman (1982b) and Pan (1985) produced seed of thirteen interspecific hybrids. All but three could be germinated and/or validated (L. leucocephala x L. diversifolia ssp. trichandra, L. pulverulenta x L. diversifolia ssp. trichandra, and L. diversifolia ssp. diversifolia x L. lanceolata ssp. sousae). The ten validated interspecific hybrids, plus two which Hutton verified cytolgically (Hutton, 1982a, 1982b), are listed in Table 1. A third interspecific hybrid found by Hutton (1981, 1982a) was probably L. lanceolata ssp. sousae K468 x L. leucocephala <K420>. This hybrid was identified by its small leaflets.

Table 1. -- Twelve verified Leucaena interspecific hybrids reported by previous researchers (Gonzalez, 1966; Booman, 1982b; Pan, 1985; and Hutton, 1982a and 1982b).

Female	K#		Male	K#
collinsii	K185	x	lanceolata ssp. lanceolata	K264
diversifolia 2x*	K409	x	diversifolia 4x*	K156
diversifolia 2x	K409	x	lanceolata ssp. lanceolata	K401
diversifolia 2x	K409	x	shannoni	K405
esculenta	-- **	x	leucocephala	K420
leucocephala	K8	x	collinsii	K185
leucocephala	K8	x	diversifolia 4x	K156
leucocephala	K8	x	shannoni	K405
leucocephala	K8	x	lanceolata ssp. lanceolata	K264
pulverulenta	K19	x	leucocephala	--
shannoni	K405	x	lanceolata ssp. lanceolata	K264
shannoni	K473 **	x	leucocephala	--

* 2x Diploid L. diversifolia with 2x=52 chromosomes.
4x Tetraploid L. diversifolia with 4x=104 chromosomes.
** Verified by Hutton, 1982b.

Several of the hybrids listed in Table 1 had parents differing in both ploidy level and morphology. This suggested that the interspecific compatibility between *L. leucocephala* and other species could be high, and that it could also be high in *Leucaena* Bentham.

Fast-growing interspecific tree hybrids are known in many tree genera, including *Larix*, *Eucalyptus*, *Quercus* and others. Vegetatively propagated interspecific tree hybrids like those of *Casuarina* (NAS, 1984a) and *Populus* (Zsuffa, 1975) became commercially useful apparently due to their fixed heterozygosity. Few successful reports of vegetative propagation of leucaneas are recorded. Recently, *in vitro* tissue culture propagation has had some success. Moreover, hybrid seed could be produced in quantity using self-incompatible clones of grafted leucaenas.

The present study focused on the following objectives: 1) To verify or determine the self-incompatibility status of the *Leucaena* species, 2) To determine the compatibility of all species combinations, 3) To estimate the economic potential of species hybrids, and 4) To compare the leaf and floral morphology of the species hybrids with their parents.

CHAPTER 2. LITERATURE REVIEW

2.1. Taxonomy of the Genus *Leucaena* Bentham.

Brewbaker (1985a, 1987a) took a cautious route in validating only 12 of the 53 species (Tables 2 and 3) described in the genus (Index Kewensis, 1886-1950, Index Londonensis, 1930-1941) based on over 800 accessions and herbarium research. The synonyms "*L. buitenzorg*" and "*L. molinae*" were never published, as far as we know.

Table 2. -- Specific epithets, epithet dates, and chromosome numbers of valid *Leucaena* species (Brewbaker, 1985a).

Species	Epithet Date	No. Somatic Chromosomes
1. L. collinsii Britton and Rose	1928	52
2a. L. diversifolia (Schlecht.) Bentham ssp. trichandra (Zucc.) Pan & Brewbaker	1842	52
2b. L. diversifolia (Schlecht.) Bentham ssp. diversifolia	1842	104
3. L. esculenta (Moc. and Sesse) Bentham	1875	52
4. L. greggii S. Watson.	1888	--
5a. L. lanceolata S. Watson ssp. lanceolata	1886	52
5b. L. lanceolata S. Watson ssp. sousae Zarate	1984	52
6a. L. leucocephala (Lam.) de Wit ssp. glabrata Rose	1897	104
6b. L. leucocephala (Lam.) de Wit ssp. leucocephala	1842	104
7. L. macrophylla Bentham	1844	--
8. L. pallida Britton and Rose	1928	104
9. L. pulverulenta (Schlecht.) Bentham	1842	56
10. L. retusa Bentham	1852	56
11. L. shannoni Donn. Smith	1914	52
12. L. trichodes (Jacq.) Bentham	1842	52

Table 3. -- Synonymous specific epithets of valid <u>Leucaena</u> species, epithet dates, and type localities.

Synonym	Species*	Epithet Date	Geographical Region/Notes**
L. blancii	6b	1909	Nicaragua (Peru type)
L. bolivarensis	12	1936	Colombia
L. boliviana	6b	1912	Bolivia
L. brachycarpa	2b	1900	Veracruz, Jamaica
L. brandegii	5a	1928	Baja Calif. (<u>Albizia</u> pods)
L. buitenzorg	2a	--	Ivory Coast (Africa)
L. canescens	12	1843	Ecuador, Peru
L. colombiana	12	1936	Colombia
L. confusa	3	1928	Jalisco, Morelos, Guerrero Oaxaca
L. cruziana	5a	1928	Veracruz
L. cuspidata	2a?	1919	San Luis Potosi, Hidalgo
L. doylei	3	1928	Chiapas
L. dugesiana	8	1928	Guanajuato
L. guatemalensis	2a	1928	Guatemala, Honduras
L. houghii	7	1928	Michoacan, Guerrero
L. insularum	--	1865	<u>Schleinitzia</u> <u>fosbergii</u>
L. latisiliqua	6b	1753	Guatemala
L. laxifolia	2b	1900	Veracruz
L. leiophylla	7	1940	Morelos
L. macrocarpa	7	1895	Jalisco, Guerrero (<u>Albizia</u> pod)
L. microcarpa	7	1897	Baja California, Sinaloa
L. molinae	2a	--	Honduras
L. multicapitula	12	1950	Panama
L. nelsonii	7	1928	Guerrero
L. nitens	7	1928	Sinaloa
L. oaxacana	8	1928	Oaxaca
L. palmeri	5a	1928	Sonora
L. paniculata	8	1928	Morelos, Jalisco, Oaxaca
L. pseudotrichodes	12	1928	Nicaragua
L. pubescens	5a	1928	Sinaloa
L. pueblana	2a	1928	Oaxaca
L. plurijuga	--	1919	(<u>Albizia</u> pods)
L. purpusii	5a	1928	Veracruz
L. rekoi	2b	1928	Oaxaca (<u>Albizia</u> pods)
L. revoluta	2a	1928	Chiapas
L. salvadorensis	6a?	1924	El Salvador
L. sinaloensis	5a	1928	Sinaloa
L. sonorensis	5a	1928	Sonora
L. standleyi	2a	1928	El Salvador
L. stenocarpa	2a	1900	Oaxaca
L. ulei	3	1907	Brazil

* Species are in reference to Table 2.

** Some type specimens of species appear to have <u>Leucaena</u> leaves and <u>Albizia</u> pods.

Brewbaker (1982b) used shrubbiness as the primary definitive characteristic in a key describing the subspecies of L. lanceolata and L. leucocephala.

Pan (1985) reduced the 11 species synonyms (Table 4) in the L. diversifolia complex to two interfertile subspecies differing in ploidy level. Pan split the diploid L. diversifolias into five groups according to leaflet morphology, however, all groups were interfertile. Pan (1985) validated L. pallida (2n=104) and determined it to be the amphidiploid of L. diversifolia and L. esculenta.

2.2. Chromosome Counts of Leucaena Species.

Pan (1985) reported chromosome counts for several Leucaena species as follows: a) 2n=52 in L. collinsii K180 and K450, L. diversifolia ssp. trichandra K406-K413, K422, K423, K454, K465, K478, K480 and K483, L. esculenta K138 and K342, L. lanceolata ssp. lanceolata K401, L. lanceolata ssp. sousae K379, L. shannoni K405 and K487, and L. trichodes K90 and K738; b) 2n=56 in L. pulverulenta K75, and L. retusa K280 and K502; and c) 2n=104 in L. diversifolia ssp. diversifolia K146, K155-K160, K164-K166, K166, and K186, L. pallida K174, K177, K178 and K376, and L. leucocephala K8.

Pan (1985) reported extra chromosomes in addition to the basic chromosome complement, and suggested that they were supernumerary chromosomes. Pan observed n=30 II and n=28 II in L. diversifolia ssp. trichandra K411 and K465, respectively; n=59 II in L. diversifolia ssp. diversifolia K156, and 56 + 58 chromosomes in L. pallida K174. Supernumerary chromosomes did not pair with chromosomes in the basic complement.

Pan (1985) observed from 1 to 8 B chromosomes in L. diversifolia ssp. trichandra K406-K413, K422, K423, K454, K465, K478, K480, and K483; L. diversifolia ssp. diversifolia K156, K160, K164-K166, and K186; and L. pallida K174, K177, K178 and K376, in 58.4, 30.2 and 49.0 % of the pollen mother cells examined. B chromosomes were not observed in nine other species. Some B chromosomes were small, but others appeared normal in size and appearance. B chromosomes remained unpaired at diakinesis but occasionally paired with numbers of the basic complement.

2.3. Self-Incompatibility Status of the Leucaena Species.

2.3.1. Leucaena Species Tested for Self-Incompatibility.

Two of the twelve Leucaena species are self-compatible (SC)-- L. diversifolia ssp. diversifolia, and both subspecies of L. leucocephala (Hutton and Eddie, 1982; Sorensson et al., 1984; Pan, 1985). Hutton and Eddie (1982) hand-selfed L. trichodes and L. esculenta without success. Likewise, inflorescences bagged by Booman (1982a) on L. diversifolia ssp. trichandra, L. shannoni, L. pulverulenta, L. lanceolata ssp. lanceolata and L. lanceolata ssp. sousae failed to produce pods.

Gonzalez (1966), however, reported that some diploid *Leucaena* species were self-compatible. Hand self-pollinated inflorescences produced pods on *L. pulverulenta* K19, *L. lanceolata* ssp. *lanceolata* K10 and *L. diversifolia* ssp. *trichandra* K11. It is not known whether the pods were harvested or had viable seeds. Gonzalez (1966) did, however, self the same species *in vitro* (callose fluorescence stained with aniline blue, technique of Majumder et al., 1964; Gorrez, 1965-- cited in Gonzalez, 1966). Only *L. pulverulenta* K19 was self-compatible *in vitro*. Bray (1986, personal communication) observed probable selfing of *L. pulverulenta* at CSIRO, Townsville, Australia.

2.3.2. Genetics of Self-Incompatibility in *Leucaena*.

Pan (1985) showed that *L. diversifolia* ssp. *trichandra* has a homomorphic gametophytic system (Brewbaker, 1967) of self-incompatibility (SI) controlled by S alleles (East and Mangelsdorf, 1925). Crosses among twenty progeny of a cross between two trees of *L. diversifolia* ssp. *trichandra* (K480 x K409) showed the presence of four incompatibility groups having apparently resulted from a parental cross of the type S_1S_2 x S_3S_4.

Brewbaker (1982b) proposed that specific combinations of SI alleles (eg., $S_1S_1S_2S_2$) in tetraploid species resulted in competition interaction (Atwood and Brewbaker, 1953; Brewbaker, 1954), which accounted for the self-compatibility of *L. leucocephala*. Chromosome-doubled SI species of Trifolium, Petunia and other genera, sometimes resulted in self-compatible (SC) tetraploids due to competition interaction.

Several corollaries follow if competition interaction causes SC in L. leucocephala (Brewbaker, 1986a). One is that 50-67 % of SC x SI tetraploid species hybrids, like L. leucocephala x L. pallida, would be self-fertile. This is because 66.7 % of the gametes of a balanced diallelic are competition gametes (S_1S_2) and unbalanced diallelics produce 50.0 % competition gametes. A $S_1S_2S_3S_4$ tetraploid hybrid produces six types of pollen (S_1S_2, S_1S_3, S_1S_4, S_2S_3, S_2S_4, S_3S_4) of which only one combination, S_1S_2, would be able to cause self-fertilization. Such a tree could probably set quantities of selfed pods due to the large numbers of pollen grains, even though only 16.7 % of the pollen could self-fertilize.

Both environmental and genetic disturbances can result in occasional selfing in otherwise SI species; none have been reported in Leucaena. Examples of factors which appeared to inhibit the SI response in certain plants were heat stress (Ascher and Peloquin, 1966; Raff et al., 1984) and the still-disputed pollen mentor effect (Stettler and Ager, 1982).

2.4. Interspecific Hybridization.

2.4.1. Emasculation Techniques.

Hutton and Gray (1959) sucessfully emasculated *L. leucocephala* by dipping the flower heads for three minutes in a solution of Gardinol K, a sulphonated lauryl alcohol. Twenty-five years later, Hutton still used the Gardinol K method with success (Hutton and de Sousae, 1985). Gonzalez (1966), however, was not successful with soap dipping (1 % detergent) from 1-4 minutes or with ethyl alcohol dippings (30 and 50 %) from 10-120 seconds. Improper timing of the soap dipping may have been responsible for Gonzalez's failure (Hutton, 1986, personal communication).

Gupta and Patil (1984b) reported success by emasculating flowers one day prior to anthesis. Florets were teased open and the anthers removed with tweezers.

Pan and Sorensson both made pre-dawn emasculations (Sorensson, 1982b; Pan, 1985). Emasculations were done before daybreak using light from miner's lamps before pollen had shed; each emasculation took 10-15 minutes.

2.4.2. Open-Pollinated Natural Interspecific *Leucaena* Hybrids.

At least two open-pollinated *Leucaena* species hybrids have been reported. In the 1940s Dutch foresters in Indonesia recognized the superiority of *L. pulverulenta* x *L. leucocephala* over endemic strains of *L. leucocephala* for shade trees in cool high-elevation plantations. They interplanted the two species to promote outcrossing between the species, and harvested up to 25 % hybrid seed (Djikman, 1958), probably from the self-incompatible L. pulverulenta parent. Similar frequencies of hybrid seed production were observed at Waimanalo by Brewbaker (1986, personal communication). Lowry et al. (1984a) discovered that one local Indonesian variety was a naturalized derivative from L. pulverulenta x L. leucocephala. This variety was prized for its edible foliage (human food) and low seed set.

Another commonly observed and also outstanding natural species hybrid is L. diversifolia ssp. diversifolia x L. leucocephala (Brewbaker, 1985a). Although some researchers could not prove that their trees were L. diversifolia ssp. diversifolia x L. leucocephala (or its reciprocal), it was often the only possbility as only the two species were planted. Raina (1984) speculated that his high-yielding hybrids were L. diversifolia K156 x L. leucocephala (either K132 or K67) and noted that their mimosine levels were only a third of L. leucocephala. Both Ozman in Mauritius and Wingerden in Haiti observed probable L. diversifolia ssp. diversifolia x L. leucocephala hybrid contaminants in their plots and lauded their excellent growth (Benge and Curran, 1982). The F2 progeny of L. diversifolia K156 x L. leucocephala K8 (called K743; Brewbaker, 1985a), and which has been planted widely, was first derived from a natural species hybrid in a row of L. diversifolia K156.

2.4.3. Species Compatibility *in vitro*.

Gonzalez (1966) tested the *in vitro* compatibility of four *Leucaena* species among themselves and with *Schleinitzia fosbergii* (Table 4). All but one of his successful pollinations made *in vitro* were later verified, Sorensson et al. (1984); self-pollination of *L. pulverulenta* has yet to be verified. Gonzalez also demonstrated *in vitro* the reproductive isolation of *Schleinitzia fosbergii*, which was at one time called *Leucaena insularum*, even though it had polyad pollen and lacked mimosine. *In vitro* pollinations may prove to be useful for studying incompatibility reactions between pollen tubes and the style or stigma.

Table 4. -- Interspecific crosses by hand (H) and *in vitro* (V) among four *Leucaena* species and *Schleinitzia fosbergii*. Data modified from Gonzalez, 1966.

Key: + = compatible o = incompatible - = not tested

\ male female \	LEU1		LEU2		PUL		DIV2		LAN		SCH	
	H	V	H	V	H	V	H	V	H	V	H	V
LEU1	+	+	-	+	-	+	-	-	+	-	-	o
LEU2	+	+	+	+	+	+	-	-	-	-	-	o
PUL	+	+	-	-	+	+	+	-	-	-	-	o
DIV2	-	-	-	-	-	-	+	-	-	-	-	-
LAN	o	-	-	-	-	-	-	-	+	-	-	-

LEU1 = *L. leucocephala* ssp. *leucocephala* (a Waimanalo strain)
LEU2 = *L. leucocephala* ssp. *glabrata* K8
PUL = *L. pulverulenta* K19
DIV2 = *L. diversifolia* ssp. *trichandra* K11
LAN = *L. lanceolata* ssp. *lanceolata* K10
SCH = *Schleintizia fosbergii* (Guill.)

2.4.4. Inheritance of Morphological Traits.

Pan (1985) studied several morphological traits of two F1 species hybrids: *L. diversifolia* ssp. *trichandra* K409 x *L. lanceolata* ssp. *lanceolata* K401, and *L. diversifolia* ssp. *trichandra* K409 x *L. shannoni* K405. He noted that most morphological characteristics were intermediate in their F1 hybrids: petiolar gland shape, pinnae number per leaf, leaflet number per pinna, leaflet length, floret number per inflorescence, seed shape, and seed size. Floral odor of *L. shannoni* was dominant in the F1 hybrid.

Pan (1985) studied the inheritance of several traits in intraspecific *L. diversifolia* ssp. *trichandra* hybrids. Non-pubescence of pods and stems was dominant over pubescence and drooping flower heads were dominant over erect heads. Both non-pubescence and dropping flower heads were suggested to be controlled by single loci from studies of F2s and backcrosses. Red stylar flower color may be controlled by a single gene if some of the parents mated were heterozygous for the alleles.

CHAPTER 3. MATERIALS AND METHODS

3.1. Maintenance of *Leucaena* Accessions at Hawaii.

Leucaena accessions have been collected since 1962 by Dr. Brewbaker and his colleagues. Each accession was assigned a K number (for "koa haole", a Hawaiian word for the local strain of *L. leucocephala* ssp. *leucocephala*). All accessions and their original neotropical collection sites, when known, are listed in Appendix 1 by specific epithet and K number. Of 904 accessions, 532 are *L. leucocephala*. Other accessions include *Leucaena* species and unidentified races.

Waimanalo is located at 21°N latitude at 20 m elevation. The mean annual temperature is 23.9°C, and ranges from 20.0-27.8°C. Incident light averaged 385 cal/cm^2/day and the wind averaged 8km/hr. Although the average mean annual rainfall is 1380 mm, Waimanalo only received 503 mm rainfall in 1983, 806 mm in 1984, 1024 mm in 1985 and 1125 mm in 1986. The soil is a mollisol (isohyperthermic Vertic Haplustoll). The pH in KCl is 5.2 and the base saturation is 80 % with no exchangeable Al and 15.5 meq/100g Ca.

3.2. Emasculation Technique.

The emasculation technique used was modified from Pan's (1985) method, as described by Sorensson (1982b). Flower heads were emasculated between 4:30-5:30 AM, or until pollen was shed. *L. diversifolia* ssp. *diversifolia* usually shed its pollen earlier in the morning than did L. *leucocephala*, hence it was emascualted first.

An emasculation method similar to that of Gupta and Patil (1984b) was attempted in 1983. Emasculation was made one day prior to anthesis by teasing anthers from the unopened florets and removing them with tweezers. Flowers nearing anthesis were selected by their yellowish sepals and the rounded shape and large size of the florets. The technique gave poorer results than predawn emasculation on the day of anthesis.

3.3. Pollination and Harvest Technique.

After emasculation, flowers were bagged with waxed paper pollination bags (#217 corn shoot bags, 5 cm wide and 16 cm long) cut 12 cm long. A 3.5 cm cut was made into the bag from the open end of the bag to accomodate the branch supporting the inflorescence. This second cut was made in the middle of the bag, rather than at the creases. The bag was spread open, placed over the inflorescence, and folded and stapled tightly to the branch. Subtending leaves at the nodes carrying the inflorescence, when present, were cut just above the petiolar gland on the leaf midrib; the midrib helped to keep the bags from revolving around the branch on windy days.

During the pre-dawn hours, inflorescences with healthy styles and stigmas were selected (see discussion in Hutton and Gray, 1959). If flowers were pre-dawn selected they were not bagged the day prior to anthesis, except for *L. retusa*. *L. retusa* had to be bagged the day prior to anthesis because its florets sometimes (about 10-30 %) opened the afternoon prior to anthesis.

Flowers bagged for pollen were picked off and sharply twirled inside 8 x 11 cm plastic ziploc bags to release their pollen. Pollen was pushed onto the back side of a fingernail clipper nail file, and then into stigmas. The clipper was sterilized between pollinations by wipping with paper tissues sprayed with 75 % ethanol.

In order to maintain pollen quality, 90 % of the pollen collected was used within 30 minutes after collection. Pollen stored longer often became powdery and was difficult to attach to the stigma. If it was necessary to use dry pollen, glycerin was sometimes dabbed onto the stigmas to make the pollen adhere.

Bags were marked with the pollination data with a black waterproof marker. Data included the year, day, number of cross of that day, number of stigmas pollinated, species crossed and the field designations of the parental trees, whether glycerin was used, whether the flower was emasculated, and an overall 1, 2, or 3-quality rating (low, medium and high) of the pollination. A floret was counted as having been pollinated when pollen could be seen adhering to the stigma. Low quality crosses were used for observational purposes and were not reported in Appendix 2.

Three to five days after pollination, the bags were carefully cut off. Unsuccessful pollinations resulted in floral abscission; successful pollinations produced pods. Recorded data from bags of both unsuccessful and successful pollinations were transferred to a spreadsheet on Lotus 1-2-3 [R]. Inflorescences with developing pods were marked by tying a colored polyethylene tape inscribed with information about the pollination and developing pods above the floral node.

Pods were often allowed to mature fully on the tree before being harvested. Seed damage during the last few weeks after pod maturation from the koa haole seed beetle, *Araecerus levipennis* Jordan, was sometimes extensive. In such instances, pods from important crosses were harvested green and the seeds were planted green. Larvae-infested seeds germinated well if the embryos were intact, however, seed lots had heavy losses (Chapter 4). The systemic insecticide, dimethoate (Cygon), foliarly applied to the whole tree at 0.1 % by volume (1 ml/l) did not give adequate control of *A. levipennis*.

3.4. Planting Procedures.

Accessions were planted at the University of Hawaii, Waimanalo Research Station. Seed lots of 100-1000 seeds of each provenance are permanently stored in a germplasm facility at the University of Hawaii at 35 % relative humidity and 15°C. Since many psyllid-susceptible or low-yielding accessions were not replanted, there are only about 200-400 accessions growing at the station at any one time.

Seeds were scarified with fingernail clippers by clipping them partially through the seed coat at the radicular lobe. If clipped opposite the radicular lobe, about 5 % of the germinated seedlings later died; the radicles of these seedlings had grown in circles in an attempt to find their way out of the seed coat.

Most seeds were dipped in a peat-rhizobia slurry (Rhizobium strain TAL582 from NifTAL, Maui) or by adding small amounts of the peat-rhizobia directly with the seed during planting. Uninoculated seeds generally resulted in nodulated plants, however, and suggested that water- or air-transfer of inoculum was fairly effective.

Seeds were planted individually into 3 x 15 cm dibble tubes and placed in trays containing 100 tubes (Walters, 1980). Potting medium contained 17.5 l of Canadian sphagnum peat, 9 l of vermiculite, 9 l of perlite, 120 ml of dolomitic lime, 60 ml of MagAMP, 60 ml of micronutrients and 60 ml of 16-16-16 fertilizer. Seedlings were grown in the greenhouse in partial sunlight for 2-3 months and hardened off outside the greenhouse for at least two weeks before transplanting.

Fields were disked, rotovated, and sprayed with the preemergent herbicide alachlor (Lasso) at 1.8 kg ai/ha (36 oz./A). Seedlings were planted using hand trowels, and periodically irrigated during the first year after planting. Seedlings were planted one meter apart in paired rows with two-meter alleys between the paired rows. Weeds were hoed around young seedlings and weeds around older trees were carefully sprayed with glyphosate (Roundup) at a final rate of 5 % by volume with about 50 % coverage.

3.5. *In vitro* Seed Rescue.

Seed rescue was attempted with ten semi-abortive seeds of two interspecific crosses. Green seeds were sterilized in 5 % chlorox, washed repeatedly in sterile water, and excised from their seed coats. Vacin and Went media (1949) was modified with 8 g agar, 845 ml water, 150 ml coconut water and 27.8 mg $FeSO_4.H_2O$ per liter. After three weeks, seedlings were transplanted into dibble tubes as previously described.

3.6. Microsection and Staining Technique.

Young leaves were selected from *L. collinsii* K450 and *L. esculenta* K138. Samples were fixed in FAA and dehydrated stepwise in 10 % increments in water:ethanol:tertiary butyl alcohol, using a modified procedured of Johansen (1940). Tissue was infiltrated with paraffin and embedded in paraplast. Sections (6-8 microns) were cut on a rotary microtome and stained sequentially in safranin and fast green.

3.7. Pollen Analyses.

Pollen was collected from bagged flowers as described in section 3.3. Pollen was either kept at 14 or 25°C until staining later that day in cotton blue and lactophenol stain (Maneval, 1936). Pollen diameters were measured at 400x following the procedure of Pan (1985) using a calibrated ocular grid. Diameters were measured from the inner wall next to a pore across to the opposite wall. Pollen of typical diameter and with complete cytoplasmic staining were considered viable.

3.8. Meiotic Analyses.

Meiotic inflorescences were handled in the manner cited by Pan (1985). Meiotic inflorescences were fixed at room temperature for at least five days in modified Carnoy's solution (chloroform, absolute ethanol and glacial acetic acid, 6:3:1 v:v) using a modified method of Beeks (1955). Anthers were excised and squashed in acetocarmine and Hoyer's medium (preparation cited in Radford et al., 1974). Unused inflorescences were stored in modified Carnoy's solution in a freezer at 4°C. Photographs were made with Kodak Technical Pan film using a Zeiss Photosystem III microscope. Polycontrast RCII resin-coated paper was used with a #4 Ilford filter to increase the contrast.

3.9. Analyses of Leaflet Morphology.

Youngest fully matured leaves of parents and putative hybrids were selected for all leaf measurements. Leaf maturity was determined on the basis of comparisons of leaf length and area to that of older leaves. Leaves arising at the base of branch junctions were avoided since they were larger than most leaves. Leaves were picked and immediately photocopied at 1x. Numbers of pinnae per leaf were counted both from leaves intact on the trees and from photocopies, while all other measurements were taken solely from the photocopies. Numbers of leaflets per pinna were counted from pinnae located at the midsection of leaves. Leaflet length was measured from the point of attachment of the leaflet to the rachis to the tip of the leaflet. Leaflet width was measured at the widest point. Both were measured with calipers to the nearest 0.01 cm from leaflets attached to the midsection of the pinnae which had been used for counts of leaflets per pinna.

Three leaf characteristics were determined mathematically from the following measured parameters: 1) pinnae per leaf (#1), 2) leaflets per pinna (#2), 3) leaflet length (#3) and 4) leaflet width (#4). Total number of leaflets per leaf was obtained from #1 x #2 x 0.95, where 0.95 was the mean correction factor determined from comparisons of actual to estimated numbers of leaflets per leaf for one tree each of L. diversifolia ssp. diversifolia

K156, *L. leucocephala* K8, *L. lanceolata* ssp. *sousae* K393 and *L. collinsii* K450. These species were selected since they varied among themselves in leaflet size and because their leaves were fairly uniform. Area per leaflet was determined using a regular ellipse formula utilizing #3 and #4.

Total area per leaf (which did not account for the area of the leaf midrib or pinnae midribs) was determined by multiplying the area per leaflet by total numbers of leaflets per leaf, themselves both derived estimates.

CHAPTER 4. SELF-INCOMPATIBILITY.

4.1. Results of Hand Self-Pollinations.

A total of 184 flower heads (2,805 florets) from ten *Leucaena* species were self-pollinated by hand. All inflorescences selfed were bagged prior to selfing in order to minimize outcrossing. Individual selfs are listed in Appendix 2a. Most species had ten or more inflorescences tested. *L. greggii* and *L. macrophylla* did not reach sexual maturity early enough in the study to be tested. Results from self-pollinations are presented in Table 5.

Table 5. -- Results of self-pollinations of ten *Leucaena* species: Total numbers of flower heads and florets selfed, total viable and abortive seeds harvested and the expected number of viable seeds produced from self-pollination of 100 florets. Modified from Appendix 2b.

Specific Epithet	# Pollinated		# Seeds		Viable Seeds Expected Per 100 Florets
	Heads	Florets	Viable	Aborted	
collinsii	35	467	0	14	0
div. diversifolia	31	471	805	15	171*
div. trichandra	19	305	0	0	0
esculenta	9	145	0	0	0
lan. lanceolata	12	176	0	5	0
lan. sousae	9	165	0	0	0
leucocephala	8	101	1333	7	1320
pallida	7	126	0	0	0
pulverulenta	15	225	0	0	0
retusa	14	289	45	1	16
shannoni	18	268	0	0	0
trichodes	7	77	0	0	0

* biased low due to 74 % pod drop induced by drought stress. *L. leucocephala*, in contrast, had only 10 % pod drop.

Most self-incompatible species did not set pods even after repeated self-pollinations. Other self-incompatible species, however, gave indications of partial self-compatibility, although contamination from foreign pollen could not be ruled out. These incompatibility data are summarized in Table 6.

Table 6. -- Horizontal line chart of the indications of self-compatibility in nine self-incompatible *Leucaena* species following self-pollinations (pod and seed abortion). Modified from Appendix 2b.

Specific Epithet	No Pods Set	*Average # Days to Pod Abortion	Abortive Seed Picked	Viable Seed Picked
collinsii	----------	----------	----X	
diversif. trichandra	----------	--4.0		
esculenta	X			
lanceolata lanceolata	----------	----------	----X	
lanceolata sousae	X			
pallida	X			
pulverulenta	----------	--9.5		
retusa	----------	----------	----------	----X
shannoni	X			
trichodes	X			

* Mean days from date of pollination to pod abortion date.

4.2. Possible Selfs Grown from Species Hybrid Seed.

4.2.1. *L. retusa* Selfs.

About fifty seedlings of apparent selfs from self-incompatible *L. retusa* were discovered among F1 interspecific hybrid progeny resulting from three different species hybridizations using unemasculated *L. retusa* as female (50 selfs per 442 florets, or 1.1 selfs per floret). Species combinations were *L. retusa* K280 x *L. esculenta* K138,

L. retusa K280 x L. pallida K376 and L. retusa K280 x L. diversifolia ssp. diversifolia K156. Other L. retusa were planted nearby, and rare pollen contamination can not be ruled out.

These seedlings were thought to be selfs because a) Their leaflets approximated the size and shape of leaflets of L. retusa; and b) The leaflets had the reticulated venation peculiar to L. retusa.

The photograph at the left side of Plate I shows two seedlings of L. retusa K280 x L. esculenta K138 and an apparent self. The hybrid seedlings have leaflets which are intermediate in size to that of the parents, displayed on the right. The self has large leaflets, and reticulated veins typical of L. retusa.

Verification of the possible L. retusa selfs grown from hybrid seed is incomplete; most died as seedlings and none have reached sexual maturity. Somatic chromosome counts were not made.

Dr. P. Felker at Texas A & I University had a phenologically-isolated L. retusa which probably set selfed seed (Felker, 1984, personal communication).

4.2.2. L. shannoni Selfs.

One cross, L. shannoni K445 x L. pallida K376, produced six apparent selfs on the basis of leaflet size, in addition to one hybrid. Selfs had large leaflets which looked like those of the mother tree. Hybrid leaflets were

Plate I. Fl seedlings resulting from L. retusa K280 x L. esculenta K138. The seedlings in the photograph (1.5x) at the left (top and bottom) are hybrids and have leaflets intermediate in size between those of the parents. The seedling at left center is an apparent self of L. retusa, and has large leaflets and reticulated veins typical of L. retusa. The silhouettes at the far right are 1x photocopies of typical pinnae of L. retusa K280 (left) and L. esculenta K138 (right).

intermediate in size between those of the parents (*L. pallida* has small leaflets and *L. shannoni* has large leaflets). The triploid hybrid died three months after germination. One selfed-tree flowered and its pollen stainability was determined (Table 7). Pollen stainability of the self was 25 % lower than that of the mother tree.

Table 7. -- Comparison of pollen stainability in cotton blue of normal diameter pollen of *L. shannoni* K445 and that of one of its possible selfs. Three stainable pollen classes include completely stained (filled), partially stained (partial), and unstained pollen (empty).

Species	Filled	Partial	Empty	N
	%	%	%	
L. shannoni K445	95.2	2.2	2.6	231
L. shannoni "self"	69.6	2.9	27.3	882
Stainability differences	25.6	0.7	24.7	

4.2.3. *L. lanceolata* ssp. *lanceolata* Selfs.

Apparent selfs of *L. lanceolata* ssp. *lanceolata* K10 were grown from seed harvested from the crosses of a) *L. lanceolata* ssp. *lanceolata* K10 x *L. collinsii* K450, and b) *L. lanceolata* K10 x *L. shannoni* K445. Five seedlings with leaf traits of *L. lanceolata* ssp. *lanceolata* germinated, but only three survived in the field. One seedling is normal-looking, but the other two have distorted leaves with wavy margins. The selfs did not flower during the study.

4.2.4. L. *pulverulenta* Selfs.

A possible self of L. *pulverulenta*, based on the similarity of its leaves to that of the mother tree, was the only seedling which grew from seed harvested from the cross L. *pulverulenta* K75 x L. *trichodes* K90. The seedling was the only seed of 56 (1.8 %) harvested which germinated. The seedling did not reach sexual maturity during this study.

Researchers have suggested that L. *pulverulenta* was self-fertile under certain circumstances. Bray (1986, personal communication) noted that his L. *pulverulenta* appeared to have selfed at CSIRO, Townsville. Gonzalez (1966) found L. *pulverulenta* appeared self-compatible in self-pollinations made *in vitro*.

4.3. Possible Selfs of Self-Incompatible Species Found Among Open-Pollinated Progeny.

4.3.1. L. *esculenta* Selfs.

Five probable L. *esculenta* selfs among ten open-pollinated seedlings of L. *esculenta* K898 were identified by leaflet size. *Leucaena* species growing in the area only included L. *leucocephala* ssp. *leucocephala* and one tree of L. *lanceolata* ssp. *sousae*. Five progeny had significantly larger leaflets and were determined through leaf measurements to be L. *esculenta* x L. *leucocephala*. The other seedlings had characteristics of K898, including tiny leaflets, high numbers of pinnae pairs per leaf, corky bark and angular young twigs. Comparisons of several leaf characteristics from the mother tree, a possible self, and a hybrid of *L. leucocephala* x *L. esculenta* are shown in Table 8 and Plate II. The self has slightly larger leaflets and more pinnae per leaf than the mother tree, however, it is significantly more similar to the mother tree than the hybrid for all leaf traits measured.

Table 8. -- Means and standard deviations for four leaf characteristics of the isolated *L. esculenta* K898 at the Univerisity campus, a self, and a species hybrid of *L. esculenta* K898 x *L. leucocephala* ssp. *leucocephala*.

Characteristic	*L. esculenta*	Self	Hybrid
leaflets/pinna	159.6±13.13	140.2±3.94	58.4±1.96
pinnae/leaf	36.3±3.16	39.6±2.45	14.4±0.80
leaflet length (cm)	0.303±0.01	0.400±0.02	1.080±0.05
leaflet width (cm)	0.068±0.01	0.070±0.01	0.285±0.01

Open-pollinated seed from the mother tree was largely abortive; only 5 of 30 (17 %) selected viable-appearing seeds germinated. Two selfs are still growing, but neither have flowered.

In most respects, the *L. esculenta* K898 mother tree appears to be a normal *L. esculenta*. Preliminary cytological analysis showed at least one pollen mother cell with 26 II at Prophase I, and several anaphase cells with normal chromosome separations. Although most *L. esculenta* trees in the Waimanalo arboretum are strongly winter-flowering, such as some K811's, are not.

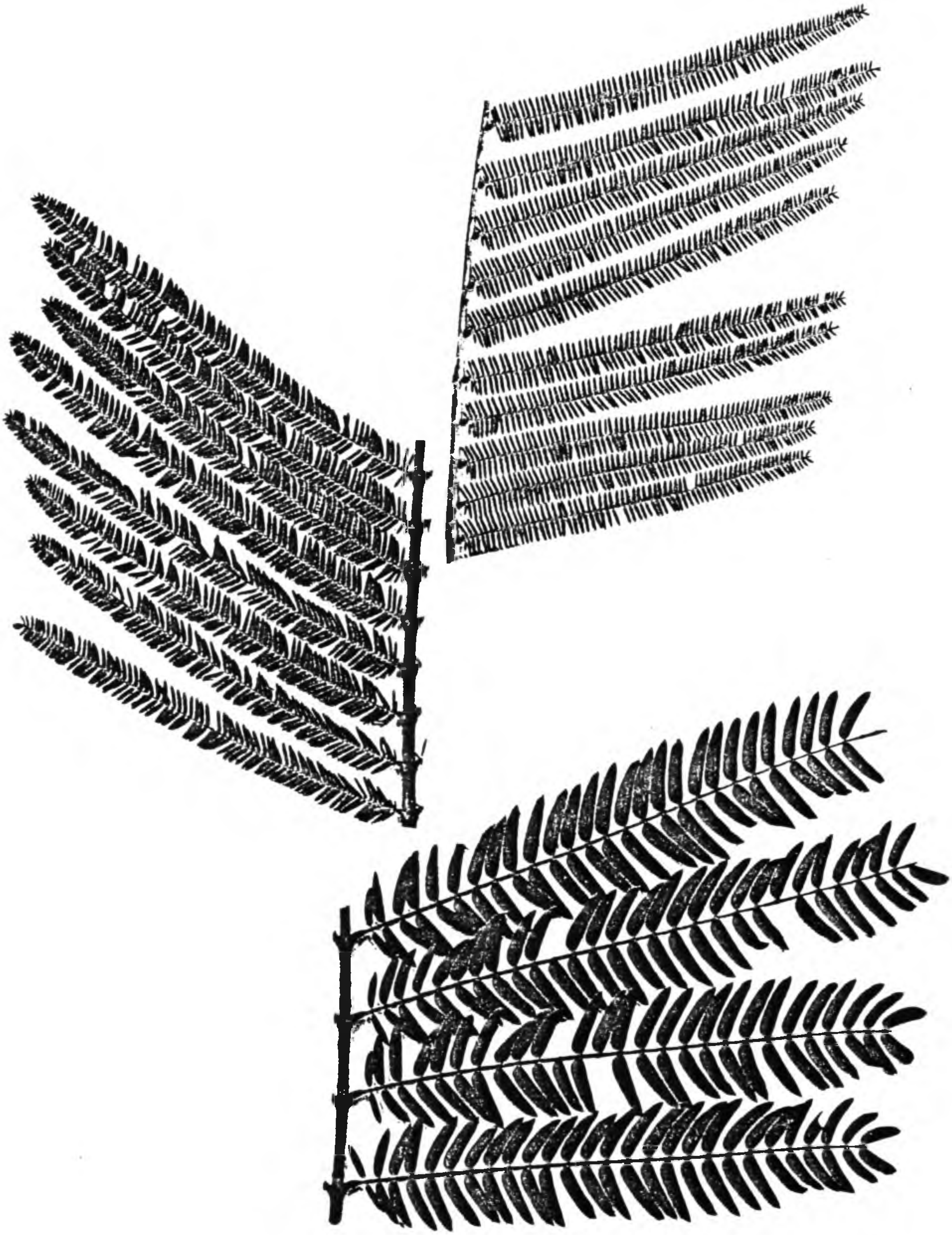


Plate II. Photocopies (1x) of midsections of leaves from L. esculenta K898 (top), a self (center left), and a species hybrid of L. esculenta K898 x L. leucocephala ssp. leucocephala (bottom).

4.3.2. *L. collinsii* Selfs.

Ten seedlings grown from open-pollinated seed collected from *L. collinsii* K450 appeared to be selfs on the basis of pubescence of twigs and leaflet size. Although intraspecific pollination may not be excluded, it was not likely as the mother tree flowered at a period during which other *L. collinsii* trees were not flowering, apparently due to drought. Selfs are vigorous and appear normal, but have not yet flowered.

4.4. Discussion of Competition Interaction and Self-Compatibility.

The only self-compatible *Leucaena* species were the two 2n=104-chromosome tetraploid species, *L. leucocephala* and *L. diversifolia* ssp. *diversifolia*. Pan (1985) showed that the gametophytic SI allele system appeared to account for self-incompatibility of *L. diversifolia* ssp. *trichandra*. Brewbaker (1986a) used Pan's account to support his hypothesis that competition interaction of SI alleles in chromosome-doubled or certain other tetraploid hybrids and/or species could account for self-compatibility.

If competition interaction (+c) accounted for self-compatibility and the SI alleles which could have competition interaction were S_1 and S_2, then the allelic complement of the self-compatible species would be either balanced diallelic ($S_1S_1S_2S_2$) or unbalanced diallelic ($S_1S_1S_1S_2$ or $S_1S_2S_2S_2$).

If a tree was a balanced diallelic, 67 % of its pollen would be +c. Unbalanced diallelics would produce 50 % +c pollen.

Hybridization among either of the self-compatible (SC) species and a self-incompatible (SI) species would, therefore, result in 50-67 % of the hybrid progeny containing both the S_1 and S_2 alleles. Frequency of self-compatible triploids would depend both on segregation of alleles and chromosomal behaviour; making the expected frequency of self-compatible triploids from an SI x SC or SC x SI species cross difficult to predict. An unreduced (3x) pollen from a triploid species hybrid which has $S_1S_2S_3$ could self-fertilize itself, and union with an unreduced (1x) egg could produce a self-compatible tetraploid $S_1S_2S_3S_4$ offspring.

Frequencies of self-compatible tetraploid species hybrids resulting from an SI x SC or SC x SI cross are predictable. In a hybrid which received S_1 and S_2 from the self-compatible species (50-67 % of the time), segregation of four alleles (e.g., $S_1S_2S_3S_4$) would result in two of every sixteen pollen (12.5 %) being S_1S_2 and therefore capable of resulting in self-pollination. All of the 50-67 % tetraploid species hybrids made from SC x SI or SI x SC matings receiving S_1S_2 gametes would be capable of self-fertilization.

To test this hypothesis, at least four flowers from each of five trees of two different tetraploid species hybrids made from SC x SI matings were hand-selfed. The hybrids were

a) L. leucocephala K8 x L. pallida K376, and b) L. diversifolia ssp. diversifolia K156 x L. pallida K376. Individual trees selected to be hand selfed were selected on the basis of heavier-than-average pod production. All self-pollinations on the ten trees failed. Competition interaction of SI alleles accounting for the self-compatibility could not be confirmed, however, due to the small number of hybrids tested, it can not be rejected. No SC species hybrids have been shown to result from SC x SI or SI x SC matings.

4.5. Mechanisms Accounting for Occasional Selfing in Self-Incompatible Leucaena Species.

Heat stress inhibits the self-incompatibility reaction in some plants (Raff et al., 1984). Bray (1986, personal communication) suggested that hot temperatures during summer could have inhibited the self-incompatibility reaction of L. pulverulenta. Periods of hot weather at Waimanalo, however, have not been correlated with successful self-pollinations on self-incompatible species.

The mentor effect (inhibition of the SI response; reviewed by Stettler and Ager, 1982) could have accounted for the all the suspected selfs, except for those arising from hand self-pollinations of L. retusa. The mentor effect could also have accounted for the suspected selfs of L. collinsii and L. esculenta which were discovered among open-pollinated seed (open-pollinated seed which was largely species hybrid seed).

As there is desagreement about the validity of the pollen mentor effect per se, and since no controlled experiments using sterilized foreign pollen were made to test for the mentor effect, it can not be concluded that the mentor effect was responsible for the production of selfs of self-incompatible Leucaena species.

Pseudo-self-compatiblity (PSC) is a condition where low frequencies of self-fertilization occur in self-incompatible plants. Stebbins (1957) considered PSC plants to be outbreeding and self-incompatible. PSC is a reversible condition lying between the extremes of complete self-incompatibility and self-fertility (Mulcahy, 1984). Denward (1963) observed in red clover that the PSC reaction ranged from complete SI to SC. East (1927) suggested that PSC was extremely common, much more so than strict SI. Genes or combinations of genes can result in weakly self-compatible plants (Leffel, 1963) and PSC is heritable (Cohen and Leffel, 1964). PSC was reported in species of Trifolium, Lilium, Brassica, Malus and others-- notably in commercial cultivars.

Most of the suspected selfs were obtained from known or apparent hybrid seed. To this extent it appears valid to call them PSC, since the mentor effect markedly enhanced the plant's ability to self-fertilize. L. retusa, however, could not be shown to have a marked increase in self-compatibility due to the mentor effect. Hand self-pollinations of *L. retusa* resulted in an average of 0.34 selfed seed per floret pollinated, whereas species hybridizations resulted in an estimated 0.11 selfs per floret pollinated.

Unequal crossing-over in the S gene, causing competition interaction by duplication of the S locus, could in rare instances account for self-compatibility in normally self-incompatible plants. Such crossovers, if they occur, are exceedingly rare.

4.6. Summary.

The source of possible selfs, and the self-incompatibility (SI) status of ten *Leucaena* species is summarized below in Tables 9 and 10.

Table 9. -- Possible and verified selfs of self-incompatible *Leucaena* species derived from hand self-pollinations (Hand), species hybrid seed (Hybrid) and open-pollinated seed (OP).

	Source of Possible Selfs		
Species	Hand	Hybrid	OP
L. collinsii			x
L. esculenta			x
L. lanceolata ssp. *lanceolata*		x	
L. shannoni		x	
L. pulverulenta		x	
L. retusa	x	x	

Table 10. -- Self-incompatiblity (SI) status of eleven *Leucaena* species grouped by chromosome number.

Species	No. Somatic Chromosomes	SI Status
L. collinsii	52	SI
L. diversifolia ssp. *trichandra*	52	SI
L. esculenta	52	SI
L. lanceolata ssp. *lanceolata*	52	SI
L. lanceolata ssp. *sousae*	52	SI
L. shannoni	52	SI
L. trichodes	52	SI
L. pulverulenta	56	SI
L. retusa	56	PSC
L. pallida	104	SI
L. diversifolia ssp. *diversifolia*	104	SC
L. leucocephala	104	SC

SI = self-incompatible.
PSC = pseudo self-compatible.
SC = self-compatible.

4.7. Research Needs.

Several areas of research are promising. *In vitro* self-pollinations (Gonzalez, 1966) and scanning electron microscopy should be tried to further describe the self-incompatibility reaction between pollen, stigmas and styles. Potted leucaenas could be allowed to flower in temperature-regulated chambers to study the effect of high temperatures on selfing. This could also test the interaction between temperature and timing of anthesis which could be useful in determining how late emasculations can be made.

The mentor effect could be tested with radioaction- or heat-sterilized pollen, however, a simpler method may also be possible. Species hybrid combinations like *L. diversifolia* ssp. *trichandra* x *L. lanceolata* ssp. *lanceolata* set hybrid seed easily (Appendix 2b), and the hybrids are morphologically separable from parental types. Pollen of both species could be mixed and pollinated on either species, and the resulting progeny searched for selfs.

The hypothesis of competition alleles accounting for the self-compatibility (SC) of the two SC tetraploid species needs to be thoroughly tested. At least 50 % of the F1 trees resulting from matings of a SC x a SI tetraploid species like *L. pallida* should be SC. Certain colchicine-induced autotetraploids of species or hybrids will be SC if competition interaction accounts for SC.

CHAPTER 5. INTERSPECIFIC HYBRIDIZATION.

5.1. Introduction to Interspecific Hybridization.

The 1420 medium and high quality interspecific crosses tested 135 of the 156 (86.5 %) combinations in a 13 x 13 diallel of eleven species and their subspecies. *L. macrophylla* was not tested as a female since it flowered for the first time in 1986 at which time flowers were nearly 100 % female-sterile. Other combinations were not tested because the species flowered in non-overlapping seasons, especially those combinations involving *L. pulverulenta* and *L. esculenta* which are strongly summer and winter-flowering, respectively.

Data summarized in this chapter are taken from Appendices 2a and 2b. All hybrids are written as female x male. Pollinations were made between 1981 and 1986 by Sorensson, Pan and Booman, as listed in Appendix 2a.

Table 11. Abbreviations for *Leucaena* species.

Species	3-letter	1-letter
1. *L. collinsii*	COL	C
2. *L. diversifolia* ssp. *diversifolia*	DV4	D
3. *L. diversifolia* ssp. *trichandra*	DV2	Z
4. *L. esculenta*	ESC	E
5. *L. lanceolata* ssp. *lanceolata*	LAN	N
6. *L. lanceolata* ssp. *sousae*	LNS	M
7. *L. leucocephala* ssp. *glabrata*	LEU	L
8. *L. macrophylla*	MAC	A
9. *L. pallida*	PAL	Y
10. *L. pulverulenta*	PUL	P
11. *L. retusa*	RET	R
12. *L. shannoni*	SHA	S
13. *L. trichodes*	TRI	T

5.2. Compatibility of Interspecific Cross-Pollinations.

Ability of the interspecific cross-pollinations to produce filled seeds is summarized in Table 12. Numbers of filled seeds are reported since seeds were often damaged by the koa seed beetle, *Araecerus levipennis* Jordan. Germination counts are not reported, since they would be reflecting insect damage, as much as viability. Table 12 lists the average percents of insect-damaged filled seeds harvested. Appendices 2a and 2b list the seed damage for individual and summarized species pollinations.

Each species combination is classified in one of six compatibility categories: a) So-- those which set no pods following cross-pollination, b) Sp-- those in which all pods set aborted prior to harvest, c) Sa-- those which only produced abortive seed, d) S?-- those which seeds were thought to be due to pollen contamination from combinations believed to be incompatible, e) <C-- those which produced less than 0.1 viable-looking seeds for every floret cross-pollinated, and f) C-- those which produced more seeds for every floret cross-pollinated.

Of the 135 of the 156 species combinations in the 13 x 13 diallel which were tested, 58 (43.0 %) produced viable seeds (C), 6 (4.4 %) produced few viable seeds (<C), 14 (10.4 %) had abortive seeds (Sa), 14 (10.4 %) had abortive pods, and 43 (31.8 %) failed to produce pods or were otherwise believed to be incompatible (So/S?).

Table 12a. -- Interspecific cross-pollination results: Compatiblity rating, numbers of flower heads, numbers of florets pollinated per cross- or self-pollination and totals for each rertility class.

Species	COL	DV4	DV2	ESC	LAN	LNS	LEU	MAC*	PAL	PUL	RET	SHA	TRI
collinsii		Sa	So	Sa	C	Sa	Sa	C	So	So	So	Sa	Sa
		7	7	8	8	16	5	4	11	1	15	12	4
		93	89	75	131	258	80	55	172	5	190	160	56
div. diversifolia	Sp		So	So	C	So	C	Sp	C	So	So	C	So
	10		24	2	8	7	3	4	27	10	5	3	2
	172		355	25	108	105	56	60	405	140	80	50	30
div. trichandra	C	C		So	C	C	<C	So	So	C	Sp	C	So
	18	71		10	8	9	8	3	14	4	11	11	9
	330	1061		140	131	125	157	45	205	72	152	176	129
esculenta	So	Sa	So		So	So	Sa	--	Sa	--	Sa	C	So
	7	14	5		10	12	4		3		5	1	3
	113	220	103		170	203	65		45		90	20	42
lan. lanceolata	C	<C	C	So		C	C	--	So	--	So	C	C
	12	12	10	9		16	6		10		5	6	11
	180	171	143	120		285	103		164		70	83	140
lan. sousae	C	Sa	Sp	S?	C		Sa	So	So	So	So	C	So
	8	8	13	7	7		8	3	8	2	9	10	5
	174	198	207	124	250		140	36	165	55	160	284	72
leucocephala	C	C	<C	C	C	So		So	C	C	C	C	C
	11	17	9	5	17	5		1	4	11	5	17	3
	165	226	142	80	260	75		10	72	155	75	252	40
pallida	<C	C	So	Sp	Sp	Sp	C	--		--	So	C	So
	14	48	69	13	14	16	14				11	19	11
	233	721	1008	266	300	277	254				200	323	172
pulverulenta	C	C	So	So	C	C	C	So	--		Sp	C	S?
	16	11	3	1	11	21	15	2			9	11	1
	241	165	45	15	165	303	215	30			130	165	15
retusa	C	C	S?	C	C	Sp	C	--	C	C		C	Sp
	3	11	9	7	10	15	8		10	2		5	5
	55	180	135	127	164	280	166		268	35		145	87
shannoni	<C	<C	C	Sp	C	C	Sp	Sp	C	Sp	C		So
	22	23	10	15	32	19	14	1	14	23	16		7
	339	343	142	194	483	285	210	15	199	345	222		73
trichodes	C	Sa	C	So	C	C	Sa	So	So	--	So	C	
	4	7	6	4	13	13	5	1	2		1	10	
	41	79	76	48	183	149	67	10	30		15	131	

* *L. macrophylla* (MAC) could not be used as female during this study.

Table 12b. Summary of compatiblity ratings.

Interspecific Compatibility		Total	% of 135	% of 156
C	Compatible	58	43.0	37.2
<C	Weakly compatible	6	4.4	3.8
Sa	Incompatible: Abortive seeds .	14	10.4	9.0
Sp	Incompatible: Abortive pods ..	14	10.4	9.0
So/S?	Incompatible: No pods or seeds	43	31.8	27.5
--	Untested	21	--	13.5

C Compatible and verified.
<C Less than one viable seed per floret pollinated.
Sa Only abortive seed collected.
Sp All pods that set aborted before harvest.
So No pods set.
S? Progeny were not hybrids; probably an incompatible combination.

Three species combinations were probably incompatible, although they produced viable-appearing seeds. These "S?" combinations produced progeny which were not morphologically intermediate between that of the species used in the cross; rather they resembled the species used as the female. This means either that the progeny were rare selfs, that they resulted from pollen contamination, or that they unreduced female gametes were stimulated to develop.

Some discrepancies exist in Table 12. For example, psyllids destroyed the pods from the crosses L. pulverulenta x L. retusa (61 pods from 130 florets pollinated) and beetle larvae destroyed all the germinable seeds of L. pallida x L. leucocephala.

Some incompatible species combinations were possibly inadequately tested and may be compatible-- therefore the interspecific compatibility percentage among the species in Leucaena as reported in this study (47.4 % of 135 tested combinations) is underestimated. One such combination which could be compatible is L. leucocephala x L. lanceolata ssp. sousae, since L. leucocephala x L. lanceolata ssp. lanceolata is compatible.

Table 13 simplifies Table 12 by showing the maximum possible compatibility of the species. For instance, if species A x species B is not compatible and species B x species A is compatible, then the combination would be listed as compatible in Table 13.

Table 13a. -- Interspecific compatibility based on combined data from reciprocal crosses. Data summarized from Table 12. Species listed at the left and top do not refer to female or male used in the pollination.

Species	COL	DV4	DV2	ESC	LAN	LNS	LEU	MAC	PAL	PUL	RET	SHA	TRI
collinsii													
div. diversifolia	Sa												
div. trichandra	C	C											
esculenta	Sa	Sa	So										
lan. lanceolata	C	C	C	So									
lan. sousae	C	C	C	So	C								
leucocephala	C	C	C	C	C	Sa							
macrophylla	C	Sp	So	--	--	So	So						
pallida	<C	C	So	Sa	Sp	Sp	C	--					
pulverulenta	C	C	C	So	C	C	C	So	--				
retusa	C	C	Sp	C	C	Sp	C	--	C	C			
shannoni	<C	C	C	C	C	C	C	Sp	C	<C	C		
trichodes	C	Sa	C	So	C	C	C	So	So	So	Sp	C	

Table 13b. -- Percentage of interspecific compatibility classes of tested and total combinations.

Compatibility Class	Total	% of 73	% of 78
C	44	60.3	56.4
<C	3	4.1	3.8
Sa	6	8.2	7.7
Sp	7	9.6	9.0
So	13	17.8	16.7
--	5	--	6.4

Table 13c. -- Percentage of combined interspecific compatibility classes of tested and total combinations.

Compatibility Class	Total	% of 73	% of 78
Compatible (C and <C) in at least one direction ..	47	64.4	60.3
Incompatible (Sa, Sp, So) in all directions tested	26	35.6	33.3
Untested (--) in either direction	5	--	6.4

C Compatible, on the basis of production of filled seed, in at least one direction.
<C Marginally compatible.
Sa Only produced abortive seed.
Sp Only produced pods which aborted.
So No pods set.
-- not tested in either direction

Of the 78 possible combinations, 73 (93.6 %) were tested in at least one direction. Of the 73 tested combinations, 47 (64.4 %) were compatible in at least one direction, and 26 (35.6 %) were sterile in the directions tested.

5.3. Expected Production of Viable Interspecific Hybrid Seed.

Appendix 2b has a column labelled "Gdsd/f". This is the average (expected) number of filled seed per floret pollinated of each species combination. The expected number of filled seeds per floret pollinated ranged from 0.01 for *L. shannoni* x *L. collinsii* (SHA x COL) to 12.94 for *L. pulverulenta* x *L. lanceolata* ssp. *lanceolata* (PUL x LAN). PUL x LAN hybrids have been unthrifty, which would indicate that ease of hybrid seed production does not guarantee a superior tree.

Table 14 is similar to the "Gdsd/f" column in Appendix 2b, except it lists how many florets a breeder must pollinate to get one filled seed (either perfect or insect-damaged), rather than the number of seeds harvested per floret pollinated. Should a breeder require 100 seeds for an experiment, 100x the number of florets listed in Table 14 should be pollinated.

Table 14. -- Average (calculated) numbers of florets which should be cross-pollinated to produce a single filled interspecific hybrid seed. Data was modified from Appendix 2b. Blanks are either untested species combinations or selfs. Females are listed down the left and males are listed across the top.

Species	COL	DV4	DV2	ESC	LAN	LNS	LEU	MAC*	PAL	PUL	RET	SHA	TRI
COL		-	-	-	3.1	-	-	0.9	-	-	-	-	-
DV4	-		-	-	0.8	-	0.4	-	0.5	-	-	1.7	-
DV2	0.4	1.8		-	0.1	0.5	11.1	-	-	0.7	-	0.3	-
ESC	-	-	-		-	-	-	-	-	-	-	2.0	-
LAN	0.3	50.0	1.1	-		0.3	5.9	-	-	-	-	0.2	7.1
LNS	0.2	-	-	-	0.1		-	-	-	-	-	0.1	-
LEU	0.8	0.1	16.7	0.8	0.3	-		-	0.1	3.6	0.8	0.1	1.9
PAL	33.3	0.9	-	-	-	-	12.5		-		-	8.3	-
PUL	0.1	0.4	-	-	0.1	0.4	0.3	-			-	0.3	1.9?
RET**	0.2	9.0	8.3?	0.4	5.6	-	0.5		2.2	0.2		0.1	-
SHA	100.0	50.0	0.9	-	0.8	7.7	-	-	1.4	-	33.3		-
TRI	0.9	-	5.5	-	0.3	1.1	-	-	-		-	5.5	

- Species combinations which did not produce filled seed.

* L. macrophylla (MAC) could not be tested as a female in this study.

** L. retusa data may be underestimated because a proportion of the seed harvested as hybrid seed often appeared to be selfed.

? Seed could not be shown to be valid interspecific hybrid seed.

5.4. Verifiable Interspecific Hybrids Grown at Waimanalo.

Table 15 summarizes the 56 interspecific hybrids which were germinated and verified. The male parent of one species hybrid grown from open-pollinated seeds could only be identified to the species level (L. macrophylla K158 x either L. lanceolata ssp. lanceolata (K162?) or x L. lanceolata ssp. sousae). Seven different species hybrids died as seedlings, but not before they could be reasonably validated as the expected hybrid. Three hybrids derived from open-pollinated seed were identified by leaf characteristics. Including the crosses by Hutton (1982b) (L. shannoni x L. leucocephala and L. lanceolata ssp. sousae x L. leucocephala), 58 Leucaena interspecific hybrids have been verified to date.

5.5. Insect Pests Which Decreased Hybridization Success.

The psyllid, Heteropsylla cubana Crawford, was the most important insect pest which limited pollination success. All pods of L. pulverulenta x L. retusa which set were killed by psyllid infestations. Caterpillars of a microlepidopteran moth believed to be a recent introduction to Hawaii, Ithome sp. nr. cincta Cresson (Gelechiidae: Chrysopeleiinae), sometimes ate as much as 20 % of the ovaries of inflorescences from L. leucocephala and L. macrophylla. Similar damage was reported on L. leucocephala in Australia from Ithome lassula Hodges (Beattie, 1981; Common and Beattie, 1982). The braconid wasp, Agathis sp. nr. cincta

Table 15. -- Fifty-six verified Leucaena hybrids grown at Waimanalo Experiment Station (selfs not included). Numbers indicate the number of trees of each species combination which could be verified. Some species hybrids were grown from open-pollinated seed.

Species	COL	DV4	DV2	ESC	LAN	LNS	LEU	MAC	PAL	PUL	RET	SHA	TRI
collinsii		-	-	-	F 2	F* 10	-	-	-	-	-	-	-
div. diversifolia	-		-	-	F 1	-	F 40	-	F 30	-	-	F 2	-
div. trichandra	F 25	F 22		-	F 35	F 15	F 4	-	-	F 1	-	F 52	-
esculenta	-	-	-		-	-	F* 5	-	-	-	-	F 1	-
lan. lanceolata	Fd 3	-	F 15	-		F 25	-	-	-	-	-	F 15	-
lan. sousae	F 5	-	-	-	F 25		-	-	-	-	-	F 25	-
leucocephala	Fd 1	F 15	-	F 12	F 9	-		-	F 80	F 18	F 2	F 15	F 4
macrophylla	-	-	F* 4	-	F? 4	-	-	-	-	-	-	-	
pallida	-	F 25	-	-	-	-	F* 1	-		-	-	Fd 2	-
pulverulenta	F 10	F 26	-	-	F 35	F 45	F 20	-	-		-	Fd 5	-
retusa	F 18	Ft 1	-	F 5	F 2	-	F 3	-	Ft 1	F 30		F 20	-
shannoni	-	-	Fd 1	-	F 10	-	-	-	Fd 1	-	F 2		-
trichodes	-	-	-	-	F 18	F 16	-	-	-	-	-	-	

* Grown from open-pollinated seed.
F Compatible species hybrid; verified.
Ft Unexpected ploidy level; tetraploid rather than triploid.
Fd All died as seedlings.
\- No viable seeds harvested, or if harvested they did not germinate or if germinated, they did not appear to be valid species hybrids.
? Four open-pollinated progenies were identified as L. macrophylla K158 x (L. lanceolata ssp. lanceolata (K162?) or L. lanceolata ssp. sousae). It was not determined which L. lanceolata subspecies was the male parent.

parasitizes, but does not effectively control *Ithome* in Hawaii.

Insects, fungi and bacteria damaged developing hybrid seeds; however, we think fungi and bacteria were generally secondary pathogens which invaded after beetles attacked the pods. *Araecerus levipennis* Jordan, the koa haole seed beetle, is our primary pod/seed pest; and damaged as much as 91 % of the viable seeds of crosses such as *L. pallida* x *L. leucocephala* (Appendix 2a). Average percentage of damaged seeds collected as selfed or species hybrid seed are presented in Table 16; average values ranged from 1.2-44.8 %.

Table 16. -- Average values for the percentage of seed damage to all viable-appearing seeds harvested as selfed or species hybrid seed from *Leucaena* species and subspecies.

Species	Average %	No. of Seeds
L. collinsii	1.2	105
L. diversifolia ssp. *diversifolia*	1.8*	1889
L. diversifolia ssp. *trichandra*	5.7*	2886
L. esculenta	11.4	10
L. lanceolata ssp. *lanceolata*	22.1	2135
L. lanceolata ssp. *sousae*	44.8	5463
L. leucocephala ssp. *glabrata*	22.8	7445
L. pallida	34.3*	901
L. pulverulenta	32.0	6422
L. retusa	9.0	2367
L. shannoni	4.1	956
L. trichodes	18.4	819

* underestimated because Dr. Pan did not take this data from his crosses.

5.6. Floral Abnormalities in *Leucaena* Species Which Decreased Hybridization Success.

Floral abnormalities in pollinations included kinked or curved styles, thin styles, or small stigmatic pores and often did not set pods when pollinated with pollen of a compatible species. Normal healthy styles which consistently set pods of compatible crosses were thick, straight, turgid, and had large stigmatic pores, except for *L. collinsii* and *L. lanceolata* ssp. *lanceolata*, which normally have rather thin pliant styles with small stigmatic pores.

Abnormal flowers occurred either in young trees or in species with over 150 florets per inflorescence (Table 17). Young trees with 30-95 % abnormal inflorescences included *L. diversifolia* ssp. *trichandra*, *L. macrophylla*, and *L. trichodes*. All species, except *L. greggii* and *L. retusa*, with over 150 florets per head had 10-70 % of the florets with abnormal styles.

5.7. Verification of Species Hybrids.

5.7.1. Overview.

Plant traits used to authenticate the species hybrids (Table 15) were a follows: leaf shape, flower color, flower size, leaf glands and floral bracts. Results are presented in Table 18. The reasoning for the use of these techniques is discussed in detail in Chapter 6.

Table 17. -- Means and standard deviations of florets per inflorescence of *Leucaena* species.

Species	K No.	Florets	N
L. collinsii	K183	219.8±11.2	4
L. collinsii	K185	218.2±12.6	5
L. diversifolia ssp. *diversifolia*	K156	78.2±5.3	4
L. diversifolia ssp. *trichandra*	K399	104.7±20.4	3
L. diversifolia ssp. *trichandra*	K409	91.4±13.3	5
L. diversifolia ssp. *trichandra*	K423	83.6±4.7	4
L. diversifolia ssp. *trichandra*	K483	138.0±11.5	5
L. esculenta	K138	107.0±9.5	5
L. esculenta	K342	158.0	1
L. greggii	K859	175.0±15.6	2
L. greggii	K864	172.4±19.5	5
L. lanceolata ssp. *lanceolata*	K10	222.8±3.7	5
L. lanceolata ssp. *lanceolata*	K162	321.8±7.6	5
L. lanceolata ssp. *lanceolata*	K257	254.0±10.5	5
L. lanceolata ssp. *lanceolata*	K264	245.2±14.7	5
L. lanceolata ssp. *lanceolata*	K401	455.8±112.6	5
L. lanceolata ssp. *sousae*	K379	450.6±21.2	5
L. lanceolata ssp. *sousae*	K384	460.4±14.3	5
L. lanceolata ssp. *sousae*	K385	484.0±5.7	5
L. lanceolata ssp. *sousae*	K393	332.6±43.2	5
L. leucocephala ssp. *glabrata*	K885	138.6±13.5	5
L. macrophylla	K158	229.6±9.7	5
L. macrophylla	K839	167.2±23.3	5
L. pallida	K748	133.8±6.7	5
L. pulverulenta	K340	42.4±7.3	5
L. pulverulenta	K19	59.6±6.2	5
L. retusa	K280	195.8±19.0	4
L. retusa	K502	183.0±19.0	5
L. shannoni	K465	171.6±12.7	5
L. trichodes	K90	118.4±13.6	5
L. trichodes	K738	117.0±4.3	5

Table 18. -- Methods of verification used to validate 56 interspecific *Leucaena* hybrids.

Species Hybrid	Ploidy	Plant Characteristics				
		Leaf Shape	Flower Color	Flower Size	Leaf Gland	Floral Bract
DV2 LAN	2x=52	x	x	x	x	
DV2 LNS	" "	x	x	x	x	
DV2 SHA	" "	x	x	x	x	
ESC SHA	" "	x	x	x	x	
LAN DV2	" "	x	x	x	x	
LAN LNS	" "	x	x	x		
LAN SHA	" "	x	x	x		
LNS LAN	" "	x	x	x		
LNS SHA	" "	x	x	x		
MAC DV2	" "	x	x	x	x	
MAC LAN?	" "	x	x	x		
SHA LAN	" "	x	x	x		
TRI LAN	" "	x	x	x		
TRI LNS	" "	x	x	x		
COL*LAN	2x=54	x	x	x		
COL*LNS	" "	x				
DV2 COL*	" "	x	x	x	x	
DV2 PUL	" "				x	
LNS COL*	" "	x				
PUL COL*	" "	x			x	
PUL LAN	" "	x			x	
PUL LNS	" "	x			x	
RET ESC	" "	x	x	x	x	x
RET SHA	" "	x	x	x	x	x
SHA RET	" "	x	x	x	x	x
RET COL*	2x=56	x	x	x	x	x
RET PUL	" "	x			x	
DV4 LAN	3x=78	x	x	x	x	
DV4 SHA	" "	x	x	x	x	
DV2 DV4	" "	x	x	x	x	
DV2 LEU	" "	x	x	x	x	
ESC LEU	" "	x	x	x	x	
LEU ESC	" "	x	x	x	x	
LEU LAN	" "	x	x	x	x	
LEU SHA	" "	x	x	x	x	
LEU TRI	" "	x	x	x	x	
LEU PUL	3x=80	x	x	x	x	
LEU RET	" "	x			x	
PUL DV4	" "		x	x		

* *L. collinsii* K450 was 2x=56.

? *L. macrophylla* x *L. lanceolata* ssp.; possibly *L. lanceolata* ssp. *lanceolata* K162.

Table 18 (continued). -- Plant traits used to authenticate 56 interspecific *Leucaena* hybrids.

Species Hybrid	Ploidy	Leaf Shape	Flower Color	Flower Size	Leaf Gland	Floral Bract
		Plant Characteristics				
PUL LEU	3x=80	x	x	x	x	
RET LEU	" "	x	x	x	x	x
DV4 LEU	4x=104	x	x	x	x	
DV4 PAL	" "	x	x	x	x	
LEU DV4	" "	x	x	x	x	
LEU PAL	" "	x	x	x	x	
PAL DV4	" "	x	x	x	x	
PAL LEU	" "	x			x	
RET DV4	4X=108	x	x	x	x	x
RET PAL	" "	x	x	x	x	x

5.7.2. Verification of *L. retusa* K280 x *L. collinsii* K450.

Fifty-six seeds of *L. retusa* K280 x *L. collinsii* K450 (RET x COL) germinated and segregated 18 seedlings with small leaflets and 38 seedlings with large leaflets. Large-leaflet seedlings were assumed to be selfs, since the small-leaflet seedlings had the expected leaflet size of the hybrid (Chapter 6.16.2), *L. retusa* was pseudo self-compatible (Chapter 4.1), and *L. collinsii* pollen was applied to unemasculated heads of *L. retusa*.

Evidence that the large-leaflet progenies are RET x COL included: a) Inflorescence placement on the trees approximated that of *L. collinsii* rather than *L. retusa* (Figure 1), b) Bark type approximated that of *L. collinsii* rather than that of *L. retusa* (Plate III), c) Floral bract type was intermediate to that of the parents (Plate IV), d) All progeny were seed-sterile (Chapter 6.9),

e) Flower color of all ten flowering trees was intermediate to the parents (Chapter 6.11.2), f) Petiolar gland shape was intermediate to the parents (Chapter 6.12), g) Percentage of pinnae pairs subtended by glands was intermediate to that of the parents (Chapter 6.13), and h) Lack of reticulated veins on the large-leaflet progenies (Chapter 6.16.2).

Figure 1. Flower heads of a large-leaflet hybrid from L. retusa K280 x L. collinsii K450. Heads are not in terminal clusters which are typical of L. retusa K280.

Plate III. Bark (1.5x) from L. retusa K280 (left) and a large-leaflet hybrid from L. retusa K280 x L. collinsii K450 (right). Bark from L. retusa is darker and rougher than that from the hybrid, and does not have the prominent lateral lenticels of the hybrid.

Plate IV. Floral bracts (10x) from L. retusa K280 (left), L. collinsii K450 (right), and a large-leaflet hybrid (middle). Filaments supporting the bracts have been removed. Hybrid bract tips are intermediate in length to those of the the parents.

Pollen mother cells of the large-leaflet progeny or L. retusa K280 x L. collinsii K450 were examined in an attempt to further authenticate its hybrid status. The progeny had 56 chromosomes (Figure 2). This was unexpected, so L. collinsii K450 was examined. L. collinsii K450 had 28 II in both Prophase and Metaphase I (Plates V, VI). L. diversifolia ssp. trichandra K399 x L. collinsii K-- was also examined and was 2x=54 (Plate VII).

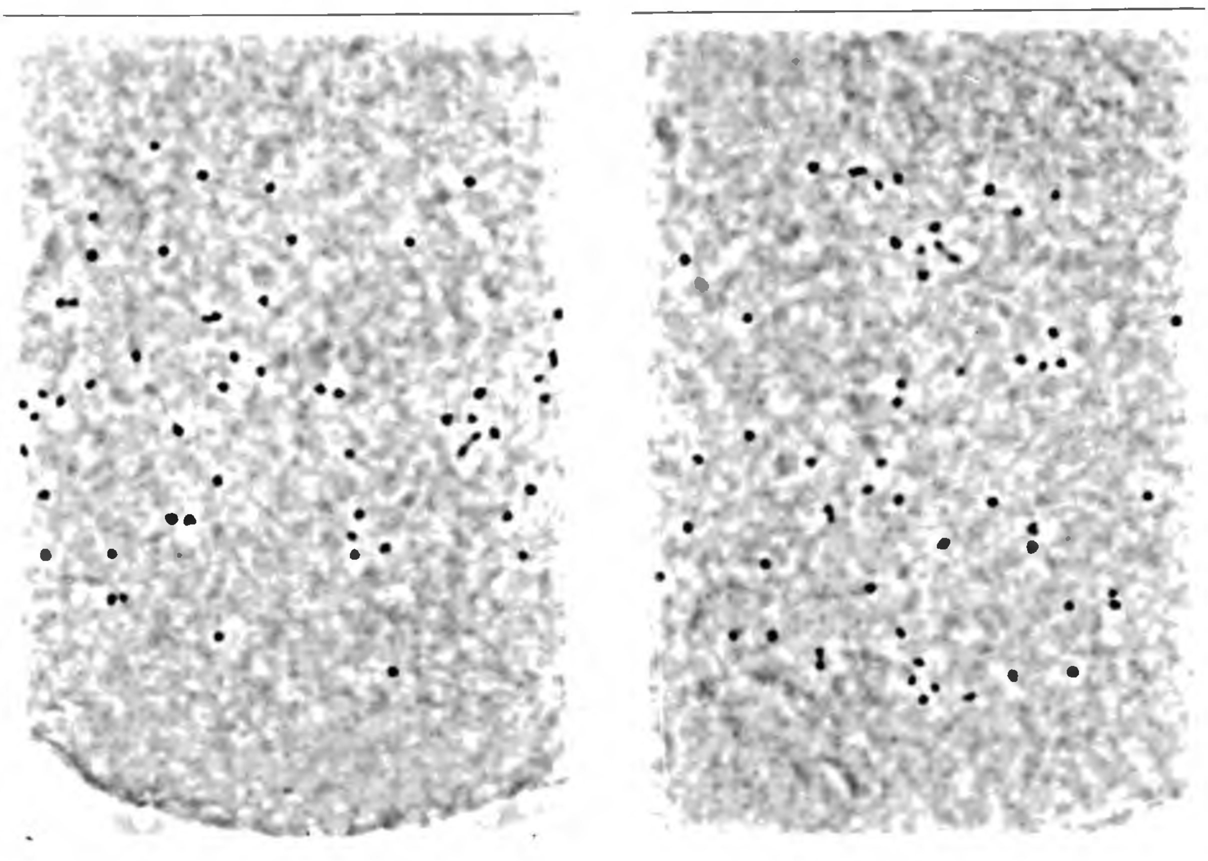


Figure 2. Prophase I meiotic chromosomes of two pollen mother cells from L. retusa K280 x L. collinsii K450. Both cells have probable 4 II + 48 I.

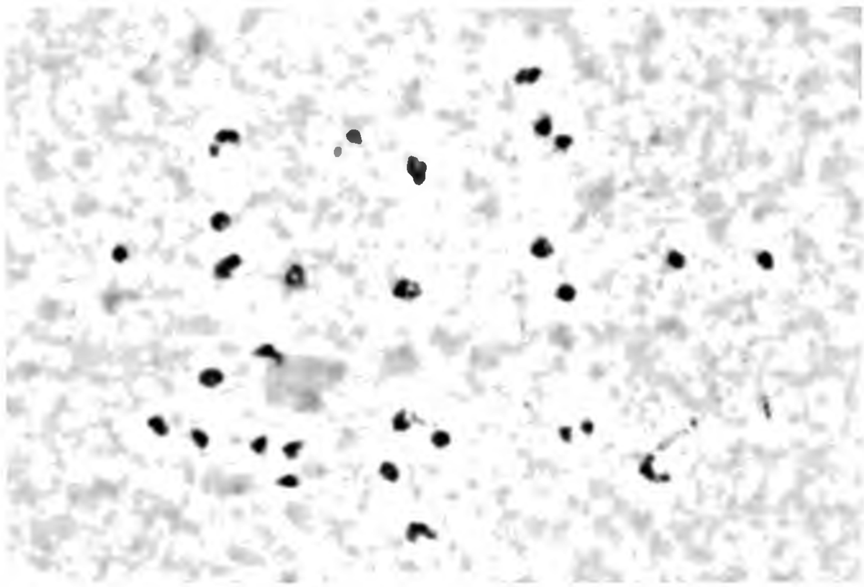


Plate V. Early diakinesis meiotic chromosomes from *L. collinsii* K450 with 28 II (2x=56).

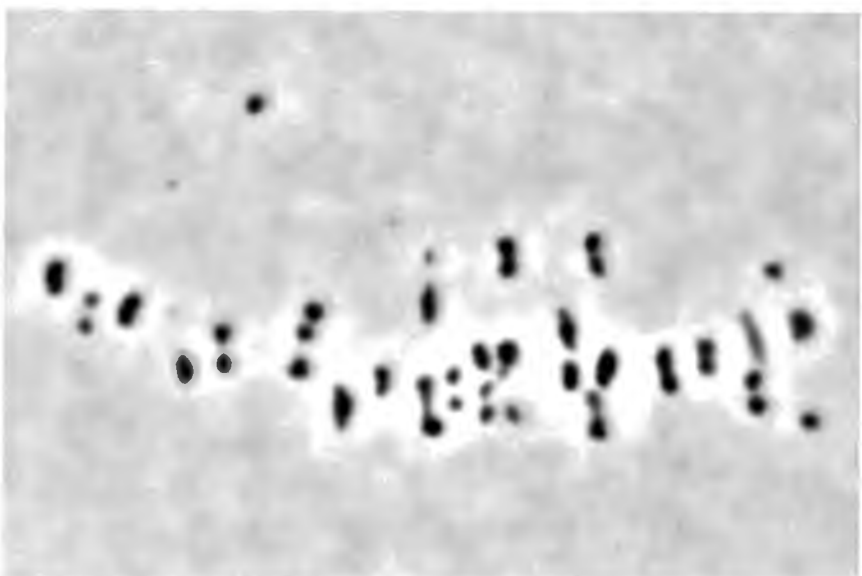


Plate VI. Late metaphase I meiotic chromosomes from *L. retusa* K280 x *L. collinsii* K450 with 28 II (2x=56).

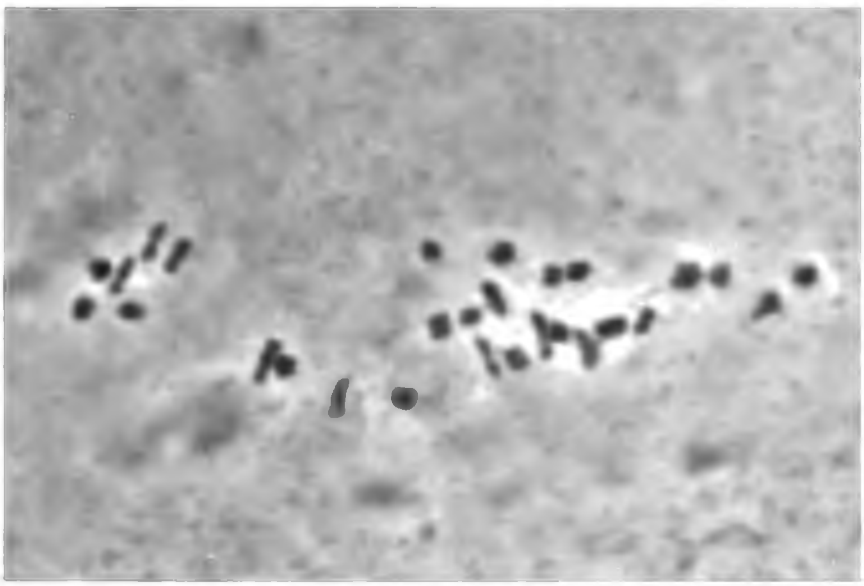


Plate VII. Metaphase I meiotic chromosomes from *L. diversifolia* ssp. *trichandra* K399 x *L. collinsii* K-- with probable 26 II + 2 I (2x=54). Univalents appear to be associated with bivalents.

5.7.3. Verification of the Ploidy Level of Tetraploid Species Hybrids Produced from Matings of Diploid x Tetraploid Species.

One verified and one probable tetraploid 4x=108-chromosome species hybrids were discovered. *L. retusa* K280 (2x=56) x *L. pallida* K376 (RET x PAL) (4x=104) produced one germinable hybrid seed from 82 pods of the cross (Appendix 2b). Pollen stainability of normal-sized pollen (42.3 microns) in cotton blue was 72.7 % of 601 pollen observed. Meiotic chromosomes of RET x PAL are shown in Figure 3.

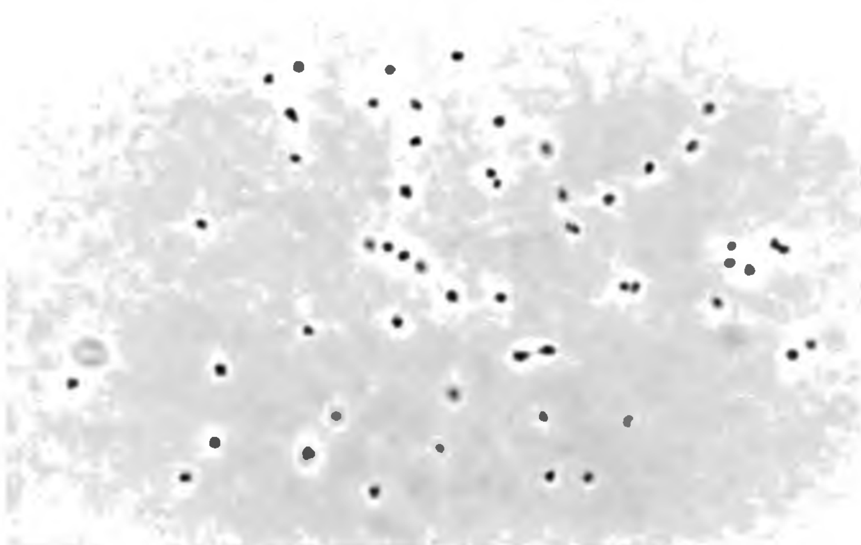


Figure 3. Prophase I meiotic chromosomes of *L. retusa* K280 x *L. pallida* K376 (4x=108) with 54 II.

Chromosomes of the tetraploid (probable 4x=108) species hybrid L. retusa K280 (2x=56) x L. diversifolia ssp. diversifolia K156 (4x=104) (RET x DV4) were not analyzed due to a scarcity of flowers. Pollen stainability of normal-sized pollen (52.7 microns) was 77.5 % of 736 pollen examined. RET x DV4 is probably a tetraploid because of its high pollen stainability, and because its pollen diameter was greater than that of either parent (L. retusa K280 had 43 micron diameter normal pollen and L. pallida K376 had 46 micron diameter normal pollen).

These hybrids probably resulted from the fertilization of an unreduced egg by a normal pollen (polyploid gametes were extensively reviewed by Veillux, 1983).

5.8. Possible Maximum Interspecific Compatibility Among Leucaena Species.

The degree of intercompatibility within the genus may be underestimated. If so, what are the compatible combinations and what is the maximum percentage of interspecific compatibility in the genus?

Three sources of information were pooled to present the information in Tables 19 and 20: a) The situations surrounding the pollination, harvest, and germinations of the species hybrids (in some cases pods broke off or aborted in response to wind or drought), and b) Possible trends in Table 12 (L. shannoni appeared to be universally capable of producing hybrids when used as a male parent; L. leucocephala

Table 19a. -- Probable species intercompatibility of eleven *Leucaena* species in all combinations. Selfs are not shown.

Specific Epithet	COL	DV4	DV2	ESC	LAN	LNS	LEU	MAC	PAL	PUL	RET	SHA	TRI
collinsii		?	I	I	C	Co	Ch	Cs	I	I	I	?	Ch
div. diversifolia	?		I	I	C	Ch	C	Ch	C	?	I	C	Ch
div. trichandra	C	C		?	C	C	C	Ch	I	Cs	?	C	Ch
esculenta	I	I	I		I	I	Co	Ih	I	Ih	?	C	I
lan. lanceolata	C	Cs	C	I		C	Cs	?	I	?	I	C	Cs
lan. sousae	C	?	Ch	I	C		?	I	I	I	I	C	I
leucocephala	C	C	Cs	C	C	Ch		Ch	C	C	C	C	C
macrophylla	Ch	Ih	Co	Ih	Ch	Ch	?		Ih	Ih	Ih	Ch	Ch
pallida	Cs	C	I	I	Ch	?	Co	I		Ih	I	C	I
pulverulenta	C	C	?	I	C	C	C	Ih	I		Cs	C	I
retusa	C	Ct	I	C	C	?	C	Ih	Ct	C		C	I
shannoni	Cs	Cs	C	Ch	C	Cs	Ch	?	C	Ch	C		?
trichodes	Cs	I	Cs	I	C	C	?	Ch	I	Ih	I	Cs	

Table 19b. Summary of probable maximum species compatibility.

Possible Intercompatibility (Not selfs)	Total	% of 156
Compatible (C, Co, Ct, Cs, and Ch)	106	67.9
Incompatible (- and Ih)	50	32.1

C Verified compatible species combination.
Co Verified compatible species combination whose hybrids originated from open-pollinated seed.
Ct Compatible combination, but the hybrid grown was tetraploid rather than triploid.
Cs Species combination which could not be verified, but which has produced seed which may have been valid viable interspecific hybrid seed.
Ch Possible compatible species combination.
I Possibly a rarely compatible species combination.
\- Tested incompatible species combination.
Ih Possible incompatible species combination.

Table 20. -- Maximum probable interspecific compatibility among <u>Leucaena</u> species of combined reciprocal crosses.

Specific Epithet	COL	DV4	DV2	ESC	LAN	LNS	LEU	MAC	PAL	PUL	RET	SHA	TRI
collinsii													
div. diversifolia	±												
div. trichandra	+	+											
esculenta	o	o	±										
lan. lanceolata	+	+	+	o									
lan. sousae	+	±	+	o	+								
leucocephala	+	+	+	+	+	±							
macrophylla	±	±	+	-	+	+	+						
pallida	±	+	o	o	±	±	+	-					
pulverulenta	+	+	±	o	+	+	+	o	-				
retusa	+	+	±	+	+	±	+	-	+	+			
shannoni	±	+	+	±	+	+	+	±	+	+	+		
trichodes	±	±	±	o	+	+	+	±	o	o	o	±	

\+ Verified (Table 17 or verified open-pollinated species hybrids) compatible interspecific combination.
± Possible compatible interspecific combination.
o Tested incompatible interspecific combination.
\- Possible incompatible interspecific combination.

Table 20b. Summary of possible maximum compatibility.

Compatibility Category	Total	% of 78
Possible compatible species combinations	62	79.5
Possible incompatible species combinations	16	20.5

appeared to be a universal parent in all combinations. L. macrophylla and L. trichodes and the L. lanceolata subspecies appeared to constitute two groups of closely related taxa, which performed similarly in interspecific hybridizations).

Tables 19 and 20 suggest that the intercompatibility among the 13 taxa tested (67.9 % and 79.5 %, respectively) is actually 24.5 % and 15.1 % higher than that shown in the corresponding tables, Tables 12 and 13. Special care should be taken, however, in utilizing these apparent values, since they need further verification.

5.9. Possible Mechanisms to Account for a High Percentage of Compatiblity among Leucaena Species.

Percentage of interspecific compatibility among species ranges somewhere between 47.4 % (Table 12) and 79.5 % (Table 20). Even the lowest value, 47.4 %, is higher than that in most plant genera.

High levels of intercompatibility in the genus could be possible if the taxonomic subdivisions were invalid. Defined on the basis of a lack of successful hybridization under natural conditions, which is one way to define species, the majority of species appear to be valid. There are unverified reports of possible hybrid swarms among L. lanceolata types near Guerrero and Oaxaca (personal communication with Hughes; Zarate, 1984), however, these are believed to be subspecific, not interspecific, swarms. Scattered trees of tetraploid hybrids between L. diversifolia ssp. diversifolia and L. leucocephala can be found scattered in Veracruz; for example, K788 and K792. There is no evidence, however, that these hybrids include more than a few scattered trees, and they clearly involve L. leucocephala trees introduced by man.

Defined on the basis of other characteristics as well, Leucaena species are well-defined. Species are delineated by their chromosome numbers, ploidy, ecological adaptation, geographical distribution, and morphology of leaves, bark, flowers, and pollen.

Pan (1985) stated that the lack of barriers to interspecific hybridization in the genus Leucaena appeared to have resulted from speciation driven primarily by geographic isolation. If so, there was no evolutionary drive to enforce species barriers through the development of species incompatibility. Even today, after man and animals have moved Leucaena species from area to area throughout Mexico, most compatible species do not appear to have extensive areas of overlap.

Pan (1985) suggested that sterility barriers could be enforced at the F2, rather than F1 generation. This could account for the lack of hybrid swarms in areas of Mexico where species have overlapping distributions (allopatric species). L. diversifolia ssp. trichandra K409 x L. shannoni

K405 F2 sibs failed completely (Pan, 1985), although backcrosses to both parents produced viable seed.

Polyploidy can act as a buffering agent to permit wide crossing. The lowest number of chromosomes in Leucaena is at least twice that of the lowest number of chromosomes of any other neotropical mimosoid genus (Lewis and Elias, 1981). Generally the geographical distributions of the tetraploid species do not overlap. Overlap between compatible diploid and tetraploid species could produce triploid interspecific hybrids. Since it is unlikely that triploids would stabilize and compete with the parental species, the need for sterility barriers between the species would be minimized.

It is only where species are allopatric, have similar ecological niches, have non-specific pollinators, flower concurrently, and have the same ploidy level, and can produce F2 seed that we would expect hybrid swarms to arise.

5.10. Unilateral Incompatibility.

Harrison and Darby (1955) described one-way or unilateral hybridization (UI) as the condition in which hybrids could be made when pollinated in only one direction. Townsend (1971) presented an excellent review of UI.

Table 21 lists the species combinations which were one-way incompatible in Table 14. Six species combinations had no indication of compatibility; these were tested by pollinating more than one hundred florets (generally 7 flower heads).

Table 21. -- Incompatible species combinations which were compatible in the reciprocal cross. Species combinations are arranged by chromosome numbers of the parents used in the cross. Data are modified from Table 12.

Incompatible Combination	Chromosome Mating	Mating	No. of Styles Pollinated	Indication of Compatibility
DV2 LNS	52 x 52	" "	207	Pods formed
DV2 TRI	" "	" "	129	--
LNS TRI	" "	" "	72	--
SHA ESC	" "	" "	194	Pods formed
SHA TRI	" "	" "	73	--
ESC RET	52 x 56	SI x PSC	90	Abortive seeds
COL PUL	" "	" SI	5	--
COL RET	" "	SI x PSC	190	--
LNS PUL	" "	SI x SI	55	--
SHA PUL	" "	" "	345	Pods formed
COL DV2	56 x 52	SI x SI	89	--
COL LNS	" "	" "	258	Abortive seeds
COL SHA	" "	" "	160	Abortive seeds
COL TRI	" "	" "	56	Abortive seeds
PUL DV2	" "	" "	45	--
PUL RET	56 x 56	SI x PSC	130	Pods formed
ESC LEU*	52 x 104	SI x SC	65	Abortive seeds
SHA LEU**	" "	" "	210	Pods formed
TRI LEU	" "	" "	67	Abortive seeds
COL LEU	56 x 104	SI x SC	80	Abortive seeds
COL PAL	" "	SI x SI	172	--
DV4 DV2	104 x 52	SC x SI	370	--
DV4 PUL	104 x 56	" "	140	--
DV4 RET	" "	SC x PSC	80	--
PAL RET	" "	SI x PSC	200	--

SI Self-incompatible.
PSC Pseudo self-incompatible.
SC Self-compatible.
* Discovered to be compatible (Table 15).
** Reported to be compatible (Hutton, 1982b)

Dropping the combinations in Table 21 which gave indications of compatibility, and those which were only tested by pollination of fewer than four inflorescences leaves ten species combinations (Table 22). The ten species combinations (Table 22) do not appear to be related. They contain matings of all ploidy levels in several combinations, and combinations of SI, PSC and SC parents in several combinations.

Table 22. -- Species combinations exhibiting unilateral incompatiblity which were tested by pollination of more than three inflorescences, and which gave no indication of compatibility. Abbreviations of species listed in Table 11. Modified from Table 21.

Incompatible Combination	Chromosome Mating*	Mating	No. Styles Pollinated	No. Heads Pollinated
DV2 TRI	52 x 52	SI x SI	129	9
LNS TRI	" "	" "	72	5
SHA TRI	" "	" "	73	7
COL RET	52 x 56	SI x PSC	190	15
COL DV2	56 x 52	SI x SI	89	7
COL PAL	56 x 104	SI x SI	172	11
DV4 DV2	104 x 52	SC x SI	370	25
DV4 PUL	104 x 56	" "	140	10
DV4 RET	" "	SC x PSC	80	5
PAL RET	" "	SI x PSC	200	11

* L collinsii K450 with 2x=56 as reported in Chapter 6.

Two types of mechanisms were cited by Harrison and Darby (1955) which accounted for unilateral incompatibility. a) Inability of pollen of SC species to grow in the styles of SI species (SI x SC fails), although the reciprocal cross is compatible (SC x SI succeeds), and b) Inability of pollen of polyploid species to successfully pollinate diploid species (diploid x polyploid fails), although the reciprocal combination (polyploid x diploid) succeeds (Rao, 1983). Table 22 lists no (0/10) SI x SC matings which were unilaterally incompatible. Table 21 has only 2 (2/25 or 8 %) SI x SC combinations which are unilaterally incompatible. Only one combination (1/10 or 10 %) in Table 22 is unilaterally compatible in a diploid x polyploid mating. Three combinations (3/25 or 12 %) in Table 22 are unilaterally compatible as diploid x polyploid matings.

A third possible mechanism which may account for UI of some species combinations is the inability of pollen from flower heads with short styles to grow the length of styles of species with longer styles. Six (6/10 or 60 %) of the combinations in Table 22 have small-headed species *L. diversifolia* ssp. *trichandra*, *L. pulverulenta*, or *L. trichodes* as males. This hypothesis may not be correct, however, because *L. diversifolia* ssp. *trichandra*, *L. pulverulenta* and *L. trichodes* were able to fertilize *L. leucocephala* (Table 12), which had long styles.

Other possible UI mechanisms are 1) Incompatibility between the hybrid embryo and maternal germplasm, 2) Incompatibility between the hybrid embryo and endosperm, and 3) Embryo-endosperm chromosomal inbalance in triploids. It is not known at this time whether these account for the observed UI combinations in *Leucaena*.

The only UI species combination which was thoroughly tested was L. diversifolia ssp. diversifolia x L. diversifolia ssp. trichandra (24 inflorescences, 355 florets, matings among ten accessions). This combinations was only tested between Veracruzan tetraploids and Central American diploids, however, leaving the possibility that matings between Veracruzan tetraploids and Oaxacan diploids could be successful. UI in this combination could be due to a embryo-endosperm chromosomal inbalance; seeds produced from diploid x tetraploid matings of L. diversifolia subspecies would have a 3x embro and 4x cotyledon, however, seeds resulting from a reciprocal mating would have a 3x embryo and a 5x cotyledon.

Most known mechanisms of unilateral incompatibility do not appear to be able to account for the observed one-way incompatibilities in Leucaena. Some "UI" species combinations may have been inadequately tested.

5.11. Summary.

This chapter discussed the results of 1420 cross-pollinations among 13 *Leucaena* species or subspecies. Of the 138 of the possible 156 (88.5 %) combinations which were tested, 64 (47.4 %) produced filled seed. Fifty-three of the 64 (82.8 %) combinations producing filled seed were grown and verified. Out of 73 of the possible 78 (93.6 %) combinations which are possible when reciprocal crosses are combined, 47 (64.4 %) produced filled seed. Maximum compatibility in the genus is 106 of 156 (67.9 %) or 62 of 78 (79.5 %) combinations.

Fifty-five of the 64 (79.7 %) combinations producing filled hybrid seed were grown and verified. Three combinations were identified from open-pollinated seedlings. Poor germination of some seed lots were often due to damage by the koa haole seed beetle, *Araecerus levipennis* Jordan.

L. collinsii K450 had 28 II chromosomes in meiosis I, *L. retusa* x *L. collinsii* had 5II + 46I and *L. diversifolia* ssp. *trichandra* x *L. collinsii* had 26II + 2I. A tetraploid *L. retusa* K280 x *L. pallida* K376 had 54 II (4x=108).

Ten species combinations from the 25 (40 %) which exhibited unilateral (UI or one-way) incompatibility had no indications of compatibility (aborted pods or seeds), and were tested by pollination of more than three inflorescences. Embryo-endosperm chromosomal inbalance may account for the UI between *L. diversifolia* subspecies.

5.12. Research Needs.

Several species combinations need further testing. These include all UI species combinations and those using *L. leucocephala* as female or male. *L. macrophylla* was not used as a female in this study. *L. greggii* was not tested in any species combinations.

Mechanism(s) accounting for incompatiblity between species need qualification; particularly with regard to pollen tube growth and to hybrid endosperm development. *In vitro* pollinations and scanning electron microscopy should be used to study the pollen tube growth on stigmas and in styles. Embryo culture should be tested to see if the 25 hybrid combinations producing abortive seeds, or filled seeds which did not germinate, could be grown and verified. Seed damage from *Araecerus* needs to be minimized.

Pollen storage techniques have not been successful in *Leucaena*, however, it is necessary to enable species combinations to be tested whose flowering seasons do not overlap. Growth chambers could be used to manipulate flowering seasons of species.

Relationships between interspecific compatibility and ploidy may be explored by doubling the chromosome-complement of diploid species and retesting their species compatibility. Unreduced gametes and three-way species crosses are other avenues which may circumvent incompatibility barriers.

Chapter 6. Germination, Growth, Psyllid Resistance, and Morphological Analyses of Interspecific *Leucaena* Hybrids.

6.1. Introduction.

Verified interspecific *Leucaena* hybrids which survived in the field, their germination and growth, their morphology, and the reasoning behind the plant characteristics used in Chapter 5 to authenticate species hybrids are presented in this chapter. All interspecific hybrids are written female x male, and all refer to the first generation F1 hybrid. Species abbreviations are listed in Table 11.

6.2. Germination of Interspecific Hybrid Seeds.

Germination rates are not presented due to biases caused by generally heavy damage from the koa haole seed beetle, *Araecerus levipennis* Jordan, and to small numbers of seeds (about 10-20). Filled seeds without insect damage germinated even if seed size was considerably smaller than than that of the parental types, such as in hybrids from *L. diversifolia* ssp. *trichandra* x *L. lanceolata* ssp. *sousae*, which had 100 % germination of twenty seeds.

Numbers of filled and aborted seeds from interspecific hybrids are given in Appendices 2a and 2b. Germination percents were estimated for each species combination in Appendix 2b under the column "Gdsd/f" (good seed per floret). This column contains the calculated average number of filled seeds produced from the interspecific pollination of a floret.

6.3. Field Mortality of Interspecific Hybrid Seedlings.

Vigorous seedling growth during the first week after germination was positively correlated with low field mortality. Four interspecific crosses which had good germination rates, but which had high rates of field mortality, were *L. retusa* K280 x *L. collinsii* K450 (58.3 % mortality of 60 seedlings), *L. leucocephala* K8 x *L. shannoni* K405 (95 % of 20 seedlings), *L. pulverulenta* K340 x *L. collinsii* K450 (93 % mortality of 71 seedlings) and *L. pulverulenta* K19 x *L. shannoni* K405 (93 % mortality of 14 seedlings).

6.4. *In Vitro* Seed Rescue of Semi-Abortive Interspecific Hybrid Seeds.

Seed rescue techniques were used to grow seed of *L. diversifolia* ssp. *trichandra* x *L. shannoni* (DV2 x SHA) and *L. diversifolia* ssp. *trichandra* x *L. leucocephala* (DV2 x LEU). None of the seeds harvested as these hybrids grew when planted as described in Chapter 3.4. Seeds excised from their seed coats germinated better and grew more vigorously than non-treated seeds, however, bacterial and fungal contamination lowered the success rate from 75 % to 10 % of the 20 seeds tested. The DV2 x SHA hybrid grown was unthrifty, and died 60 days after transplanting. The DV2 x LEU hybrid is growing vigorously in the field.

6.5. Growth Rates of Interspecific Hybrids.

Above-ground biomass was not estimated for the interspecific hybrids, because it was uncertain whether the biomass formulae derived from L. leucocephala (Kanazawa, 1981; Pecson, 1985) would be applicable to trees as varied in shape and branchiness as the interspecific hybrids. Tables 23-25 list the rates of growth of 50 species hybrids; rates range from 0.2-4.3 m/yr.

Species combinations which averaged over 2 m/yr included 14/28 (50 %) diploid hybrids, 4/14 (29 %) triploid hybrids, and 5/8 (63 %) tetraploid hybrids. Species combinations which averaged over 3 m/yr included 6/28 (21 %) diploid hybrids, 1/14 (7 %) triploid hybrids, and 1/8 (13 %) tetraploid hybrids.

Environmental conditions during the study have been unusually harsh due to both drought and psyllids. Many of our previously exceptional L. leucocephala did not grow appreciably (<1 m/yr) since the introduction of the psyllids into Hawaii in 1984. Growth rates of 2 m/yr of a L. leucocephala accession would indicate it had unusually high psyllid-tolerance. L. pulverulenta x L. leucocephala and its reciprocal cross both had low average growth rates (1.3 m/yr) due to psyllid damage; however, it is capable of exceptional growth in psyllid-free environments (Chapter 2.4.2). Probably all hybrids which had low growth rates would have grown significantly faster without psyllids.

Table 23. -- Average age and and height, and growth rates of 28 diploid interspecific Leucaena hybrids. Interspecific hybrids arranged by chromosome number.

Female	K#	Male	K#	Ploidy	N	Age	Height	Growth Rate
						days	m	m/yr±std. dev.
DV2	K409	LAN	K10	2x=52	17	1284	6.2	1.75±0.61
DV2	K409	LNS	K393	" "	3	660	3.9	2.30±2.29
DV2	K409	SHA	K405	" "	43	1139	4.3	1.45±0.70
ESC	K138	SHA	K445	" "	1	795	5.7	2.62
LAN	K10	DV2	B85***	" "	12	481	3.5	2.68±0.60
LAN	K10	LNS	K393	" "	15	485	4.5	3.45±0.71
LAN	K10	SHA	K445	" "	13	1022	5.0	1.82±0.38
LNS	K393	LAN	K10	" "	23	485	5.5	4.19±0.84
LNS	K393	SHA	K445	" "	11	708	6.7	3.57±0.83
MAC	K158	DV2	K--	" "	1	1160	1.2	1.20
MAC	K158	LAN?	K--	" "	3	1057	7.9	2.72±0.31
SHA	K445	LAN	K10	" "	5	494	4.2	3.15±0.93
TRI	K738	LAN	K10	" "	9	487	3.3	2.46±1.36
TRI	K738	LNS	K393	" "	8	489	4.5	3.38±1.03
COL**	K183	LAN	K254	2x=54	2	833	4.9	2.42±1.17
COL**	K450	LNS	K393	" "	1	480	0.6	0.46
DV2	B409	COL**	K183	" "	25	963	7.7	3.40±1.49
DV2	K409	PUL	K19	" "	1	1162	0.6	0.19
LNS	K393	COL**	K450	" "	1	1006	0.5	0.18
PUL	K340	COL**	K450	" "	5	651	0.9	0.50±0.67
PUL	K19	LAN	K10	" "	12	1057	1.8	0.65±0.49
PUL	K19	LNS	K393	2x=54	22	1177	1.8	0.61±0.39
RET	K280	ESC	K138	" "	4	1109	4.1	1.33±0.22
RET	K502	LAN	K10	" "	2	795	1.3	0.60±0.39
RET	K280	SHA	K445	" "	16	1030	4.0	1.42±0.77
SHA	K445	RET	K280	" "	1	795	6.1	2.80
RET	K280	COL**	K450	2x=56	16	799	4.3	2.48±1.40
RET	K280	PUL	K881	" "	1	560	2.3	1.50
Averages							3.8	1.94

* Mean age in days from transplanting to measurement date.
** L. collinsii K450 is 2x=56 (Chapter 5.6.2).
*** Intraspecific hybrid of K409 x K480.
? Unidentified male, either L. lanceolata ssp. sousae or L. lanceolata ssp. lanceolata (K162?).

Table 24. -- Average age and height, and growth rates of 14 triploid interspecific *Leucaena* hybrids. Interspecific hybrids arranged by chromosome number.

Female	K#	Male	K#	Ploidy		N	Age*	Height	Growth Rate
							days	m	m/yr±std. dev.
DV4	K156	LAN	K10	3x=78		1	646	6.4	2.37
DV4	K156	SHA	K405	"	"	2	1030	0.7	0.25±0.92
DV2	K409	DV4	K156	"	"	22	1310	6.7	1.85±1.01
DV2	K11	LEU	K8	"	"	2	646	6.4	3.62
ESC	K898	LEU	K--	"	"	2	527	2.2	1.42±0.05
LEU	K8	ESC	K138	"	"	9	986	6.6	2.62±0.90
LEU	K42	LAN	K264	"	"	8	830	2.8	1.33±0.44
LEU	K8	SHA	K405	"	"	2	700	0.7	0.02±
LEU	K8	TRI	K738	"	"	3	1123	5.9	1.93±0.15
LEU	K614	PUL	K75	3x=80		17	1036	3.5	1.29±0.65
LEU	K8	RET	K280	"	"	2	1132	3.1	0.99±0.10
PUL	K19	DV4	K156	"	"	23	1057	7.2	2.66±1.20
PUL	K19	LEU	K8	"	"	18	1716	6.1	1.31±0.59
RET	K280	LEU	K500	"	"	3	1295	5.3	1.48±0.65
Averages								4.5	1.65

* Days from transplanting to measurement date.

Table 25. -- Average age and height, and growth rates of eight tetraploid interspecific *Leucaena* hybrids. Interspecific hybrids arranged by chromosome number.

Female	K#	Male	K#	Ploidy		N	Age*	Height	Height Rate
							days	m	m/yr±std. dev.
DV4	K156	LEU	K500	4x=104		36	1080	7.8	2.62±0.39
DV4	K156	PAL	K376	"	"	20	670	6.7	4.2/±1.37
LEU	K8	DV4	K156	"	"	15	708	4.0	2.19±1.16
LEU	K8	PAL	K376	"	"	76	967	5.0	1.9/±0.89
PAL	K376	DV4	K165	"	"	10	1239	8.0	2.36±0.57
PAL	K376	LEU	K--	"	"	1	362	2.8	2.82
RET	K280	DV4	K156	4x=108		1	795	2.8	1.29
RET	K280	PAL	K376	"	"	1	591	3.0	1.85
Averages								5.0	2.42

* Days from transplanting to measurement date.

Growth rates in Table 26 are shown as percentages of the fastest average rate of growth of all species hybrids, 4.27 m/yr -- *L. diversifolia* ssp. *diversifolia* K156 x *L. pallida* K376.

Growth rates in Table 27 are shown as percentages of the fastest growth rate of any individual hybrid tree, *L. diversifolia* ssp. *trichandra* K399 x *L. collinsii* K-- -- 6.19 m/yr. Thirty species hybrids had at least one tree which had greater than 3 m/yr growth rate. These hybrids included 18 (60 % of the 30) diploid hybrids, 7 triploid hybrids (23 % of the 30), and 5 (17 % of the 30) tetraploid hybrids.

6.6. Comparisons of Growth Rates of Interspecific *Leucaena* Hybrids and Parental Species.

Species hybrids planted during this study were not generally managed to enable statistically valid comparisons to be made between species hybrids and their parents; however, several plantings grew as mixed plots of hybrids and parents (Table 28). Statistical value of the data are limited due to small numbers of trees, unreplicated plots, and overshading of parental trees by hybrid trees. Hybrids consistently outgrew parental species by 150-246 %.

Table 26. -- Growth rates of 54 interspecific *Leucaena* hybrids shown as percents of 4.27 m/yr-- the average growth rate of the *L. diversifolia* ssp. *diversifolia* x *L. pallida*, which had the fastest overall growth rate.

	COL	DV4	DV2	ESC	LAN	LNS	LEU	MAC	PAL	PUL	RET	SHA	TRI	$\bar{X}$*
	%	%	%	%	%	%	%	%	%	%	%	%	%	
L. collinsii	-	-	-	-	57	11	-	-	-	-	-	-	-	34
L. d. diversifolia	-	-	-	-	56	-	61	-	100	-	-	0	-	72
L. d. trichandra	80	43	-	-	41	54	85	-	-	4	-	34	-	49
L. esculenta	-	-	-	-	-	-	33	-	-	-	-	61	-	47
L. l. lanceolata	-	-	63	-	-	81	-	-	-	-	-	43	-	62
L. lan. sousae	0	-	-	-	98	-	-	-	-	-	-	84	-	91
L. leucocephala	0	51	-	61	31	-	-	-	76	30	23	0	45	45
L. macrophylla	-	-	28	-	64?	-	-	-	-	-	-	-	-	46
L. pallida	-	55	-	-	-	-	66	-	-	-	-	0	-	61
L. pulverulenta	0	62	-	-	15	14	31	-	-	-	-	0	-	31
L. retusa	58	30	-	31	14	-	35	-	43	35	-	33	-	35
L. shannoni	-	-	0	-	74	-	-	-	-	-	66	-	-	70
L. trichodes	-	-	-	-	58	79	-	-	-	-	-	-	-	69

* Average percentage of species hybrids with greater than 0 % of the growth rate of *L. diversifolia* ssp. *diversifolia* x *L. pallida*.
? Male is one of the *L. lanceolata* ssp., possibly *L. lanceolata* ssp. *sousae*.

Table 27. -- Growth rates of 54 interspecific *Leucaena* hybrids shown as percents of 6.2 m/yr-- the growth rate of *L. diversifolia* ssp. *trichandra* K399 x *L. collinsii* K--, which was the fastest growth rate of any hybrid tree observed.

	COL	DV4	DV2	ESC	LAN	LNS	LEU	MAC	PAL	PUL	RET	SHA	TRI	$\bar{X}$*
	%	%	%	%	%	%	%	%	%	%	%	%	%	
L. collinsii	-	-	-	-	52	7	-	-	-	-	-	-	-	30
L. d. diversifolia	-	-	-	-	38	-	56	-	89	-	-	0	-	61
L. d. trichandra	100	49	-	-	50	79	58	-	-	3	-	54	-	56
L. esculenta	-	-	-	-	-	-	23	-	-	-	-	42	-	33
L. l. lanceolata	-	-	55	-	-	69	-	-	-	-	-	42	-	55
L. lan. sousae	0	-	-	-	84	-	-	-	-	-	-	68	-	76
L. leucocephala	0	71	-	65	30	-	-	-	71	45	17	0	33	47
L. macrophylla	-	-	19	-	-	49?	-	-	-	-	-	-	-	34
L. pallida	-	46	-	-	-	-	46	-	-	-	-	0	-	46
L. pulverulenta	0	71	-	-	27	24	46	-	-	-	-	0	-	32
L. retusa	69	21	-	26	14	-	31	-	30	24	-	46	-	33
L. shannoni	-	-	0	-	78	-	-	-	-	-	45	-	-	62
L. trichodes	-	-	-	-	63	69	-	-	-	-	-	-	-	66

* Average percentage of species hybrids with greater than 0 % of the growth rate of *L. diversifolia* ssp. *trichandra* x *L. collinsii*.
? Male is one of the *L. lanceolata* ssp., possibly *L. lanceolata* ssp. *sousae*.

Table 28. -- Comparison of growth rates of species hybrids with that of the parental species used as female. Data taken from observation nurseries in Waimanalo, Hawaii.

Hybrid or Species	K#	No. of Trees	Tree Height	Age of Tree*	Growth Rates	%
			m	days	m/yr	%
1. DV2 x COL	K399 x K--	8	7.6 ± 0.5	508	5.5	172
DV2	K399	22	4.5 ± 1.1	" "	3.2	100
2. LEU x PAL	K8 x K376	13	6.1 ± 1.6	695	3.2	246
LEU	K8	5	2.5 ± 1.2	" "	1.3	100
3. MAC x LAN?	K158 x K--	3	7.9 ± 0.9	1045	2.8	175
MAC	K158	18	4.6 ± 1.7	" "	1.6	100
4. PUL x LEU	K19 x K8	6	12.8 ± 1.6	3205	1.5	150
PUL	K19	2	9.2 ± 0.9	" "	1.0	100

? Unknown male; either L. lanceolata ssp. sousae or L. lanceolata ssp. lanceolata (K162?).
* Between measuring date and date that seedlings were transplanted to the field.

6.7. Winter Rootstock Survival of Leucaena Species Hybrids.

Leucaena species and species hybrids were planted in a cold-tolerance trial at Bogalusa, Louisiana in the summer of 1985 under a grant from Crown Zellerbach to the University of Hawaii to Dr. Brewbaker. Tree survival and average plot heights were measured one year later (Table 29). L. leucocephala K8 x L. pallida K376 (55 % survival, 2.4 m/yr) and L. leucocephala K8 x L. diversifolia K165 (55 % survival, 2.1 m/yr) had the best overall survival and growth rates. Both hybrids outperformed their parents (Table 30).

6.8. Psyllid Resistance of Species and Hybrids.

Our 1986 paper on psyllid resistance of Leucaena species and interspecific hybrids is presented in Appendix 3. The

Table 29. -- Winter survival and average growth rates of surviving one-year old interspecific *Leucaena* hybrids at Bogalusa, Louisiana. Data of Crown Zellerbach, November, 1986.

Species Hybrid	Parents	Survival		Plot Heights	Plots
		%	Trees	m/yr	
LEU x PAL	K8 x K376	55	(11/20)	2.4	1
LEU x DV4	K8 x K165	55	(22/40)	2.1±1.3	2
LEU x ESC	K8 x K138	55	(11/20)	0.9	1
(DV4 x LEU)xLEU	K743 x K500	35	(7/20)	2.1	1
(DV4 x LEU) OP	K743	31	(25/80)	1.5±0.6	4
(DV4 x LEU)self	K743 self	20	(4/20)	1.2	1
LEU x RET	K8 x K280	20	(4/20)	0.9	1
(PUL x LEU) OP	K75 OP	19	(27/140)	1.2±0.5	8
(DV4 x LEU)xDV4	K743 x K156	15	(6/40)	1.2±0.0	2
(DV4 x LEU) sib	K743 x K743	15	(3/20)	1.2	1
(PUL x LEU) OP	K19 OP	15	(3/20)	1.8	1
PUL x COL	K75 x K450	5	(1/20)	0.6	1
RET x COL	K280 x K450	0	(0/20)	--	1

Table 30. -- Winter survival and average plot height of surviving one-year old *Leucaena* species at Bogalusa, Louisiana. Data of Crown Zellerbach, November, 1986.

Species Hybrid	Parents	Survival		Plot Heights	Plots
		%	Trees	m/yr	
L. leucocephala	K770	65	(13/20)	1.8	1
L. diversifolia	K146	45	(9/20)	2.1	1
L. leucocephala	K8	37	(44/120)	0.9±0.4	5
L. leucocephala	K636	28	(22/80)	0.8±0.4	4
L. esculenta	K682	25	(5/20)	0.3	1
L. diversifolia	K156	18	(14/80)	1.4±0.9	3
L. diversifolia	K145	5	(1/20)	0.9	1
L. pallida	K178	5	(1/20)	0.6	1
L. collinsii	K450	0	(0/20)	--	1
L. "guatemalensis"	K740	0	(0/20)	--	1
L. gregggii	K744,K756-K765	0	(0/220)	--	11
L. macrophylla	K158	0	(0/20)	--	1
L. retusa	K503,K506	0	(0/40)	--	2

paper lists the range of psyllid tolerance in terms of damage and numbers of psyllids on twelve species and 51 verified interspecific hybrids observed at Waimanalo, Hawaii, between 1984 and early 1987. One hybrid in the paper, L. diversifolia ssp. diversifolia x L. lanceolata ssp. sousae was later found invalid; all other hybrids were valid.

Most hybrids had psyllid resistance intermediate to their parents. Species hybrids made between a highly resistant parental species, L. collinsii, L. esculenta, or L. pallida, and a susceptible species, like L. pulverulenta or most L. leucocephala, produced hybrids with better resistance than those between moderately resistant and susceptible species. Direction of the cross did not appear to affect the psyllid rating of the hybrids. L. retusa was generally resistant to the psyllid, however, the tetraploid hybrid of L. retusa K280 x L. diversifolia ssp. diversifolia K156 appeared to have more psyllid damage than that found on either parent. L. pulverulenta K19 x L. diversifolia ssp. diversifolia K156 appeared to have psyllid resistance similar to or greater than the that of the L. diversifolia parent (Figure 4).

Figure 4. Highly psyllid-resistant *L. pulverulenta* K19 x *L. diversifolia* ssp. *diversifolia* K156 three years (1000 days) after transplanting)

Several *L. esculenta* accessions had high psyllid populations and heavy psyllid damage on young leaves up to three months after transplanting, after which the trees became highly psyllid resistant. Mature trees were occasionally damaged by psyllids for a few days following frequent rains. These trees had at least one thing in common-- the shiny transparent mucilaginous leaf exudate usually found on L. esculenta leaves was not present. This mucilage coats young leaves and twigs and is generally lacking on older leaves. The mucilage became a soft gel after rains and was easily stripped off by pulling the leaves. Frequent rains soften and gradually remove the mucilage from L. esculenta leaves. The gel was colorless and tasteless. Three branch tips of L. esculenta K813 were bagged with corn pollination bags to protect the mucilage from rains; however, these bagged leaves did not produce mucilage and were heavily damaged by psyllids. Unbagged leaves on the same tree had mucilage and were psyllid-free.

Figure 5 shows a longitudinal microsection of a gland on a young leaf of L. esculenta K138. Glands were scattered along the rachises and midrib.

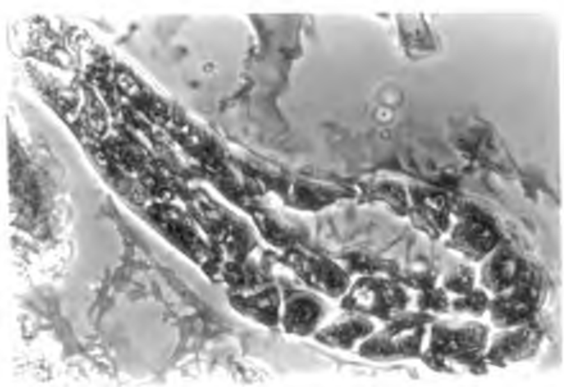


Figure 5. Gland (31.5x) of a young L. esculenta K138 leaf embedded in a matrix of mucilage, and containing mucilage (arrow). Serial slices showed the area containing mucilage to be a cavity and not a channel leading to the exterior of the gland.

The gland in Figure 5 has a mucilaginous cavity, and lies in a mucilaginous matrix, as did the young leaflets (not pictured). Not all glands observed had cavities, but all were composed of cells which were several times larger than those composing the leaflets. Similarly-shaped glands, produced mucilage in Selaginella species (Bilderback, 1987).

Mucilage-covered leaves may repel psyllids in one of at least four ways: 1) Repellent chemicals embedded in the mucilage, 2) Psyllids are repelled by the stickyness of the mucilage, 3) Mucilage is too soft for the psyllids to grip the plant surface to probe for sap, and/or 4) Psyllids do not receive the mechanical cues associated with host plants and therefore do not probe the tissue.

In lab tests using water-extracted mucilage (applied to filter paper and dried at 40^{o}C under vacuum), psyllids were not visibly repelled by the mucilage (#1); however, extraction procedures may have altered or removed the compound(s). Psyllids avoided or became stuck in mucilage-treated filter paper after water was misted over the paper, causing the mucilage to soften and become sticky (#2). To probe a vascular bundle, psyllids must grip the plant (#3) in order to push their stylets tip deep enough into the plant to be held fast, since their stylets are under tension (Ullman and McLean, 1986). Leaf surface mechanoreception (#4) was postulated by antennae (Moran and Brown, 1973) and by hairs on the legs (Ullman, 1987, personal communication).

L. collinsii is highly psyllid resistant (Appendix 3); however, its mechanism of resistance does not appear to be similar to that postulated for *L. esculenta*. Figure 6 shows young leaflets of *L. collinsii* K450 stained sequentially in safranin and fast-green. No glands were observed on rachises; however, most leaflet tips had darkly-staining bodies which could be involved in psyllid resistance.

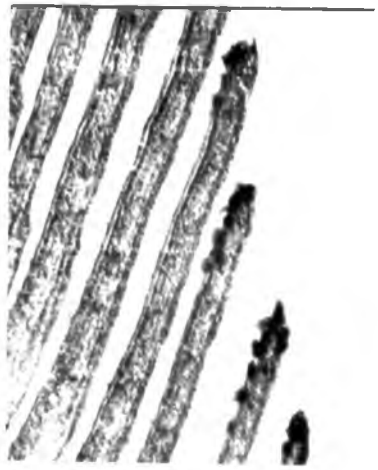


Figure 6. Thin sections (4.67x) of young leaflet tips of *L. collinsii* K450. Leaflet tips have darkly-stained secretions/bodies.

6.9. Open-Pollinated Pod Set and Percentage of Filled Seeds Produced by F1 Interspecific *Leucaena* Hybrids.

Table 31 lists the percentage of pods set from open-pollination of 50 interspecific hybrids which survived in the field. Tetraploid hybrids had the highest mean open-pollinated pod set (80 %), triploid hybrids the lowest (33.3 %), and diploid hybrids had 53.6 % pod set. Similarly, the highest mean percentage of filled seeds in pods was that of tetraploid hybrids (59 %), followed by diploid (29 %) and triploid species hybrids (25 %).

Table 31. -- Open-pollinated pod and seed set of 50 *Leucaena* interspecific hybrids arranged by chromosome number. Code: + = Yes - = No.

Female	K	Male	K	Chromosome Number		N	Flowers?	Pods Set?	Filled Seed?	Approx. Seed %
DV2	K409	LAN	K10	2x=52		17	+	+	+	60
DV2	K409	LNS	K393	"	"	3	+	+	+	40
DV2	K409	SHA	K405	"	"	43	+	+	+	60
ESC	K138	SHA	K445	"	"	1	+	-		
LAN	K10	DV2	B85	"	"	12	+	+	+	40
LAN	K10	LNS	K393	"	"	15	+	+	+	20
LAN	K10	SHA	K445	"	"	13	+	+	+	30
LNS	K393	LAN	K10	"	"	23	+	+	+	20
LNS	K393	SHA	K445	"	"	11	+	+	+	30
MAC	K158	DV2	K--	"	"	2	+	-		
MAC	K158	LAN?	K--	"	"	3	+	+	+	30
SHA	K445	LAN	K10	"	"	5	+	+	+	30
TRI	K738	LAN	K10	"	"	9	+	+	+	10
TRI	K738	LNS	K393	"	"	8	+	+	+	10
COL*	K183	LAN	K254	2x=54		2	+	+	+	5
COL*	K450	LNS	K393	"	"	1	-			
DV2	K409	COL*	K183	"	"	25	+	+	+	30
DV2	K409	PUL	K19	"	"	1	-			
LNS	K393	COL*	K450	"	"	1	-			
PUL	K340	COL*	K450	"	"	9	-			
PUL	K19	LAN	K10	"	"	12	-			
PUL	K19	LNS	K393	"	"	22	-			
RET	K280	ESC	K138	"	"	4	+	+	+	20
RET	K502	LAN	K10	"	"	2	-			
RET	K280	SHA	K445	"	"	16	+	-		
SHA	K445	RET	K280	"	"	2	+	-		
RET	K280	PUL	K881	2x=56		1	-			
RET	K280	COL*	K450	"	"	16	+	-		
DV4	K156	LAN	K10	3x=78		1	+	-		
DV4	K156	SHA	K405	"	"	2	+	-		
DV2	K409	DV4	K156	"	"	22	+	+	+	20
DV2	K11	LEU	K8	"	"	2	+	+	+	40
ESC	K898	LEU	K--	"	"	3	+	-		
LEU	K8	ESC	K138	"	"	9	+	+	-	
LEU	K42	LAN	K264	"	"	8	+	+	+	10
LEU	K8	SHA	K405	"	"	2	+	-		
LEU	K8	TRI	K738	"	"	3	+	+	+	30

? Male is *L. lanceolata* ssp., probably *L. lanceolata* K162.
* *L. collinsii* K450 is 2x=56 chromosomes (Chapter 5.7.2).
** Unpublished data of Booman in 1981 showed an average of 70 % filled seed (6.4 good seeds and 2.7 aborted seeds per pod) in 91 open-pollinated pods of *L. pulverulenta* x *L. leucocephala*.

Table 31 (continued). -- Open-pollinated pod and seed set of 50 *Leucaena* interspecific hybrids arranged by chromosome number.
Code: + = Yes - = No.

Female	K	Male	K	Chromosome Number	N	Flower?	Pods Set?	Filled Seed?	Approx. Seed %
LEU	K614	PUL	K75	3x=80	17	+	-		
LEU	K8	RET	K280	" "	2	-			
PUL	K19	DV4	K156	" "	23	+	-		
PUL	K19	LEU	K8	" "	18	+	+	+	70**
RET	K280	LEU	K500	" "	3	+	+	+	53
DV4	K156	LEU	K500	4x=104	43	+	+	+	98
DV4	K156	PAL	K376	" "	20	+	+	+	60
LEU	K8	DV4	K156	" "	15	+	+	+	100
LEU	K8	PAL	K376	" "	76	+	+	+	40
PAL	K376	DV4	K165	" "	10	+	+	+	50
PAL	K376	LEU	K--	" "	1	+	-		
RET	K280	DV4	K156	4x=108	1	+	-		
RET	K280	PAL	K376	" "	1	+	+	+	5

All eight species hybrids which averaged more than 3 m/yr growth rates (Tables 23-25) produced viable seed. Nineteen of the 23 (83 %) species hybrids averaging over 2 m/yr growth rates produced viable seed.

Several species hybrids which have flowered for several seasons without producing pods include *L. pulverulenta* x *L. diversifolia* ssp. *diversifolia*, *L. retusa* x *L. collinsii*, and *L. retusa* x *L. shannoni* and its reciprocal. Unless a hybrid has flowered for more than one season and not set viable seed, it may be premature to call it seed-sterile. For example, *L. retusa* K280 x *L. leucocephala* K500 was seed-sterile when it first flowered in 1984, but produced germinable seeds in 1985.

During our germplasm collecting trip to Mexico in spring of 1985, we discovered a seed-sterile tree in Tehuacan, Puebla, Mexico, an area only colonized by L. esculenta and L. leucocephala (probably giant). The ground was littered with flowers but no pods could be seen, nor was the owner of the yard aware of it having ever set pods. The tree was several years old, about 13 meters tall and about 15 cm diameter at breast height (DBH). A comparison of the Tehuacan tree and our L. leucocephala K8 x L. esculenta K138 (LEU x ESC) in Waimanalo is presented in Table 32.

Table 32. -- Leaf and pollen characteristics of a natural (probable) seed-sterile L. leucocephala x L. esculenta in Tehuacan, Pueblo, Mexico and L. leucocephala K8 x L. esculenta K138 planted at Waiamanalo, Hawaii.

Character	Waimanalo	N	Tehuacan	N
Pollen stainability (%)	5.7	872	3.2*	323
Pollen diameter (microns)				
normal pollen	38.2	11	39.9	12
macro pollen**	57.0	7	47.2	9
Leaflets/pinna	58.4	10	58.8	5
Pinnae/leaflet	28.8	10	21.6	5
Leaflet length (cm)	1.08	10	0.62	5
Leaflet width (cm)	0.29	10	0.13	5

* Could be biased as they were teased from dried, unopened anthers.

** Macro-sized (possibly 3x) pollen.

6.10. Tree Shape of Leucaena Interspecific Hybrids.

Tree shapes of the 50 interspecific Leucaena hybrids which survived in the field are presented in Table 33.

Table 33. -- Tree shape of 50 *Leucaena* interspecific hybrids; hybrids are arranged by chromosome number. Tree shape legend: C=columnar G=globular V=v-shaped

Female	K#	Male	K#	Chromosome Number	Tree Shape	Multiple-Trunked Trees	
						Trees	%
DV2	K409	LAN	K10	2x=52	G,V	2/17	12
DV2	K409	LNS	K393	" "	G,V	2/3	67
DV2	K409	SHA	K405	" "	V	10/43	23
ESC	K138	SHA	K445	" "	V	0/1	0
LAN	K10	DV2	B85**	" "	G	6/12	50
LAN	K10	LNS	K393	" "	G	6/15	40
LAN	K10	SHA	K445	" "	G	2/13	15
LNS	K393	LAN	K10	" "	G	9/23	39
LNS	K393	SHA	K445	" "	V	6/11	55
MAC	K158	DV2	K--	" "	V	0/1	0
MAC	K158	LAN?	K--	" "	V	0/3	0
SHA	K445	LAN	K10	" "	V	1/5	20
TRI	K738	LAN	K10	" "	G	1/9	11
TRI	K738	LNS	K393	" "	G	4/8	50
COL*	K183	LAN	K254	2x=54	G	1/2	50
COL*	K450	LNS	K393	" "	G	0/1	0
DV2	K409	COL*	K183	" "	G	4/22	18
DV2	K409	PUL	K340	" "	V	0/1	0
LNS	K393	COL*	K450	" "	V	0/1	0
PUL	K340	COL*	K450	" "	V	0/5	0
PUL	K19	LAN	K10	" "	G	5/12	42
PUL	K19	LNS	K393	" "	V	3/22	14
RET	K280	ESC	K138	" "	G	1/4	25
RET	K502	LAN	K10	" "	G	1/3	33
RET	K280	SHA	K445	" "	V	9/16	56
SHA	K445	RET	K280	" "	V	0/1	0
RET	K280	PUL	K881	2x=56	C	0/1	0
RET	K280	COL*	K450	" "	G	11/16	69
DV4	K156	LAN	K10	3x=78	V	1/1	100
DV4	K156	SHA	K405	" "	G	2/2	100
DV2	K409	DV4	K156	" "	C,G	4/22	18
DV2	K11	LEU	K8	" "	C	0/2	0
ESC	K898	LEU	K--	" "	C	0/2	0
LEU	K8	ESC	K138	" "	V	1/9	11
LEU	K42	LAN	K264	" "	V	4/8	50
LEU	K8	SHA	K405	" "	V,G	2/4	50
LEU	K8	TRI	K738	" "	V	0/3	0

* *L. collinsii* K450 is 2x=56 (Chapter 5.7.2).
** A intraspecific hybrid of K480 x K409.
? Male is a *L. lanceolata* ssp.; possibly *L. lanceolata* ssp. *lanceolata* K162.

Table 33 (continued). -- Tree shape of 50 *Leucaena* interspecific hybrids; hybrids are arranged by chromosome number.
Tree shape legend: C=columnar G=globular V=v-shaped

Female	K#	Male	K#	Chromosome Number	Tree Shape	Multiple-Trunked Trees	
						Trees	%
LEU	K614	PUL	K75	3x=80	C	0/17	0
LEU	K8	RET	K280	" "	G	0/2	0
PUL	K19	DV4	K156	" "	C	2/23	9
PUL	K19	LEU	K8	" "	C	3/18	17
RET	K280	LEU	K500	" "	V	1/3	33
DV4	K156	LEU	K500	4x=104	C	0/43	0
DV4	K156	PAL	K376	" "	G	3/20	15
LEU	K8	DV4	K156	" "	C	0/15	0
LEU	K8	PAL	K376	" "	G	37/76	49
PAL	K376	DV4	K165	" "	G	1/10	10
PAL	K376	LEU	K--	" "	V	0/1	0
RET	K280	DV4	K156	4x=108	C	0/1	0
RET	K280	PAL	K376	" "	G	0/1	0

F1 *L. leucocephala* x *L. pallida* (4x=104) and *L. diversifolia* ssp. *trichandra* x *L. diversifolia* ssp. *diversifolia* (3x=78) hybrids both segregated dwarf trees (22/76 or 28.9 % and 4/22 or 18.2 %, respectively). Dwarf trees had multiple trunks and severely shortened internodes; often a dozen or more branches often arose within 40 cm of the crown (Figure 7). Leaves of dwarf trees were usually normal, however, some had fewer than normal numbers of pinnae per leaf. *L. diversifolia* triploid dwarfs had thick and deeply cracked bark. This type of bark was also observed in *L. pulverulenta* K340 x *L. collinsii* K450, and *L. diversifolia* ssp. *trichandra* K409 x *L. pulverulenta* K19.

Figure 7. Two and a half-year old (915 days after transplanting) L. leucocephala K8 x L. pallida K376. The author is sitting between a dwarfed tree (top left) and a strongly-branched tree (top right). Both trees in front of the author (bottom left, bottom right) are single-trunked and have notably higher growth rates than the other hybrids.

6.11. Flower Color of Interspecific Hybrids and Their Parental Species.

6.11.1. Overview.

Leucaena species have flowers with white, yellow or red pigmentation. Styles have different hues than that of anthers. Stylar color is relatively stable; anther color may be different before and after anthesis, and turn reddish or darker as the day progresses, perhaps due to changes in pH.

Table 34. -- Flower color of *Leucaena* species and subspecies. Observations made from trees at Waimanalo (examples of accessions observed are listed) unless otherwise noted.

Species	Example	Stylar Color	Anther color
L. collinsii	K450	white	creamy white
L. div. ssp. *trichandra*	K483	deep red	light red
L. div. ssp. *diversifolia*	K156	medium red	light red
L. esculenta	K138	white	light yellow
L. greggii	Mexico*	deep yellow	deep yellow
L. lanc. ssp. *lanceolata*	K10	creamy white	creamy white
L. lanc. ssp. *sousae*	K393	" "	" "
L. leucocephala	K8	white	creamy white
L. macrophylla	K158	white	" "
L. pallida	K376	medium red	light red
L. pulverulenta	K19	white	creamy white
L. retusa	K280	deep yellow	deep yellow
L. shannoni	K405	creamy white	creamy white
L. trichodes	K738	" "	yellowish white

* 1984 observation in Nuevo Leon, Mexico.

6.11.2. Yellow Flower Color.

Yellow flower color was incompletely dominant in species hybrids matings of deep yellow (*L. retusa*) x whitish flowers. Dosage effects were probably present. *L. retusa* x *L. leucocephala* (3x=80; one dose yellow and two doses white) had lighter yellow styles and anthers than *L. retusa* x *L. shannoni* (2x=54) and *L. retusa* x *L. collinsii* (2x=56) (Figure 8). Both of these diploid species hybrids have one dose of yellow and white.

Red color appeared to be recessive to yellow in the yellow x red flower matings of *L. retusa* x *L. diversifolia* and *L. retusa* x *L. pallida*. Flowers of these hybrids were yellowish, rather than reddish or orangish.

Table 35. -- Flower color of interspecific hybrids having L. retusa as a parent (which has deep yellow anthers and styles). Arranged by chromosome number.
Flower Color Code: Y=yellow W=white R=red
Yellow>Pale yellow>Light yellow>Yellowish white>Near white.

Species Hybrid	Chromosome Number	N	Mating	Color of Hybrid Styles	Color of Hybrid Anthers
RET SHA	2x=54	14	Y x W	near white*	pale yellow
RET ESC	" "	1	Y x W	white	yellow
SHA RET	" "	1	W x S	yellowish white	pale yellow
RET COL	2x=56**	8	Y x W	yellowish white	pale yellow
RET LEU	3x=80	3	Y x W	near white	light yellow
RET DV4	4x=108	1	Y x R	yellowish white	pale yellow
RET PAL	4x=108	1	Y x R	near white	yellow

* One tree had pale yellow styles (Figure 5).
** L. collinsii K450 is 2x=56 (Chapter 5.7.2).

Figure 8. A deep-yellow flower from L. retusa K502 (far left), an off-white flower from L. leucocephala K42 (far right), a light-yellow flower from L. retusa K280 x L. leucocephala K500 (bottom center), and pale yellow flowers from L. retusa K502 x L. shannoni K445 (top left) and from L. retusa K280 x L. collinsii K450 (top right).

Stylar pigmentation appears to be independent of anther pigmentation. One tree of L. retusa x L. shannoni had yellower styles than thirteen other trees examined (Plates VIII and IX).

6.11.3. Red Flower Color.

Two species have reddish flowers, L. diversifolia and L. pallida. Matings of red x white or white x red resulted in similarly colored flowers. Red flower color was incompletely dominant in the F1. Four of twelve matings (33.3 %) produced whiter flowers than expected (Table 36). Comparisons of flower color of diploid and tetraploid species hybrids in Plate X to flower color of triploid species hybrids suggests coloration varies with dosage effects.

Table 36. -- Flower color of interspecific hybrids resulting from white x red, or red x white flower color matings. Arranged by chromosome number.
Flower Color Code: W=white R=red
Deep red>Red>Pale red>Light red>Near white>White.

Species Hybrid	Chromosome Number	N	Mating	Color of Hybrid Styles	Color of Hybrid Anthers
MAC DV2	2x=52	1	W x R	white	near-white
DV2 LAN	" "	5	R x W	near white	pale red
DV2 LNS	" "	2	R x W	near white	pale red
DV2 SHA	" "	2	R x W	white	near-white
DV2 COL	2x=54*	15	W x R	white	near white
DV2 LEU	3x=78	2	R x W	near white	light red
PUL DV4	3x=80	14	W x R	light red	pale red
DV4 LEU	4x=104	35	R x W	white	light red
DV4 PAL	" "	28	R x W	pale red	red
LEU DV4	" "	1	W x R	white	near white
LEU PAL	" "	20	W x R	white	pale red
PAL DV4	" "	14	R x W	pale red	red

* L. collinsii K450 is 2x=56 (Chapter 5.7.2).

Plate VIII. Flower heads from L. retusa K502 x L. shannoni K445 (center) in comparison to those from its parents (K502 left, and K445 right). Anthers of the species hybrid are pale yellow and stylar color is a very light yellow. Scale is in centimeters.

Plate IX. Flower heads from L. retusa K502 x L. shannoni K445 (center) in comparison to those from its parents (K502 right, and K445 left). Styles and anthers of the species hybrid are a uniform pale yellow. Scale is in centimeters.

Plate X. Flower heads of reddish-flowered species and species hybrids.

Top row, left to right: *L. diversifolia* ssp. *diversifolia* K776, *L. diversifolia* ssp. *diversifolia* K156 x *L. pallida* K376, *L. leucocephala* K8 x *L. pallida* K376, and *L. pallida* K748.

Middle row, left to right: *L. diversifolia* ssp. *trichandra* (K480 x K409) x *L. lanceolata* ssp. *sousae* K393, and *L. diversifolia* ssp. *trichandra* K409 x *L. collinsii* K450.

Bottom row, left to right: *L. diversifolia* ssp. *trichandra* K749, *L. pulverulenta* K19 x *L. diversifolia* ssp. *diversifolia* K156, and *L. diversifolia* ssp. *trichandra* K11 x *L. leucocephala* K8.

Plate XI. Flower heads (2x) from L. *diversifolia* ssp. *trichandra* (K480 x K409) (left), L. *diversifolia* ssp. *trichandra* (K480 x K409) x L. *lanceolata* ssp. *sousae* K393 (middle), and L. *lanceolata* ssp. *sousae* K393 (right). This red flower x white flower mating resulted in a pink flower.

Plate XII. Flower heads (2x) from L. *diversifolia* ssp. *trichandra* K423 (left), L. *diversifolia* ssp. *trichandra* K423 x K409) x L. *collinsii* K180 (middle), and L. *collinsii* K180 (right). In this mating, a red flower x white flower results in an off-white flower, lacking in obvious reddish color.

6.12. Petiolar Leaf Gland Shape of Species and Species Hybrids.

Petiolar glands of *Leucaena* species can be grouped into four categories by their shape (Table 37). Classes III and IV may be small and large forms of the same gland shape; thereby reducing the categories to three-- pin, bump and bathtub-shaped glands.

Table 37. -- *Leucaena* species grouped into four classes on the basis of the shape of the petiolar leaf gland. Observations from species at the arboretum in Waimanalo, Hawaii.

Species	K#	Class	Leaf Gland Description
GRE	K758	I	Thin, tall, ending in a point.
RET	K280	I	"
COL	K450	II	Smooth gradual bump with a small dimple.
LAN	K10	II	"
LNS	K393	II	"
MAC	K158	II	"
SHA	K445	II	"
TRI	K738	II	"
DV2	K399	III	Columnar, flat-topped, large depression.
LEU	K8	III	"
PAL	K806	III	"
DV4	K156	IV	Very broad, thin and flat.
ESC	K138	IV	"
PUL	K75	IV	"

Petiolar glands of 50 species hybrids were compared to those of the parental species. Gland shape of 49 species hybrids (49/50 or 98 %) was intermediate between that of the parents. The exception, *L. diversifolia* ssp. *trichandra* K409 x *L. pulverulenta* K340, had glands which approximated the broad flat glands of *L. pulverulenta*. Occasionally glands of diploid and triploid *L. diversifolia* vary among the leaves of the same tree from columnar glands (Class III) to broad flat glands (Class IV).

Table 38. -- Hybrid gland shape resulting from gland shape matings without regard to direction of the cross. Gland classes are described in Table 37.

Mating by petiolar shape	Example	Resulting Gland Shape
Class I x Class II	RET x LAN	Small gland, small dimple.
Class I x Class III	RET x PAL	"
Class I x Class IV	RET x ESC	Medium gland, rounded top.
Class II x Class III	LAN x DV2	"
Class II x Class IV	ESC x SHA*	"
Class III x Class IV	LEU x ESC	Broad flat gland.

* Class IV x Class II mating, no species hybrids have been produced from Class II x Class IV matings yet.

Gland shape is variable on some *L. diversifolia* ssp. *trichandra* (Figure 9). Tall, thin glands were the least common type of gland observed. Gland shapes are less variable on other species planted at Waimanalo.

Figure 9. Leaf glands on petioles (2.9x) from a tree of *L. diversifolia* ssp. *trichandra* K823: Glands absent (left), tall and thin (next right), short and columnar (next right) and broad and columnar glands (far right).

Three species hybrids occasionally produced glands which approximated those of L. retusa; tall, thin and pointed. These hybrids were L. retusa K280 x L. collinsii K450, L. retusa K280 x L. diversifolia ssp. diversifolia K156 and L. shannoni K445 x L. retusa K280. Most glands of these hybrids, however, were intermediate in shape between those of the parents.

Pan (1985) studied the gland shapes of 84 F2 plants of L. diversifolia ssp. trichandra K409 x L. lanceolata ssp. lanceolata K401 and concluded gland shape was controlled by at least two loci.

6.13. Number of Petiolar Glands Per Leaf As a Marker for L. retusa Species Hybrids.

Number of glands per leaf can be used to help verify species hybrids with L. retusa. L. retusa leaves have 4-6 pairs of pinnae per leaf; all pinnae pairs are subtended by a single gland. L. retusa and L. greggii are the only Leucaena species observed which have petiolar glands subtending all pinnae pairs. Species such as L. esculenta had an average of 4.7 glands per leaf, but these subtend only 10 % of the pinnae pairs of typical leaves.

Numbers of glands and numbers of pinnae pairs of leaves of eight species hybrids with L. retusa as a parent were counted (Table 39). Percentages of pinnae pairs subtended by glands of interspecific hybrids were intermediate to those of the parental species. Five diploid hybrids and two tetraploid hybrids both had an average of 79 % of their pinnae subtended by glands, and one triploid species hybrid had 42 % of its leaves subtended by glands-- suggesting a dosage effect.

Table 39. -- Numbers and percentages of petiolar glands, and numbers of pinnae pairs from ten leaves of eight species hybrids. All hybrids had the common parental species, *L. retusa*. Arranged by chromosome number.

Species Hybrid	Chromosome Number	N	Glands/Pinnae Pairs of 10 Leaves Female		Hybrid		Male	
		Trees		%		%		%
RET COL	2x=54*	10	50/50	100	38/59	64	15/154	10
RET ESC	" "	3	50/50	100	65/110	59	47/489	10
RET LAN	" "	2	50/50	100	45/48	94	10/43	23
RET SHA	" "	6	50/50	100	38/49	78	10/51	20
SHA RET	" "	1	10/51	20	51/52	98	50/50	100
RET PUL	2x=56	1	50/50	100	72/90	91	20/165	12
RET LEU	3x=80	3	50/50	100	29/69	42	20/80	25
RET DV4	4x=108	1	50/50	100	131/164	80	36/306	12
RET PAL	" "	1	50/50	100	78/101	77	19/153	12

* *L. collinsii* K450 is 2x=56 (Chapter 5.7.2).

Percentages of pinnae pairs subtended by glands from the hybrids were not the arithmetic average of the percentages of the two parents; hybrids values were generally (7/8 or 88 %) closer to those from *L. retusa*.

Percentage of pinnae pairs subtended by glands may be useful in estimating ploidy levels of hybrids resulting from matings of *L. retusa* and tetraploid species. RET x DV4 and RET x PAL had fewer percentages of glands per leaf than expected if they had been triploid hybrids.

6.14. Floral Bracts As a Marker for L. retusa Species Hybrids.

Length of floral bract tips were intermediate in species hybrids between L. retusa, which has a uniquely long bract tip (Figure 10), and other species which commonly have short bract tips. Long bract tips of L. retusa may serve to discourage insects from feeding.

Figure 10. Floral bracts (10x) from L. retusa K502 (left) and that of five Leucaena species (bottom row) and that of their species hybrids (top row). Bract filaments were removed.

Center left: L. retusa K502.

Top, left to right: L. retusa K502 x L. shannoni K445, L. retusa K280 x L. collinsii K450, L. retusa K280 x L. esculenta K138, L. retusa K280 x L. leucocephala K500, and L. retusa K280 x L. pallida K376.

Bottom, left to right: L. shannoni K445, L. collinsii K450, L. esculenta K695, L. leucocephala K42 and L. pallida K376.

6.15. Flower Head Diameters at Anthesis from Interspecific Hybrids of Small-Flowered x Large-Flowered *Leucaena* Species.

Four *Leucaena* species have notably small inflorescences: *L. diversifolia ssp. trichandra*, *L. macrophylla*, *L. pulverulenta* and *L. trichodes*. Flower head diameter can be measured either between opposing anthers or between opposing styles.

Flower head diameters from species hybrids resulting from matings of small- x large- or large- x small-flowered species were intermediate between that of the parental species (Tables 40 and 41).

Table 40. -- Flower head diameter measured between anthers from ten flower heads at anthesis of parents and interspecific *Leucaena* hybrids resulting from matings of small- and large-flowered species. Hybrids are arranged by their chromosome number.

Hybrid	Chromosome Number	K x K	Flower Head Diameter (mm) Female	Hybrid	(% of parents) %	Male
DV2xLAN	2x=52	B85*xK10	11.7±1.0	15.2±0.6	(27)	25.4±0.5
TRIxLAN	" "	K738xK10	13.5±0.6	18.5±0.9	(42)	25.4±0.5
TRIxLNS	" "	K738xK393	13.5±0.6	19.3±1.0	(43)	26.9±0.6
DV2xCOL	2x=54	K423xK183	9.1±0.9	17.8±0.5	(48)	27.2±0.9
DV2xLEU	3x=78	K11 xK8	9.1±0.9	20.2±0.5	(67)	25.6±1.1

* Intraspecific hybrid of K480 x K409.

Table 41. -- Flower head diameters measure between styles from ten flower heads at anthesis of of parents and interspecific Leucaena hybrids resulting from matings of small- and large-flowered species. Hybrids are arranged by their chromosome number.

Hybrid	Chromosome Number	K x K	Flower Head Diameter (mm) Female	Hybrid	(% of parents)	Male
					%	
DV2xLAN	2x=52	B85*xK10	13.5±1.5	16.7±1.5	(27)	25.4±0.5
TRIxLAN	" "	K738xK10	16.5±1.0	19.0±1.2	(28)	25.4±0.5
TRIxLNS	" "	K738xK393	16.5±1.0	22.8±0.7	(61)	26.9±0.6
DV2xCOL	2x=54	K423xK183	10.6±0.7	17.8±0.5	(43)	27.2±0.9
DV2xLEU	3x=78	K11 xK8	10.6±0.7	23.5±0.8	(86)	25.6±1.1

* K480 x K409.

Head diameters from three of the four diploid species hybrids were slightly less than averages of the head diameters of the parental species when measured between anthers (42, 43 and 48 % of the difference between parental data), and were greater or less than the averages of parental head diameters when measured between styles (28, 61 and 43 %). Head diameter of DV2 x LAN was less than expected measured between anthers (27 %) between styles (27 %).

Head diameter of the triploid hybrid approximated that of its tetraploid parent, L. leucocephala (67 %-- measured between anthers; 86 %-- measured between styles). Accounting for dosage effects, hybrid flower head diameter could be predicted within 0.1 mm with weighted anther-to-anther measurements of the parental flowers (20.1 mm= ((25.6+25.6+9.1)/3) or within 2.9 mm with weighted style-to-style measurements (20.6 mm=(10.6+25.6+25.6)/3).

Head diameter was measured from a species hybrid resulting from a medium- x large-flowered species mating. L. shannoni K445 x L. lanceolata ssp. lanceolata K10 (25.0±0.5 mm, measured from anther to anther) was 92 % of the difference in head diameters of the parental species, L. shannoni (20.4±0.2 mm; anther to anther) and L. lanceolata ssp. lanceolata (25.4±0.5 mm; anther to anther). Flowers of this hybrid approximated the larger-flowered species.

Flower head diameters of hybrids resulting from small- x large- or large- x small-flowered species are predictable. This is helpful in field-identification of most open-pollinated species hybrids resulting from open-pollination of small-flowered species as female. L. macrophylla K158 x L. lanceolata K-- (Table 15) was identifiable solely on the basis of flower head size.

6.16. Leaflet and Pinnae Measurements.

6.16.1. Introduction.

Of the 55 verified interspecific Leucaena hybrids grown at Waimanalo, Hawaii (Table 15), 52 (95 %) were measured for four leaf traits-- leaflet length, leaflet width, numbers of leaflets per pinna and number of pinnae per leaf. From these data, three leaf traits were extrapolated, leaflets per leaf, leaflet area, and area per leaf. Procedures for taking and modifying data are described in

Chapter 3.9. Natural logs of these data, and those of their parents, are listed and plotted in Appendix 4.

All species hybrids, except for L. retusa K280 x L. collinsii K450, had leaf traits which were intermediate to that of the parents. Hybrid data was not arithmetically intermediate to that of the parents. For example, in Table 42 the hybrid data (HYB) are significantly less than the average of the data of the two parental species ((LAN + DV2)/2).

Table 42. -- Comparisons of arithmetic means and standard deviation of data of L. lanceolata ssp. lanceolata K10 (LAN) and L. diversifolia ssp. trichandra (K480 x K409) (DV2) for leaflets per pinna, pinnae per rachis, leaflet length and leaflet width with that of their species hybrid (HYB). Data were abstracted from Appendix 4.

Leaf Trait	LAN	HYB	(LAN + DV2)/2	DV2
leaflets/pinna	10.4	36.2	53.0	95.6
pinnae/leaf	8.0	19.4	24.7	41.4
leaflet length (cm)	3.8	0.9	2.1	0.3
leaflet width (cm)	1.5	0.3	0.8	0.1

Converting the data to their natural log allows hybrid leaf traits to be predicted from those of the parental species (Table 43). Predicted values in Table 43 are the arithmetic averages of the natural log values of the parents ((ln LAN + ln DV2)/2). Discrepancies between actual and predicted leaf trait values (Tables 47-50) are 4.7 leaflets/pinna (13 %), 1.3 pinnae/leaf (7 %), 0.27 cm leaflet length (31 %), and 0.03 cm leaflet width (9 %). All predicted hybrid values slightly underestimated the measured hybrid data.

Table 43. -- Comparisons of arithmetic means of natural logs of data of L. lanceolata ssp. lanceolata K10 (ln LAN) and L. diversifolia ssp. trichandra (K480 x K409) (ln DV2) for leaflets per pinna, pinnae per rachis, leaflet length and leaflet width with that of their species hybrid (ln HYB). Data were abstracted from Appendix 4.

Leaf Trait	ln LAN	ln HYB	(ln LAN + ln DV2)/2	ln DV2
leaflets/pinna	2.34	3.59	3.45	4.56
pinnae/leaf	2.08	2.97	2.90	3.72
leaflet length (cm)	1.34	-0.14	0.13	-1.09
leaflet width (cm)	0.41	-1.15	-1.06	-2.53

Plate XIII shows 1x photocopies of representative pinnae of eight species hybrids of L. retusa-- L. retusa x 1) L. lanceolata ssp. lanceolata (2x=54), 2) L. shannoni (2x=54), 3) L. leucocephala (3x=80), 4) L. collinsii (2x=56), 5) L. pallida (4x=108), 6) L. pulverulenta (2x=56), 7) L. diversifolia ssp. diversifolia (4x=108), and 8) L. esculenta (2x=54)). All hybrid pinnae and leaflets are intermediate between those of the parents, except for L. retusa x L. collinsii, which is heterotic for leaflet dimension. None of the pinnae shown of the hybrids are the arithmetic averages of the parental species, in terms of either leaflets per pinnae, leaflet length or leaflet width. Using natural log parental data, however, one can predict these hybrid leaf traits fairly accurately, except for that of L. retusa x L. collinsii.

Taking the arithmetic mean of natural log data from diploid and tetraploid parental species helps in prediction of leaf trait values of triploid species hybrids. If

Plate XIII. Photocopies (1x) of representative pinnae (and their leaflets) of eight *L. retusa* species hybrids and their parents. All pinnae were picked on 10/25/87 at Waimanalo, Hawaii. The species hybrids shown include the following:

A L. *retusa* K280.

B-C L. *retusa* K280 x L. *lanceolata* ssp. *lanceolata* K10 (B) (2x=54), and L. *lanceolata* ssp. *lanceolata* K10 (C).

D-E L. *retusa* K502 x L. *shannoni* K445 (D) (2x=54), and L. *shannoni* K445 (E).

F-G L. *retusa* K280 x L. *leucocephala* K500 (F) (3x=80), and L. *leucocephala* K42 (G).

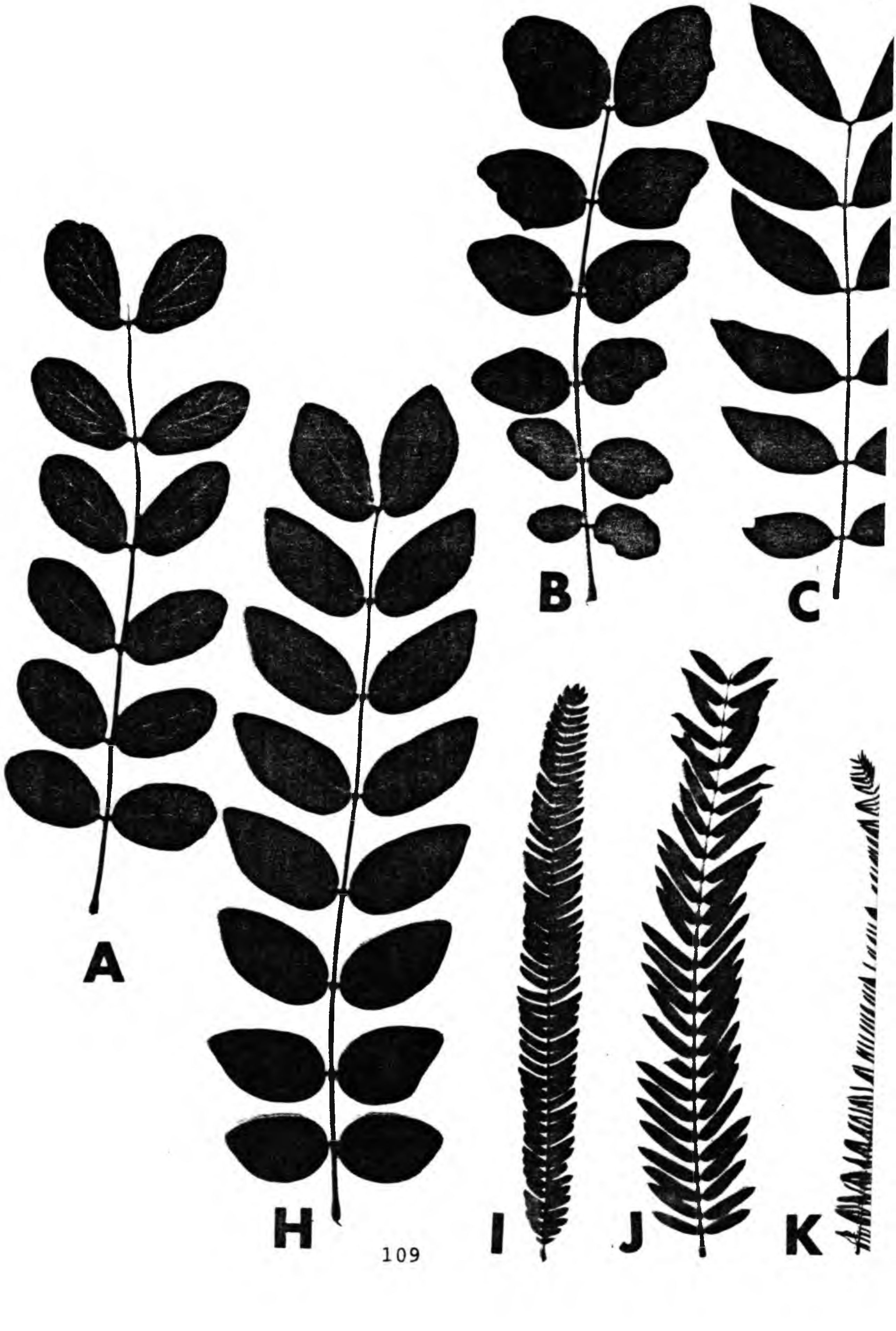
H-I L. *retusa* K280 x L. *collinsii* K450 (H) (2x=56), and L. *retusa* K280 x L. *collinsii* K450 (I).

J-K L. *retusa* K280 x L. *pallida* K376 (J) (4x=108), and L. *pallida* K376 (K).

L-M L. *retusa* K280 x L. *diversifolia* ssp. *diversifolia* K156 (L) (4x=108), and L. *diversifolia* ssp. *diversifolia* K156 (M).

N-O L. *retusa* K280 x L. *pulverulenta* K881 (N) (2x=56), L. *pulverulenta* (O).

P-Q L. *retusa* K280 x L. *esculenta* K138 (P) (2x=54), and L. *esculenta* K138 (Q).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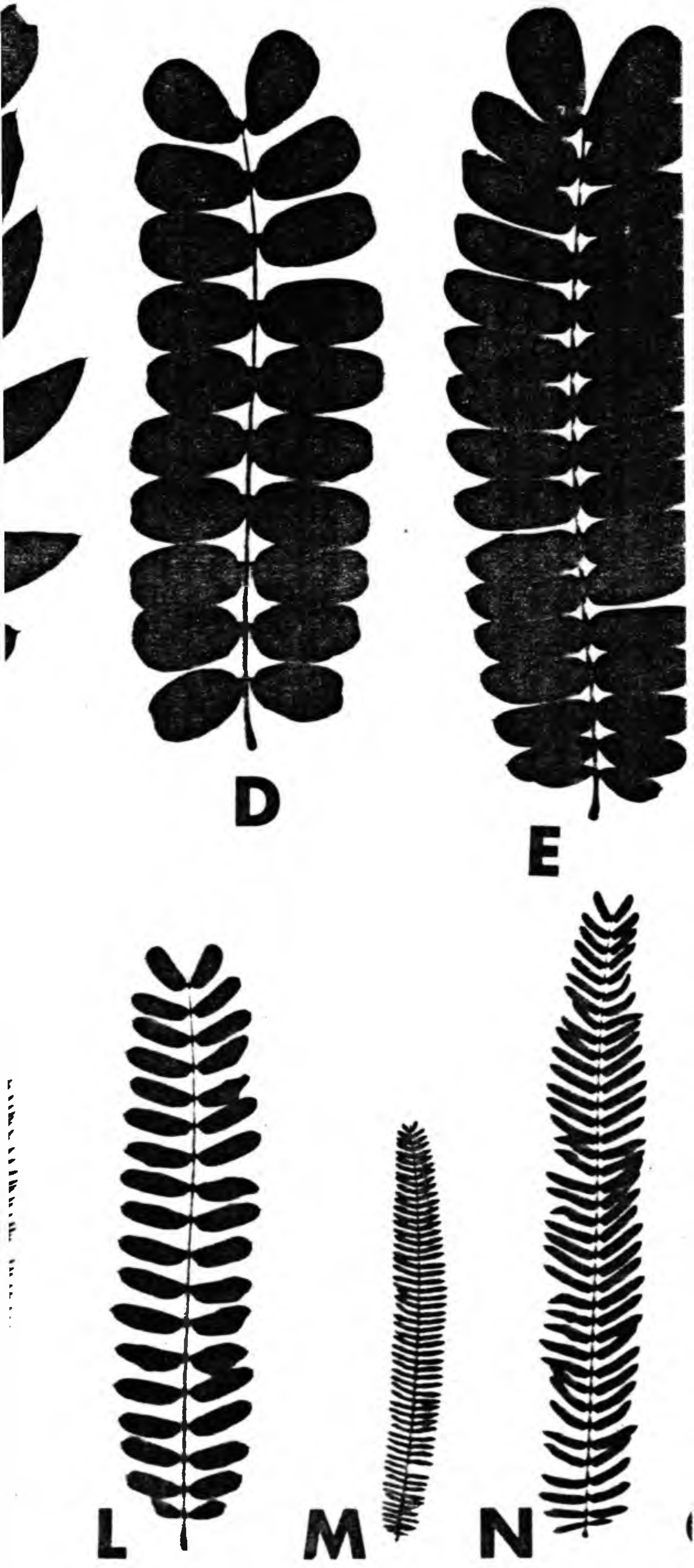

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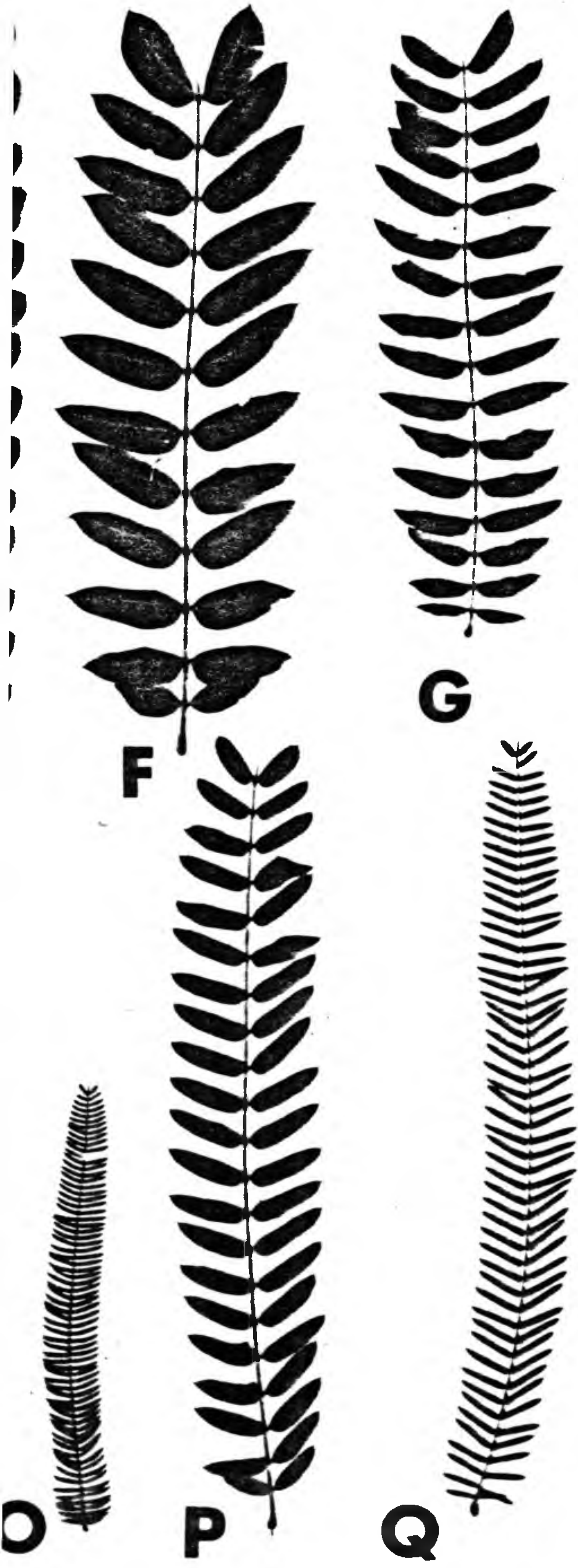
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weighted parental natural log means are used, however, predicted values become more accurate; apparently by reducing a dosage effect (Table 44). The dosage effect is due to the tetraploid species parent contributing twice as many chromosomes to the hybrid as the diploid parent.

Table 44. -- Comparisons of arithmetic and weighted means of natural log-converted data of L. leucocephala K8 (LEU) and L. esculenta K138 (ESC) for leaflets per pinna, pinnae per rachis, leaflet length and leaflet width with that of their species hybrid (HYB). Data were abstracted from Appendix 4.

Leaf Trait	LEU	HYB	(LEU+ESC)/2	(2LEU+ESC)/3	ESC
Leaflets/pinna	3.50	4.07	4.30	4.03	5.10
Pinnae/leaf	2.83	3.36	3.67	3.39	4.50
Leaflet length (cm)	0.48	0.08	0.02	0.17	-0.46
Leaflet width (cm)	-0.70	-1.26	-1.52	-1.24	-2.33

Using weighted means, predicted and actual hybrid data become more alike (values of (2LEU+ESC)/3 are closer to the hybrid (HYB) values than (LEU+ESC)/2 values). Discrepancies between predicted and actual values (Tables 47-50) are 2.3 leaflets per pinna (4%), 0.9 pinnae pairs per leaf (3 %), 0.1 cm leaflet length (9 %), and 0.006 cm in leaflet width (2 %).

Data from the same tree of L. retusa K502 x L. pulverulenta K881 was taken at 21, 50 and 350 days after planting (Table 45). The purpose of this was to determine which leaf traits of young seedlings were most similar to that of mature trees. This would be useful in identifying the male parentage of open-pollinated species hybrids before seedlings are transplanted to the field.

Natural log data at 21 days from L. retusa x L. pulverulenta underestimated that of the same tree at 350 days by 55, 66, 67 and 12 % respectively for leaflets/pinna, pinnae/leaf, leaflet length and leaflet width. Hybrid data at 50 days underestimated the hybrid data at 350 days by 43 and 55 %, respectively, for leaflets per pinna and pinnae per leaf, and overestimated the leaflet size by 23 and 41 %, respectively, for leaflet length and leaflet width. These discrepancies could be related to the unusual rhizobial preference of L. retusa (Appendix 5).

At 21 days leaflet width was the trait which was closest to that of the mature tree. At 50 days, leaflet length was the trait which most approximated that of the mature tree.

Table 45. -- Natural log of leaflet number per pinna, pinnae per leaf, and leaflet length and width of the same tree of L. retusa K502 x L. pulverulenta K881 at 21 and 50 days after transplanting, and natural log data of the mature (500 days after transplanting) tree.

	Mean Log Data of Hybrid Days After Germination			Mean Log Data		
Trait	21	50	500	Female	Male	Exp.*
Leaflets/pinna	3.03	3.28	3.84	2.55	4.83	3.69
Pinnae/leaf	1.79	2.08	2.87	2.20	3.59	2.90
Leaflet length (cm)	-1.10	0.20	-0.01	0.89	-0.68	0.11
Leaflet width (cm)	-1.27	-0.79	-1.14	0.12	-2.20	-1.04

* Expected natural log data of species hybrid based on the averages of the natural log of parental data.

Predicted hybrid values differed from the actual values taken from the hybrid at 350 days by 6.5 leaflets/pinna (14 %), 0.5 pinnae/leaf (3 %), 0.13 cm leaflet length (13 %) and 0.03 cm in leaflet width (9 %).

Three other leaf traits were derived from the measured parameters following the procedures listed in Chapter 3.5. These traits were leaflets per leaf, leaflet area and area per leaf. Many of the graphs for these traits in Appendix 4 have fairly straight lines connecting the hybrid and its parents; however, in general, graphs of numbers of leaflets per pinna and leaflet length and width have straighter lines connecting species and their hybrids.

Parents in the graphs of Appendix 4 are graphed in a standard way. The parent graphed at the left side of the x-axis has fewer leaflets per pinna and larger leaflets than the parent graphed at the far right. Graphs which do not present the parents in the order the hybridization was made (female x male, female at the left and male at the right) are denoted by a black dot attached to the abbreviation for the species hybrid. Vertical distances on the y-axis denote the relative dissimilarity between the values of the species and hybrids, but the y-axis scales may differ from graph to graph. Strongly sloping lines are less affected by sampling error than relatively flat lines.

6.16.2. Analysis of Diploid Interspecific Hybrids for Leaf Traits.

Twenty diploid hybrids are graphed using log transformations in Appendix 4 (Plates XV-XXV). Most hybrids were healthy, although a few had growth problems or were immature.

Plate XV a-g has four diploid species hybrids-- 1) L. pulverulenta K340 x L. collinsii K183 (PC), 2) L. esculenta K138 x L. shannoni K445 (ES), 3) L. diversifolia ssp. trichandra (K480 x K409) x L. lanceolata K10 (ZN), and 4) L. trichodes K738 x L. lanceolata ssp. sousae K393 (TM). All species hybrids were vigorous and healthy except for PC, which was dwarfed and later died.

In general, the graphs have straight lines connecting the parents and hybrids. TM was unusual since it had more pinnae/leaf and larger leaflet dimensions than expected. PC had remarkably straight lines considering the tree's poor health.

Plate XVI a-g has four diploid species hybrids-- 1) L. diversifolia ssp. trichandra K423 x L. collinsii K180 (ZC), 2) L. collinsii K183 x L. lanceolata ssp. lanceolata K264 (CN), 3) L. lanceolata ssp. sousae K393 x L. shannoni K445 (MS), and 4) L. trichodes K738 x L. lanceolata ssp. lanceolata K10 (TN). All four species hybrids were healthy.

Generally, the lines connecting parents and hybrids in the graphs are straight, except for leaf area. These hybrids appear to be heterotic for leaf area.

Plate XVII a-g has four diploid species hybrids-- 1) *L. lanceolata* ssp. *lanceolata* K10 x *L. diversifolia* ssp. *trichandra* (K480 x K409) (NZ), 2) *L. lanceolata* ssp. *sousae* K393 x *L. collinsii* K450 (MC), 3) *L. lanceolata* ssp. *lanceolata* K10 x *L. shannoni* K445 (NS) and 4) Its reciprocal hybrid, SN. These hybrids were healthy except for MC, which was sickly and died soon after data was taken.

The graphs of all leaf traits, except for leaf area, of the three healthy species hybrids were reasonably straight. MC had approximately the expected number of leaflets/pinna and leaflet length and width, but fewer pinnae/leaf than expected. Because pinnae/leaf of MC was low, leaflets per leaf and leaf area were also less than expected.

Plate XVIII a-g has four diploid species hybrids-- 1) *L. diversifolia* ssp. *trichandra* K409 x *L. pulverulenta* K19 (ZP), 2) *L. retusa* K280 x *L. esculenta* K138 (RE), 3) *L. diversifolia* ssp. *trichandra* (K480 x K409) x *L. lanceolata* ssp. *sousae* K393 (ZM), and 4) *L. shannoni* K445 x *L. retusa* K280 (SR). *L. retusa* and *L. shannoni* did not differ significantly for most leaf traits measured. Three of these hybrids were healthy, but ZP was a small sickly tree, which periodically died back to the crown.

Graphs of leaflets/pinna, pinnae/leaf, and leaflets/leaf had straight lines between parents and their hybrids.

Leaflet length of ZM was slightly heterotic, while leaflet length and width of RE and ZP was slightly less than expected. The bent lines of species and hybrids for leaf area are largely due to unexpectedly low values for leaflet dimension, although greater than expected numbers of pinnae/leaf of SR contributed to its apparently heterotic leaf area.

Plate XIX a-g has two diploid species hybrids-- L. retusa K280 x L. pulverulenta K881 (RP), and L. collinsii K450 x L. lanceolata ssp. sousae K393 (CM). Leaves of these hybrids were measured 21 days after transplanting of 60 day-old dibble tubed seedlings (RP1 and CM1), and again at 43 days after tranplanting of the same seedlings (RP2 and CM2). Both hybrids were unhealthy-- RP due to psyllid damage and possibly problems with nodulation, and CM for unknown reasons. RP has since become a vigorous tree, while CM has remained a small weak tree.

These two hybrids had surprisingly similar plots for all traits. There were substantial increases in all leaf values between measuring dates. Leaflets/pinna and pinnae/leaf never reached the expected values of a mature tree, although leaflets/pinna more closely approximated expected values than did pinnae/leaf. Both leaflet length and width for both species hybrids at 43 days after transplanting were greater than expected.

The use of leaflet characters as an aid to hybrid parentage analysis was tested using two open-pollinated progenies, and graphed in Plate XX a-g. Both trees grew from open-pollinated seed picked from L. macrophylla K158; one had smaller leaflets than the mother tree, and the other had larger leaflets than the mother tree.

Pollen stainability in cotton blue of the small leaflet tree was 97 %, so it was assumed that the mother tree was not pollinated by the tetraploid species L. diversifolia ssp. diversifolia nor L. pallida. The remaining possibilities were either L. macrophylla x L. diversifolia ssp. trichandra (AZ?) or L. macrophylla K158 x L. collinsii (AC?). AZ? had straighter lines for leaflets/pinna and leaflet width and length than AC?, therefore, the small leaflets hybrid was L. macrophylla K158 x L. diversifolia ssp. trichandra K--.

The second open-pollinated progeny graphed in Plate XX a-g grown from L. macrophylla K158 had larger leaflets than the mother tree (Plate XIV). If the progeny was a species hybrid, then it could only be L. macrophylla x L. lanceolata ssp. As L. lanceolata ssp. sousae has slightly larger leaflets than L. lanceolata ssp. lanceolata (Appendix 4), the progeny was only graphed as L. macrophylla K158 x L. lanceolata ssp. sousae K393 (AM?). L. trichodes K738 x L. lanceolata ssp. sousae K393 (TM) served as an

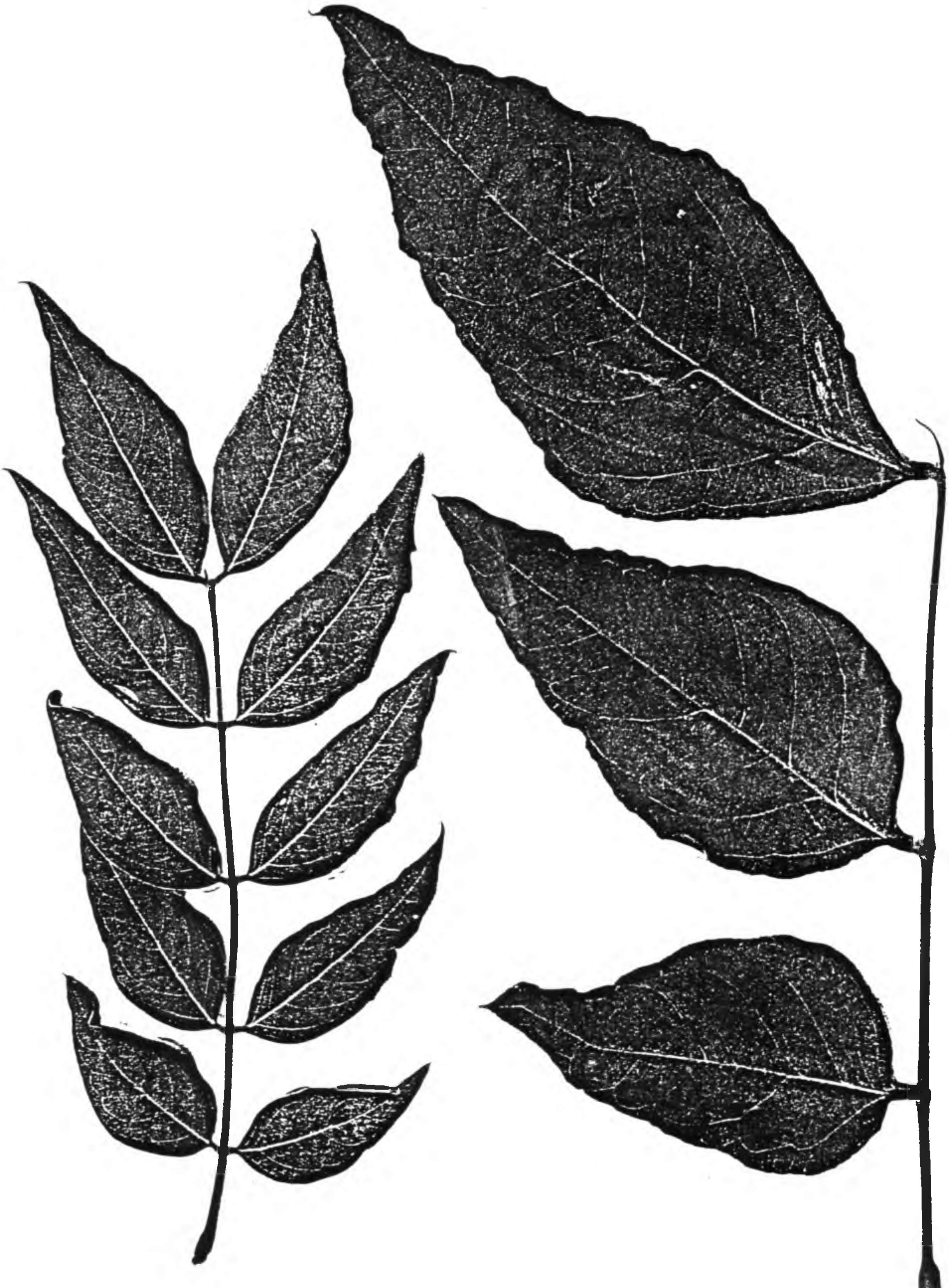

Plate XIV. Photocopies of representative pinna (1x) of
L. macrophylla K158 (left), and a half-pinna from its large-leaflet progeny (right).

expected graph since L. macrophylla K158 has similar leaves (and also flower size) to L. trichodes K738.

Comparison of the graphs of TM and AM? shows that they are quite different; AM? has too few leaflets and pinnae and its leaflets size is too great to be the hybrid with L. lanceolata ssp. sousae. Observation of several newly received accessions of L. macrophylla showed that small-leaflet L. macrophylla are unusual; large-leaflet trees which look like the large-leaflet progeny of K158 are common. Since the progeny does not have characteristics of a species hybrid, and because other L. macrophylla have similarly large leaflet leaves, the tree was decided to be an unusual form of L. macrophylla.

Fifty-six seeds of L. retusa K280 x L. collinsii K450 (RET x COL) germinated, producing 38 (68 %) seedlings with large leaflets and 18 (32 %) with small leaflets (a ratio of 2.1:1) (Figure 11). All 18 seedlings with small leaflets died within three months after transplantation to the field. Leaflet length and width of the surviving hybrids was strongly heterotic, however, numbers of leaflets/pinna and pinna/leaf approximated L. retusa and were less than expected (Table 46). This was the only hybrid studied which had values which could not be predicted.

Discrepancies between predicted and actual values of leaf traits of L. retusa K280 x L. collinsii K450 were 160 %

for number of leaflets/pinna, 28 % for number of pinnae/leaf, 97 % for leaflet length and 142 % for leaflet width.

Table 46. -- Predicted and actual means and standard deviations of values of leaf traits of *L. retusa* K280 x *L. collinsii* (RET x COL) K450, and its parental species, *L. retusa* (RET) and *L. collinsii* (COL).

Measured Leaf Trait	RET	RET x COL		COL
	Actual	Actual	Expected*	Actual
Leaflets/pinna	14.6	14.3	37.16	94.6
Pinnae/leaf	10.0	12.40	15.9	25.2
Leaflet length (cm)	2.15	2.64	1.34	0.84
Leaflet width (cm)	1.01	1.14	0.47	0.22

* Expected values determined by taking the antilog of the average of natural log of parental data.

Figure 11. F1 seedlings (1.2x) resulting from *L. retusa* K280 x *L. collinsii* K450. The two at the top have leaflets intermediate between those of the parental species, while the seedling at the bottom has leaflets approximating the size of *L. retusa*. Silhouettes at the right are photocopies (1x) of pinnae sections of *L. retusa* K280 and *L. collinsii* K450.

6.16.3. Analysis of Triploid Hybrids for Leaf Traits.

Plate XXI a-g shows six triploid species hybrids-- 1) L. leucocephala K8 x L. esculenta (LE), 2) L. leucocephala K8 x L. pulverulenta K75 (LP), 3) L. diversifolia ssp. trichandra K11 x L. leucocephala K8 (ZL), 4) L. leucocephala K8 x L. shannoni K405 (LS), 5) L. leucocephala K8 x L. lanceolata ssp. lanceolata K10 (LN), and 6) L. leucocephala K8 x L. trichodes K738 (LT). These hybrids were fairly healthy except for LS, which died soon after data collection. LP and LN had heavy leaf damage from psyllids.

Plate XXII a-g used the same x-axis scale as that used for the diploid species hybrids. The graphs are not straight when plotted on this x-axis scale; the hybrid leaf traits approximate the tetraploid parent used in the matings, L. leucocephala.

Dosage effects were minimized by using a weighted x-axis in Plates XXII a-g and XXIII a-g. The weighted axis places the hybrid two-thirds between the parental species, and closer towards the tetraploid species L. leucocephala since it contributed twice as many chromosomes to the hybrid as the diploid parents. Plate XXII a-g has graphs of three species hybrids that have smaller leaflets than L. leucocephala. Plate XXIII a-g has graphs of the hybrids with larger leaflets than L. leucocephala.

Plate XXII a-g has three small-leaflet triploid species hybrids graphed on a weighted x-axis to minimize dosage effects-- 1) L. leucocephala K8 x L. esculenta (LE), 2) L. leucocephala K8 x L. pulverulenta K75 (LP), and 3) L. diversifolia ssp. trichandra K11 x L. leucocephala K8 (ZL). Nearly all graphs have straight lines connecting the parents and hybrids. LP had a slightly heterotic leaf area due to more pinnae/leaf than expected.

Plate XXIII a-g has three large-leaflet triploid species hybrids graphed on a weighted x-axis to minimize dosage effects-- 1) L. leucocephala K8 x L. shannoni K405 (LS), 2) L. leucocephala K8 x L. lanceolata ssp. lanceolata K10 (LN), and 3) L. leucocephala K8 x L. trichodes K738 (LT). Graphs of leaflets/pinna and pinnae/leaf had straight lines connecting parents and hybrids. Leaflet length of LN and LS hybrids were less than expected, and caused the leaf areas of these hybrids to be lower than expected. Low values of leaflet length could be related to the generally poor health of these trees at the time of data sampling.

Plate XXIV a-g shows the graphs of data from a young seedling of L. pallida K376 x L. shannoni K445 (YS), which was sickly and died soon after transplanting. Data from a young sick tree was graphed in order to determine which leaf trait of the hybrid most closely approximated that of the expected mature tree. Graphs of most traits are noticeably poorer than expected; however, leaflets/pinna and leaflet width are relatively close to expected values. Leaflet width, however, was greater than expected.

6.16.4. Analysis of Tetraploid Hybrids for Leaf Traits.

Plate XXV a-g has four tetraploid species hybrids--1) L. leucocephala K8 x L. diversifolia ssp. diversifolia K156 (LD), 2) Its reciprocal DL, 3) L. diversifolia ssp. diversifolia K156 x L. pallida K376 (DY), and 4) Its reciprocal YD. Graphs of leaflets/pinna, pinnae/leaf and leaflets/leaf of all hybrids had straight lines connecting parents and species hybrids. LD had slightly smaller leaflet length and width than expected, and YD had slightly greater leaflet length and leaflet width than expected.

6.17. Discussion of Leaf Traits of Species Hybrids.

Additive gene inheritance has been reported to be the primary mode of leaf dimension inheritance in several plants. It was the primary mode of inheritance of leaf characters in Vicia faba (Suso et al., 1986), particularly leaflets per leaf. From this and earlier sudies (Martin and Cubrero, 1979, Suso et al., 1983), dominance effects in both primitive and advanced Vicia groups were considered to be negligible.

Pan (1985) studied two leaf traits of backcross populations of L. diversifolia ssp. trichandra K409 x L. shannoni K405 with each of its parental species. Leaflet length and leaflet number per pinna exhibited quantitative inheritance and leaflet length was controlled by several loci having variable expressivity.

The sample size, ten, was usually adequate for precise analyses, however, it should be emphasized that the leaves used for sampling were chosen subjectively. The largest source of sampling error was probably due to the environment -- interactions of shading, insect attack, water availability, and incident light on leaf traits. Other sources of sampling error included leaf placement on the branch, leaflet placement in the leaf, leaf age, and timing of data sampling with respect to the flowering cylces of the trees. Representative leaf samples can probably be obtained from the first fully-sized leaf on a branch in full sun on an actively growing tree.

6.18. Discussion of Economic Potential of Species Hybrids.

Economic potential of trees can be determined on the basis of a number of considerations including these: 1) Fast rates of accumulation of biomass, fodder, or wood accumulation, and coppicing ability, 2) High quality wood or fodder, 3) Tolerance of cold temperatures, harsh soils and pests, 4) Tree and root structure, and 5) Production (or lack thereof) of flowers, fruits, etc. Above-ground biomass accumulation is a key determining factor of the economic potential of a tree.

Several hybrids had poor growth rates and/or were psyllid susceptible. It should be noted, however, that most *L. leucocephala* performed poorly during the study (<1 m/yr).

Some hybrids had good rates of increase in height and high psyllid resistance, but failed to produce viable open-pollinated seeds-- for example, L. pulverulenta x L. diversifolia ssp. diversifolia and L. leucocephala x L. esculenta. Although lack of hybrid seed of hybrids like these precludes their use in the near future, they may be the needed enticement for the development of a Leucaena hybrid seed industry.

Exceptional triploid hybrids, like L. diversifolia ssp. trichandra x L. leucocephala (DV2 x LEU), produced small proportions of filled open-pollinated seed. Because the seed production is poor, and the progeny may not approximate the parents, we feel that these types of hybrids do not generally have economic potential. DV2 x LEU triploids were, however, the basis for a successful program to breed acid-tolerant leucaenas for Brazil (Hutton and De Sousae, 1985).

Currently we are focusing our breeding program on the tetraploid hybrids among three Leucaena species, L. diversifolia ssp. diversifolia (DV4), L. leucocephala (LEU), and L. pallida (PAL). DV4 x LEU and LEU x DV4 F1 and later generation hybrids are already being tested as KX3 in the Pacific Basin, Asia, Africa and the southern United States. LEU x DV4 and DV4 x LEU are the only tetraploid hybrids which have been self-compatible. They produce seed easily and abundantly. Psyllid-resistance of the most widely grown DV4 K156 x LEU K8-derived hybrid, K743, varies from poor to moderate, but new KX3 made from matings of psyllid-resistant *L. leucocephala* and *L. diversifolia* may have improved resistance.

LEU x PAL and PAL x LEU have fairly high growth rates and psyllid resistance, but have had some problems. LEU x PAL F1 hybrids segregated dwarf trees (22 %), and nearly half (37/76 or 49 %) had multiple stems and generally much reduced growth rates (Figure 8). Even so, several of our LEU x PAL appear to have exceptionally high accumulation rates for both leaves and wood. This hybrid is being called KX2.

DV4 x PAL and PAL x DV4 was one of the best hybrids observed during the study. DV4 x PAL had the highest average growth rate of all hybrids studied (4.3 m/yr) and had excellent psyllid resistance. Open-pollinated seed production is lighter than that of KX3 (DV4 x LEU), but recent (October, 1987) hand crosses of (DV4 x PAL) as female and *L. leucocephala* as pollen have set up to 35 pods per head, suggesting that bee pollination was not effective. This hybrid is being called KX1.

The tetraploid hybrids which resulted from diploid x tetraploid matings, *L. retusa* x *L. diversifolia* ssp. *diversifolia* (RET x DV4), and *L. retusa* x *L. pallida* (RET x PAL), had slow growth rates (1.3 and 1.9 m/yr, respectively), and RET x DV4 was psyllid susceptible. Hybridizations with *L. leucocephala* may enable cold-tolerance genes of *L. retusa* to be utilized in tetraploids.

6.19. Summary.

Growth rates of 547 trees of 50 species hybrids, varying in age and population number, were measured at Waimanalo, Hawaii. The best average growth rate was that of *L. diversifolia* ssp. *diversifolia* K156 x *L. pallida* K376 (4.3 m/yr), and the fastest growing tree was a tree of *L. diversifolia* ssp. *trichandra* K399 x *L. collinsii* K-- (6.2 m/yr). At least one tree of 30 species hybrids had growth rates over 3 m/yr. Fourteen of 41 (34 %) flowering species hybrids were seedless.

Generally the hybrids with high growth rates also had high psyllid tolerance. Several hybrids with the potental for fast growth were inhibited by psyllids. Psyllid resistance of species hybrids was generally intermediate to that of the parental species, although *L. retusa* x *L. diversifolia* ssp. *diversifolia* (4x=108) appeared to have greater psyllid damage than either parent, and *L. pulverulenta* x *L. diversifolia* ssp. *diversifolia* had heterosis for psyllid resistance.

Several morphological traits were followed in parental species and their hybrids. Traits which appeared to be inherited additively and probably had dosage effects (in triploid species hybrids) were 1) Red and yellow floral color, 2) Gland number per leaf, 3) Inflorescence diameter, and 4) Leaf traits. Petiolar gland shape appeared to be inherited additively.

6.20. Research Needs.

The tetraploid species and their hybrids need to be field tested under different management schemes, soils and environments. Three- and four-way tetraploid hybrids should be attempted; self-incompatible L. *diversifolia* or L. *leucocephala* x L. *pallida* hybrids could be used as female.

Autotetraploids of diploid species and chromosome-doubled diploid species hybrids should be grown and crossed with tetraploid species. Tetraploid hybrids resulting from matings of diploid and tetraploid species via unreduced gametes may be another way to produce unique tetraploid hybrids.

All hybrids, but particularly those with strong basal branching, should be checked for forage production and forage quality. A large-leaflet gene(s) of L. *macrophylla* K158 might be useful if transferred to fodder leucaenas.

Inheritance and mechanisms of psyllid resistance deserve immediate attention.

Many genetic traits (mimosine, leaflet size, flower color, etc.) can be studied using hybrids like L. *diversifolia* ssp. *trichandra* x L. *lanceolata*, which differ morphologically, but hybridize and produce viable F2 seed.

Studies are needed comparing the leaf traits of young seedlings with that of mature trees so that parentage analyses can be accurately made from young open-pollinated seedlings.

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Appendix 1. K Number Accession Directory.

Leucaena accessions of the U. Hawaii are listed in this directory from K1 to K903. Abbreviations for species were listed in Table 11. **Origin** is the country or Mexican state where the accession was collected. **PI** numbers are those used by the USDA. Other **ID** numbers include those of CSIRO, or refer to personal numbers of collectors.

Latitude and **longitude** have been listed only for those accessions whose original collection site was known in order to allow native geographical distributions of the species to be mapped. When actual latitude and longitude were not reported by collectors, they were determined to the nearest degree using maps and gazetters by Sorensson.

When **elevations** were not known, they were determined by Sorensson from descriptions of accession locations using 1:1,000,000 scale topographic maps (U.S.A. Defense Mapping Aerospace Center, St. Louis, Mo. 63118, revised January 1983). Estimations are denoted by an "e". Elevations from 0-150 meters were probably accurate to ±50 meters. Elevations ≥300 meters probably had a maximum error of ±150 meters. The maps used to determine elevation showed 300 meter increments above 150 meters. The error at elevations above 150 m may have been less, about ±100 m, since estimations could be made on the maps.

Accessions found to include more than one species were marked with asterisks.

Not Leucaenas

K#	SPECIES	ORIGIN	LAT/LONG		PI#	ID#	ELEV
9*	N.L.	Tonga	21.10S	175.10E	282460		
93	N.L.	Guam	13.29N	144.44E	317915		
100	N.L.	S.L. Potosi	22.01N	100.12W	312119		1160e
112	N.L.	Veracruz	18.28N	95.19W			245e
125	N.L.	Michoacan	20.19N	101.12W	324413		1830e
126	N.L.	Michoacan	20.09N	101.11W	324343		2425e
127	N.L.	Michoacan	20.09N	101.11W	324344		2425e
128	N.L.	Guanajuato	21.01N	101.15W	324414		1975e
129	N.L.	Guanajuato	21.10N	100.56W			2025e
133	N.L.	Morelos	18.39N	99.12W	324345		975e
135	N.L.	Morelos	18.49N	98.56W	324342		1325e
136	N.L.	Puebla	18.38N	98.41W	324423		1160e
139	N.L.	Puebla	18.25N	97.22W			1525e
263	N.L.	Sinaloa	23.20N	106.25W			75e
272	N.L.	Nayarit	22.52N	105.06W?		P421	1300e
283	N.L.	Guatemala	14.44N	90.21W	326482		900e
299	N.L.	Yucatan	21.05N	89.38W	324917		30e
300	N.L.	Yucatan	21.05N	89.38W	324918		30e
301	N.L.	Yucatan	20.58N	89.38W	324919		30e
302	N.L.	Yucatan	20.20N	89.41W	324920		60e
333	N.L.	Oaxaca	16.22N	95.10W	342960		100e
396	N.L.	Oaxaca	16.25N	95.25W			450e
398	N.L.	Oaxaca	16.29N	95.55W			1000e
496	N.L.	Indonesia	No locale		442828		
716	N.L.	S.L. Potosi	22.00N	100.08W			1125e
844	N.L.	Baja Calif.	23.23N	109.45W		J85-77	800e
845	N.L.	Baja Calif.	23.20N	109.45W		J85-78	800e
846	N.L.	Baja Calif.	23.20N	109.45W		J85-79	800e
877*	N.L.	Mexico			435937		

Leucaena Species - Unidentified - No seed.

K#	SPECIES	ORIGIN	LAT/LONG		PI#	ID#	ELEV
286	SHA?	Guatemala	14.53N	90.03W	326485		350e
287	LEU?	Guatemala	14.39N	90.28W	326486		1550e
308	ESC?	No locale	No locale			MBG1268310	
309	MAC?	No locale	No locale			MBG1032819	

Unidentified Leucaenas - Possibly New Species

K#	SPECIES	ORIGIN	LAT/LONG		PI#	ID#	ELEV
285	GUA	Guatemala	14.56N	89.58W	326484		300e
288	GUA	Guatemala	14.41N	90.26W	326487		1200e
547	DV4?	Veracruz	19.32N	96.55W	443524	Oak3231	1375e
740	GUA?	Guatemala	15.02N	89.40W		Oxford	480
745	CUS	Puebla	17.38N	97.37W		CPI85897	2400

746	SAL	Honduras	13.52N	87.18W		Oxford	660
747*	CUS	Mexico	16.48N	96.21W		CPI85880	2025
769	SHA?	Guatemala	14.40N	89.42W		Oxford	950
803	PAL?	Puebla	18.37N	97.24W		J85-35c	2000e
804	PAL?	Puebla	18.37N	97.24W		J85-36	2000e
805	PAL?	Puebla	18.37N	97.24W		J85-37c	2000e
806	PAL?	Puebla	18.37N	97.24W		J85-38	2000e
838	ESC?	Guerrero	17.50N	99.34W		J85-71	500e
904	SAL	Honduras	13.26N	87.11W		Oxford	600

Natural Hybrids (either contaminates or collected as such)

K#	SPECIES	ORIGIN	LAT/LONG		PI#	ID#	ELEV
11	ZxL	Ivory Coast	5.19N	4.02W	286296	CPI31167	
15	LxP	N.Guinea	9.35S	147.10E	281766	PA22	
16	LxP	N.Guinea	9.35S	147.10E	281767	PA7	
17	LxP	N.Guinea	9.35S	147.10E	281768	PA10	
18	LxP	New Britain	4.30S	152.05E	281769		
19*	PxL	Texas	No locale		286223		
103	PxL	Oahu	21.21N	157.42W	317916		
146*	DxL	Veracruz	18.54N	97.03W	324353		1200e
147	DxL	Veracruz	18.50N	96.49W	324346		550e
170*	LxD?	Veracruz	19.25N	96.40W	324405		600e
340	PxL	Oahu	21.21N	157.42W			
399*	ZxC	Hawaii	No orig. locale				
402	PxL	Philippines	No orig. locale			<=K340a>	
743	DxL	Oahu	21.21N	157.42W			
747*	DxL	Australia	No orig. locale			CPI85880	
788	DxL	Veracruz	18.54N	97.00W		J85-20	1175e
792	DxL	Veracruz	18.58N	96.57W		J85-24	1200e
868	PxL	Texas	26.25N	98.50W		J85-22c	75e
869*	PxL	Texas	26.25N	98.50W		V85-23c	75e
877	PxD	Mexico			435937		
891	LxP?	Sinaloa	25.44N	109.03W		CPI90814	25

L. collinsii

K#	SPECIES	ORIGIN	LAT/LONG		PI#	ID#	ELEV
180	COL	Chiapas	16.45N	93.07W	324347		750e
181	COL	Chiapas	16.46N	93.07W	324348		750e
182	COL	Chiapas	16.46N	93.07W	324349		750e
183	COL	Chiapas	16.46N	93.07W	324350		750e
185	COL	Chiapas	16.45N	93.07W	324351		750e
450	COL	Chiapas	16.45N	93.07W	443514	J78-45c	750e
456	COL	Chiapas	16.45N	93.07W	443515	J78-52c	750e
461	COL	Chiapas	16.45N	93.07W	443516	J78-57c	750e
462	COL	Chiapas	16.41N	93.00W	443517	J78-58c	675e
463	COL	Chiapas	16.41N	93.00W	443518	J78-59c	675e
466	COL	Chiapas	15.50N	91.57W	443519	J78-62c	850e

476	COL	Chiapas	16.45N 93.07W	443520	J78-73c	750e

L. diversifolia ssp. trichandra

K#	SPECIES	ORIGIN	LAT/LONG	PI#	ID#	ELEV
11	DV2	Ivory Coast	No orig. locale	286296	CPI31167	
107	DV2	Cameroons	No orig. locale	317917		600
184	DV2	Chiapas	16.45N 93.07W	324368		750e
215	DV2	Honduras	No locale	324308		
216	DV2	Honduras	14.00N 87.01W	324309		550e
248	DV2	Guatemala	14.15N 90.08W	324371		1200e
249	DV2	Guatemala	14.47N 90.12W	324372		800e
250	DV2	Guatemala	14.47N 90.12W	324373		800e
282	DV2	Guatemala	14.47N 90.14W	326481		800e
284	DV2	Guatemala	14.47N 90.14W	326483		800e
399*	DV2	Cameroons	No orig. locale			
406	DV2	Guatemala	14.41N 90.26W	443489	J78-01	3000e
407	DV2	Guatemala	14.42N 90.25W	443490	J78-2c	3000e
408	DV2	Guatemala	14.55N 89.57W	443491	J78-3	900
409	DV2	Guatemala	15.34N 91.52W	443492	J78-4	900e
410	DV2	Guatemala	14.43N 90.23W	443493	J78-5	900e
411	DV2	Guatemala	14.44N 90.21W	443494	J78-6c	900e
412	DV2	Guatemala	14.44N 90.21W	443495	J78-7	900e
413	DV2	Honduras	14.49N 90.11W	443497	J78-8	750e
422	DV2	El Salvador	13.49N 89.38W	443476	J78-17	1500
423	DV2	El Salvador	13.56N 89.32W	443477	J78-18c	1800e
454	DV2	Chiapas	16.45N 93.07W	443521	J78-49	750e
464	DV2	Chiapas	16.09N 92.08W	443522	J78-60	1525e
465	DV2	Chiapas	16.05N 92.02W	443523	J78-61	1475e
466	DV2?	Chiapas	15.42N 92.00W	443519	J78-62c	900e
478	DV2	Honduras	14.01N 87.05W	443498	J78-75c	1525e
479	DV2	Honduras	14.01N 87.05W	443499	J78-76c	1525e
480	DV2	Honduras	14.01N 87.05W	443500	J78-77c	1525e
483	DV2	Honduras	14.01N 86.21W	443501	J78-80	1200
749	DV2	Australia	No orig. locale		CPI46568	
752	DV2	Australia	No orig. locale		CPI85875	
777*	DV2?	Veracruz	18.58N 97.01W		J85-7	1375e
821	DV2	Oaxaca	17.05N 96.55W			2475e
822	DV2	Oaxaca	17.05N 96.56W		J85-55c58	2500e
823	DV2	Oaxaca	17.20N 96.26W		J85-56	2600e

L. diversifolia ssp. diversifolia

K#	SPECIES	ORIGIN	LAT/LONG	PI#	ID#	ELEV
145	DV4	Veracruz	18.54N 97.01W	324352		1175e
146	DV4	Veracruz	18.54N 97.01W	324353		1175e
154	DV4	Veracruz	18.54N 96.57W	324354		925e
155	DV4	Veracruz	18.56N 97.00W	324355		1225e
156	DV4	Veracruz	18.56N 97.00W	324356		1225e
157	DV4	Veracruz	19.01N 97.02W	324357		1525e

159	DV4	Veracruz	19.09N	96.58W	324358		1425e
160	DV4	Veracruz	19.13N	97.56W	324359		1425e
164	DV4	Veracruz	19.27N	96.45W	324360		600e
165	DV4	Veracruz	19.27N	96.45W	324360		600e
166	DV4	Veracruz	19.31N	96.52W	324362		1200e
167	DV4	Veracruz	19.32N	96.52W	324363		1200e
186	DV4	Veracruz	19.32N	96.55W	324369		1600e
583	DV4	Veracruz	19.22N	96.23W		Oak3279	75e
585	DV4	Veracruz	19.24N	96.39W	443526	Oak3281	300e
775	DV4	Veracruz	19.07N	97.03W		J85-5	1525e
776	DV4	Veracruz	18.54N	97.00W		J85-6c	1130e
777	DV4	Veracruz	18.58N	97.01W		J85-7	1375e
778	DV4	Veracruz	18.53N	97.04W		J85-8	1160e
779	DV4	Veracruz	18.53N	97.04W		J85-9	1160e
780	DV4	Veracruz	18.53N	97.04W		J85-11	1160e
781	DV4	Veracruz	18.54N	97.04W		J85-12	1160e
782	DV4	Veracruz	18.52N	97.03W		J85-13	1175e
783	DV4	Veracruz	18.52N	97.03W		J85-14	1175e
784	DV4	Veracruz	18.52N	97.03W		J85-15	1175e
785	DV4	Veracruz	18.52N	97.03W		J85-16	1175e
786	DV4	Veracruz	18.52N	97.04W		J85-17	1175e
787	DV4	Veracruz	18.52N	97.04W		J85-18	1175e
789	DV4	Veracruz	18.52N	96.55W		J85-21	775e
790	DV4	Veracruz	18.52N	96.55W		J85-22	775e
791	DV4	Veracruz	18.54N	96.55W		J85-23	850e
793	DV4	Veracruz	19.33N	96.55W		J85-25	1525e
794	DV4	Veracruz	19.33N	96.56W		J85-26	1525e
795	DV4	Veracruz	19.33N	96.56W		J85-27c	1525e
796	DV4	Veracruz	19.33N	96.56W		J85-28	1525e
797	DV4	Veracruz	19.35N	96.55W		J85-29	1400e
798	DV4	Veracruz	19.24N	96.57W		J85-30c	1200e
799	DV4	Veracruz	19.24N	96.57W		J85-31	1200e
802	DV4	Veracruz	19.23N	96.57W		J85-34	1200e

L. esculenta

K#	SPECIES	ORIGIN	LAT/LONG		PI#	ID#	ELEV
124	ESC	Mexico D.F.	19.02N	100.03W	324374		1825e
130	ESC	Morelos	18.53N	99.13W	324422		1200e
137	ESC	Puebla	18.36N	98.28W	324376		1450e
138	ESC	Puebla	18.53N	97.44W	324377		2050e
172	ESC	Oaxaca	17.04N	96.44W	324378		1650e
173	ESC	Oaxaca	17.07N	96.37W	324379		1825e
179	ESC	Oaxaca	17.04N	96.44W	324381		1650e
277	ESC	Morelos	18.58N	98.10W	326192		2025e
339	ESC	Mexico	No locale			HAES7816	
342	ESC	No locale	No locale				
380	ESC	Oaxaca	16.57N	96.33W		J77-37	1525e
457	ESC	Chiapas	16.45N	93.07W	443528	J78-53c	750e
459	ESC	Chiapas	16.45N	93.07W		J78-55c	750e
534	ESC	Morelos	18.39N	99.12W	443531	Oak3212	925e

535	ESC	Morelos	18.34N 99.11We	443532	Oak3213	925e
546	ESC	Guerrero	18.21N 99.51W	443534	Oak3230	1650e
561	ESC	Michoacan	19.57N 102.26W	443536	Oak3250	1800e
563	ESC	Colima			Oak3254	
642	ESC	Zacatecas	21.38N 102.59W		Oak3343	1375e
643	ESC	Zacatecas	21.31N 103.06W		Oak3344	1350e
644	ESC	Zacatecas	21.31N 103.06W		Oak3345	1350e
646	ESC	Jalisco			Oak3347	
649	ESC	Jalisco	20.04N 104.08W		Oak3350	1400e
650	ESC	Jalisco			Oak3351	
651	ESC	Jalisco			Oak3352	
681	ESC	Morelos	18.45N 99.15We			1150e
682	ESC	Morelos	18.45N 99.15We			1150e
683	ESC	Morelos	18.45N 99.15We			1150e
684	ESC	Morelos	18.45N 99.15We			1150e
685	ESC	Morelos	18.45N 99.15We			1150e
686	ESC	Morelos	18.45N 99.15We			1150e
687	ESC	Morelos	18.45N 99.15We			1150e
688	ESC	Morelos	18.45N 99.15We			1150e
689	ESC	Morelos	18.45N 99.15We			1150e
690	ESC	Morelos	18.45N 99.15We			1150e
691	ESC	Morelos	18.45N 99.15We			1150e
692	ESC	Morelos	18.45N 99.15We			1150e
693	ESC	Morelos	18.45N 99.15We			1150e
694	ESC	Morelos	18.45N 99.15We			1150e
695	ESC	Morelos	18.45N 99.15We			1150e
808	ESC	Puebla	18.30N 97.25W		J85-40	1700e
810	ESC	Puebla	18.25N 97.25W		J85-42	1600e
811	ESC	Puebla	18.25N 97.25W		J85-43c	1600e
812	ESC	Puebla	18.20N 97.25W		J85-45	1375e
829	ESC	Mexico D.F.	18.50N 99.45W		J85-62	2000e
830	ESC	Mexico D.F.	18.50N 99.45W		J85-63	2350e
894	ESC	Morelos	No locale			
895	ESC	Puebla	No locale			
896	ESC	Tlaxcala	No locale			
897	ESC	Morelos	18.37N 99.11W			1100e
898	ESC	No locale			#1:UH	

L. greggii

K#	SPECIES	ORIGIN	LAT/LONG	PI#	ID#	ELEV
310	GRE?	No locale	No locale		MBG802178	
744	GRE	Nuevo Leon	26.30N 100.23W			550e
756	GRE	Nuevo Leon	24.44N 99.55W			1650e
757	GRE	Nuevo Leon	24.50N 100.04W			1640
758	GRE	Nuevo Leon	24.42N 99.58W			1750
759	GRE	Nuevo Leon	24.42N 99.56W			1650
760	GRE	Nuevo Leon	24.42N 99.56W			1660
761	GRE	Nuevo Leon	24.42N 99.56W			1650
762	GRE	Nuevo Leon	24.42N 99.56W			1650
763	GRE	Nuevo Leon	24.42N 99.58W			1780

764	GRE	Nuevo Leon	24.42N	99.58W			1780
765	GRE	Nuevo Leon	24.42N	99.58W			1780
848	GRE	Nuevo Leon	24.40N	99.58W		VS85-2	1830e
849	GRE	Nuevo Leon	24.40N	99.58W		VS85-3	1830e
850	GRE	Nuevo Leon	24.40N	99.58W		VS85-4	1830e
851	GRE	Nuevo Leon	24.40N	99.55W		VS85-5	1830e
852	GRE	Nuevo Leon	24.40N	99.55W		VS85-6	1830e
853	GRE	Nuevo Leon	24.40N	99.55W		VS85-7	1830e
854	GRE	Nuevo Leon	24.40N	99.55W		VS85-8	1830e
855	GRE	Nuevo Leon	24.50N	100.05W		VS85-9c	1830e
856	GRE	Nuevo Leon	24.55N	100.05W		VS85-10c	1800e
857	GRE	Nuevo Leon	24.55N	100.05W		VS85-11	1800e
858	GRE	Coahuila	25.25N	101.00W		VS85-12	1880
859	GRE	Coahuila	24.50N	100.05W		VS85-13	1880
860	GRE	Coahuila	24.50N	100.05W		VS85-14c	1880e
862	GRE	Nuevo Leon	25.45N	100.50W		VS85-16c	1830e
863	GRE	Nuevo Leon	25.45N	100.50W		VS85-17	1830e
864	GRE	Nuevo Leon	25.45N	100.50W		VS85-18	1830e
866	GRE	Nuevo Leon	26.30N	100.25W		VS85-20	500e
867	GRE	Nuevo Leon	26.30N	100.25W		VS85-21c	500e
878	GRE	Coahuila	No locale				

L. lanceolata ssp. lanceolata

K#	SPECIES	ORIGIN	LAT/LONG		PI#	ID#	ELEV
10	LAN	Nayarit	21.50N	105.07W	286248		100e
162	LAN	Veracruz	19.20N	96.26W	324383		75e
163	LAN	Veracruz	19.20N	96.26W	324384		75e
168	LAN	Veracruz	19.27N	96.38W	324385		600e
169	LAN	Veracruz	19.27N	96.38W	324386		600e
171	LAN	Veracruz	19.23N	96.38W	324387		325e
206	LAN	Colombia	4.11N	76.09W	324443		950e
254	LAN	Sinaloa	23.11N	106.17W	324415		30e
255	LAN	Sinaloa	23.12N	106.10W	324416		100e
256	LAN?	Sinaloa	23.15N	106.08W	324417		150e
257	LAN	Sinaloa	23.15N	106.05W	324418		175e
258	LAN	Sinaloa	23.17N	106.06W	324419		125e
259	LAN	Sinaloa	23.17N	106.05W	324420		125e
262	LAN	Sinaloa	23.18N	106.26W	324421		10e
264	LAN	Sinaloa	23.11N	106.25W	324389		50e
265	LAN	Sinaloa	23.11N	106.25W	324390		50e
327	LAN	No locale	No locale			MBG117171	
401	LAN	Guerrero	17.58N	101.49W			150e
545	LAN	Guerrero	18.10N	100.30W	443618	Oak3229	450e
556	LAN	Michoacan	17.58N	102.19W	443724	Oak3244	75e
557	LAN	Michoacan	18.19N	102.18W	443548	Oak3245	910e
560	LAN	Michoacan			443549	Oak3249	
566	LAN	Michoacan			443725	Oak3250	
567	LAN	Colima	19.15N	103.44W	443550	Oak3260	490e
577	LAN	Veracruz			443551	Oak3273	
579	LAN	Veracruz	19.20N	96.18W	443552	Oak3275	30e

580	LAN	Veracruz	19.20N 96.18W	443553	Oak3276	30e
581	LAN	Veracruz	19.20N 96.25W	443554	Oak3277	85e
712	LAN	Colima	19.00N 103.50W		NU40714	250e
713	LAN	Sinaloa	25.20N 107.32W		NU40711	300e
714	LAN	Nayarit	21.50N 105.07W		NU42473	185e
766	LAN?	Veracruz	19.15N 96.19W			50
772	LAN	Veracruz	19.15N 96.25W		J85-2c	100e
773	LAN	Veracruz	19.15N 96.25W		J85-3	100e
774	LAN	Veracruz	19.15N 96.25W		J85-4	100e

L. lanceolata ssp. sousae

K#	SPECIES	ORIGIN	LAT/LONG	PI#	ID#	ELEV
379	Ln.S	Oaxaca	16.26N 95.53W		J77-36	1075e
381	Ln.S	Oaxaca	16.21N 95.09W		J77-39c	90e
384	Ln.S	Oaxaca	16.35N 94.57W		J77-42c	150e
385	Ln.S	Oaxaca	16.36N 94.57W		J77-43	150e
393	Ln.S	Oaxaca	16.44N 95.00W		J77-51	200e
468?	Ln.S	Chiapas	16.15N 93.54W		J78-65c	275e
470?	Ln.S	Chiapas	16.13N 93.52W		J78-67	225e

L. leucocephala

K#	SPECIES	ORIGIN	LAT/LONG	PI#	ID#	ELEV
1	LEU	N. Guinea	No orig. locale	281770?	CPI18623?	
2	LEU	Senegal	No orig. locale	281784		
3	LEU	N. Guinea	No orig. locale	281771		
4	LEU	Australia	No orig. locale	284758	CPI18228	
5	LEU	Australia	No orig. locale	280122	CPI18614	
6	LEU	N.Guinea	No orig. locale	281772		
7	LEU	Australia	No orig. locale	288002		
8	LEU	Zacatecas	21.16N 103.10W	263695		1100e
9	LEU	Tongai	No orig. locale	282460		
12	LEU	Honduras	14.05N 86.46We	282405		500e
13	LEU	Taiwan	No orig. locale	282474	CSR31182	
21	LEU	Philippines	No orig. locale	188810		
22	LEU	Philippines	No orig. locale	241167		
23	LEU	Zaire	No orig. locale	247682		
24	LEU	S.Africa	No orig. locale	274470		
25	LEU	India	No orig. locale	279180		
26	LEU	Virgin Isl.	No orig. locale	281605		
27	LEU	Colombia	3.32N 76.16W	281606		
28	LEU	El Salvador	13.41N 89.17W	281607		750e
29	LEU	Honduras	14.24N 89.13W	281608		750e
30	LEU	Yucatan	20.58N 89.36W	281609		15e
31	LEU	Australia	No orig. locale	281627		
32	LEU	Tanzania	No orig. locale	281636		
33	LEU	N.Guinea	No orig. locale	281773		
34	LEU	N.Guinea	No orig. locale	281774		
35	LEU	New Britain	No orig. locale	281775		

36	LEU	New Caledonia	No orig. locale	281777		
37	LEU	New Caledonia	No orig. locale	281778		
38	LEU	New Caledonia	No orig. locale	281779		
39	LEU	Puerto Rico	18.24N 66.03W	281780		
40	LEU	Sri Lanka	No orig. locale	281781		
41	LEU	Ghana	No orig. locale	281782		
42	LEU	Sierra Leone	No orig. locale	281783		
43	LEU	Philippines	No orig. locale	282396		
44	LEU	Colombia	3.32N 76.17W	282404		900e
45	LEU	Colombia	2.27N 76.36W	282458		1700e
46	LEU	Australia	No orig. locale	282461		
47	LEU	Fiji	No orig. locale	282462	CPI19580	
48	LEU	New Caledonia	No orig. locale	282463	CPI19852	
49	LEU	Brazil	No orig. locale	282464	CPI28106	
50	LEU	Philippines	No orig. locale	282465	CPI29215	
51	LEU	Thailand	No orig. locale	282466	CPI29633	
52	LEU	Vietnam	No orig. locale	282467	CPI30479	
53	LEU	Vietnam	No orig. locale	282468	CPI30481	
54	LEU	Australia	No orig. locale	282469		
55	LEU	Australia	No orig. locale	282470		
56	LEU	Australia	No orig. locale	282471		
57	LEU	Australia	No orig. locale	282472		
58	LEU	Australia	No orig. locale	282473		
59	LEU	Veracruz	No locale	282692		
60	LEU	Taiwan	No orig. locale	282817		
61	LEU	New Caledonia	No orig. locale	283697		
62	LEU	Ivory Coast	No orig. locale	286295		
63	LEU	Oahu	No orig. locale	288000		
64	LEU	Uganda	No orig. locale	288001		
65	LEU	Veracruz	No locale	288003		
66	LEU	El Salvador	13.36N 88.28W	288004		750e
67	LEU	El Salvador	13.36N 88.28W	288005		750e
68	LEU	Philippines	No orig. locale	288006		
69	LEU	Colombia	2.27N 76.36We	288007		1700e
70	LEU	Singapore	No orig. locale	288008		
71	LEU	Indonesia	No orig. locale	288009		
72	LEU	Maui	No orig. locale	288011		
73	LEU	Philippines	No orig. locale	290753		
74	LEU	Bolivia	No orig. locale	292345		
76	LEU	Taiwan	No orig. locale	279577	C32	
77	LEU	Taiwan	No orig. locale	295360	C60	
78	LEU	Taiwan	No orig. locale	295361	C61	
79	LEU	Taiwan	No orig. locale	295362	C62	
80	LEU	Taiwan	No orig. locale	295363	C63	
81	LEU	Taiwan	No orig. locale	295364	C64	
82	LEU	Taiwan	No orig. locale	295364	C65	
83	LEU	Indonesia	No orig. locale	317908		
84	LEU	Fiji	No orig. locale	317909		
85	LEU	Am. Samoa	No orig. locale	317910		
86	LEU	Tahiti	No orig. locale	317911		200
87	LEU	S. Africa	No orig. locale	300010		
88	LEU	S. Africa	No orig. locale	300011		

89	LEU	Sierra Leone	No orig. locale		305453		
91	LEU	Venezuela	9.10N	67.27W	317912		100e
92	LEU	Brazil	No orig. locale		317913		
94	LEU	Colombia	4.09N	73.37W	308544		305
95	LEU	Peru	10.30S	75.21W	308519		760
96	LEU	Venezuela	10.15N	67.36W	308568		460
97	LEU	Nicaragua	11.53N	85.57W	311128		65
98	LEU	Brazil	No locale		311513		
99	LEU	Argentina	No orig. locale		304650	<=K111>	
101	LEU	Virgin Isl.	No orig. locale		312118	CPI18623	
102	LEU	Bolivia	No orig. locale		313957		
104	LEU	Australia =K5	No orig. locale		316263	CPI18614	
105	LEU	Australia	No orig. locale		316264	CPI35541	
106	LEU	Australia	No orig. locale		316265	CPI36130	
108	LEU	Cameroon	No orig. locale		317918	298618	
109	LEU	Puerto Rico	18.25N	66.04We		BN12027	
110	LEU	Costa Rica	No locale		237147		
111	LEU	Argentina	No orig. locale		304650	<=K99>	
115	LEU	Tanzania	No orig. locale		319842		
116	LEU	Venezuela	10.04N	69.19W	319843		625e
117	LEU	Venezuela	10.04N	69.19W	319844		625e
118	LEU	Venezuela	10.04N	69.19W	319845		625e
119	LEU	Venezuela	10.04N	69.19W	319846		625e
120	LEU	Argentina	No orig. locale			A4255	
121	LEU	Virgin Isl.	No orig. locale				
122	LEU	Puerto Rico	18.03N	66.33W			
123	LEU?	Virgin Isl.	No orig. locale				
131	LEU?	Morelos	18.44N	99.16W	324375		1100e
132	LEU	Morelos	18.39N	99.13W	324391	J76-9	925e
134	LEU	Morelos	18.41N	99.06W	324392	J67-10	950e
140	LEU	Puebla	18.22N	97.15W	324393		1200e
141	LEU	Puebla	18.20N	97.15W	324394		1150e
142	LEU	Puebla	18.18N	97.14W	324395		1075e
143	LEU	Puebla	18.16N	97.09W	324396		1160e
144	LEU	Puebla	18.16W	97.09W	324397		1160e
148	LEU	Veracruz	18.51N	96.49W	324398		500e
149	LEU	Veracruz	18.49N	96.55W	324399		725e
150	LEU	Veracruz	18.35N	96.25W	324400		225e
151	LEU	Veracruz	18.28N	95.45W	324401		50e
152	LEU	Veracruz	18.28N	95.45W	324402		50e
153	LEU	Veracruz	18.55N	96.11W	324403		100e
161	LEU	Veracruz	19.20N	96.28W	324404		150e
170	LEU	Veracruz	19.25N	96.40W	324405		300e
189	LEU?	Colombia	4.18N	74.48W	324426		300e
190	LEU	Colombia	4.18N	74.48W	324427		300e
191	LEU	Colombia	4.18N	74.48W	324428		300e
192	LEU	Colombia	4.18N	74.48W	324429		300e
193	LEU	Colombia	4.18N	74.48W	324430		300e
194	LEU	Colombia	4.18N	74.48W	324431		300e
195	LEU	Colombia	4.18N	74.48W	324432		300e
196	LEU	Colombia	4.18N	74.48W	324433		300e
197	LEU	Colombia	4.18N	74.48W	324434		300e

198	LEU	Colombia	4.14N	74.35W	324435	500e
199	LEU	Colombia	3.28N	76.28W	324436	950e
200	LEU	Colombia	4.05N	76.11W	324437	950e
201	LEU	Colombia	4.05N	76.11W	324438	950e
202	LEU	Colombia	4.05N	76.11W	324439	950e
203	LEU	Colombia	4.10N	76.10W	324440	925e
204	LEU	Colombia	4.10N	76.10W	324441	925e
205	LEU	Colombia	4.10N	76.10W	324442	925e
207	LEU	Colombia	4.35N	75.46W	324444	900e
208	LEU	Colombia	4.35N	75.46W	324445	900e
209	LEU?	Colombia	4.31N	76.01W	324446	900e
210	LEU	Colombia	4.31N	76.01W	324447	900e
211	LEU	Colombia	4.31N	76.01W	324448	900e
212	LEU	Colombia	4.26N	76.08W	324449	825e
213	LEU	Colombia	4.12N	76.11W	324450	925e
214	LEU	Colombia	4.21N	76.11W	324451	900e
217	LEU	El Salvador	13.36N	88.29W	324310	750e
218	LEU	El Salvador	13.36N	88.29W	324311	750e
219	LEU	El Salvador	13.36N	88.29W	324312	750e
220	LEU	El Salvador	13.36N	88.29W	324313	750e
221	LEU	El Salvador	13.36N	88.29W	324314	750e
222	LEU	El Salvador	13.36N	88.29W	324315	750e
223	LEU	El Salvador	13.36N	88.29W	324316	750e
224	LEU	El Salvador	13.36N	88.29W	324317	750e
225	LEU	El Salvador	13.36N	88.29W	324318	750e
226	LEU	El Salvador	13.36N	88.29W	324319	750e
227	LEU	El Salvador	13.36N	88.29W	324320	750e
228	LEU	El Salvador	13.36N	88.29W	324321	750e
229	LEU	El Salvador	13.36N	88.29W	324322	750e
230	LEU	El Salvador	13.36N	88.29W	324323	750e
231	LEU	El Salvador	13.36N	88.29W	324324	750e
232	LEU	El Salvador	13.36N	88.29W	324325	750e
233	LEU	El Salvador	13.36N	88.29W	324326	750e
234	LEU	El Salvador	13.36N	88.29W	324327	750e
235	LEU	El Salvador	13.36N	88.29W	324328	750e
236	LEU	El Salvador	13.36N	88.29W	324329	750e
237	LEU	El Salvador	13.36N	88.29W	324330	750e
238	LEU	El Salvador	13.36N	88.29W	324331	750e
239	LEU	El Salvador	13.36N	88.29W	324332	750e
240	LEU	El Salvador	13.36N	88.29W	324333	750e
241	LEU	El Salvador	13.36N	88.29W	324334	750e
242	LEU	El Salvador	13.36N	88.29W	324335	750e
251	LEU	Sinaloa	23.11N	106.25W	324406	50e
252	LEU	Sinaloa	23.11N	106.25W	324388	50e
253	LEU	Sinaloa	23.10N	106.26W	324407	50e
260	LEU	Sinaloa	23.11N	106.25W	324408	50e
261	LEU	Sinaloa	23.11N	106.25W	324409	50e
266	LEU	Sinaloa	23.11N	106.25W	324410	50
267	LEU	Sinaloa	23.11N	106.25W	324411	50
268	LEU	Sinaloa	23.11N	106.25W	324412	50e
269	LEU	Sierrra Leone	No orig. locale		320983	
271	LEU	Argentina	No orig. locale		321077	

273	LEU	Brazil	No orig. locale	337088		
274	LEU	Colombia	No locale	326537		
275	LEU	Australia	No orig. locale	331797	<=K1?>	
276	LEU	Australia	No orig. locale	331798	<=K5?>	
278	LEU	Kauai	No orig. locale			
279	LEU	Kauai	No orig. locale			
281	LEU	Oahu	No orig. locale			
289	LEU	Brazil	No orig. locale	322552	IRI1239	
290	LEU	Brazil	No orig. locale	322553	IRI1988	
291	LEU	Brazil	No orig. locale	337009		
292	LEU	El Salvador	13.21N 88.27W	324905		250e
293	LEU	El Salvador	13.36N 88.29W?	324906		750e
294	LEU	Guatemala	14.55N 89.47W	324908		225e
295	LEU	Yucatan	20.58N 89.36W	324913		25e
296	LEU	Yucatan	20.22N 89.46W	324914		50e
297	LEU	Yucatan	20.58N 89.36W	324915		25e
298	LEU	Yucatan	20.53N 89.45W	324916		25e
303	LEU	Ivory Coast	No orig. locale	330480		
304	LEU	Benin	No orig. locale	330481		
305	LEU	Costa Rica	9.54N 83.41W	338605	Oak791	600e
306	LEU	Costa Rica	9.54N 83.41W	338606		600e
307	LEU	Costa Rica	9.54N 83.41W	338607		600e
312	LEU	Thailand	No orig. locale			10
313	LEU	Thailand	No orig. locale			60
314	LEU	Thailand	No orig. locale			
315	LEU	Thailand	No orig. locale			
316	LEU	Thailand	No orig. locale			0
317	LEU	Thailand	No orig. locale			15
318	LEU	Thailand	No orig. locale		<=K8?>	
319	LEU	Thailand	No orig. locale			
320	LEU	Thailand	No orig. locale			
321	LEU	Thailand	No orig. locale			
322	LEU	Thailand	No orig. locale			
323	LEU	Thailand	No orig. locale			
324	LEU	Thailand	No orig. locale			
325	LEU	Thailand	No orig. locale			
326	LEU	Thailand	No orig. locale			
328	LEU	Venezuela	No orig. locale	339550		
329	LEU	Honduras	14.42N 86.15W			450e
330	LEU	Nicaragua	11.53N 85.57W			100e
331	LEU	Honduras	14.26N 87.37W			650e
332	LEU	Nicaragua	11.53N 85.57W			120e
334	LEU	Lebanon	No orig. locale			
335	LEU	Yucatan	20.27N 90.02W	342959		50e
336	LEU	Yucatan	21.10N 89.38W	342957		10e
337	LEU	Veracruz	19.46N 96.25W	342956		10
338	LEU	Campeche	19.23N 90.42W	342958		10e
341	LEU	Oahu	20.14N 155.50W			
344	LEU	Veracruz	18.46N 96.42W		J77-1	325e
345	LEU	Veracruz	18.47N 96.45W		J77-2	400e
346	LEU	Veracruz	18.50N 96.23W		J77-3	115e
347	LEU	Veracruz	18.50N 96.23W		J77-4	115e

348	LEU	Veracruz	18.46N	96.28W		J77-5	125e
349	LEU	Veracruz	17.57N	96.10W		J77-6	150e
350	LEU	Oaxaca	17.47N	96.19W		J77-7	300e
351	LEU	Veracruz	18.10N	96.07W		J77-8	110e
352	LEU	Campeche	19.05N	90.43W		J77-9	10e
353	LEU	Campeche	18.55N	90.43W		J77-10	50e
354	LEU	Campeche	18.50N	90.43W		J77-11	35e
355	LEU	Campeche	18.45N	90.43W		J77-12	75e
356	LEU	Campeche	18.45N	90.43W		J77-13	75e
357	LEU	Australia	No orig. locale			<=K500>	
358	LEU	Campeche	19.51N	90.32W		J77-16	5e
359	LEU	Campeche	19.45N	90.38W		J77-17c	5e
360	LEU	Campeche	19.45N	90.36W		J77-18c	15e
361	LEU	Campeche	19.48N	90.34W		J77-19c	5e
362	LEU	Campeche	19.51N	90.32W		J77-20	15e
363	LEU	Campeche	19.50N	90.20W		J77-22	50e
364	LEU	Campeche	19.51N	90.32W		J77-23c	10e
365	LEU	Yucatan	20.20N	89.40W		J77-24c	75e
366	LEU	Yucatan	20.58N	89.37W		J77-25c	30e
367	LEU	Yucatan	20.54N	89.25W		J77-26c	30e
368	LEU	Yucatan	20.41N	88.38W		J77-27c	50e
369	LEU	Campeche	19.51N	90.32W		J77-28c	10e
370	LEU	Campeche	20.40N	88.34W		J77-29	50e
371	LEU	Quintana Roo	21.09N	86.45W		J77-29c	5e
372	LEU	Quintana Roo	20.12N	87.26W		J77-30c	5e
373	LEU	Quintana Roo	20.12N	87.26W		J77-30c2	5e
374	LEU	Belize	17.30N	88.12W		J77-31c	5e
375	LEU	El Salvador	13.42N	89.19We		J77-32c	900e
377	LEU	Oaxaca	16.45N	96.20W		J77-34	1600e
378	LEU	Oaxaca	16.40N	96.18W		J77-35	775e
382	LEU	Oaxaca	16.35N	95.00W		J77-40c	50e
383	LEU	Oaxaca	16.31N	94.57W		J77-41c	75e
386	LEU	Oaxaca	16.40N	96.18W		J77-44	800e
387	LEU	Quintana Roo	18.30N	88.19W		J77-45	30e
388	LEU	Quintana Roo	18.29N	88.20W		J77-46	30e
389	LEU	Veracruz	17.33N	95.04W		J77-47	50e
390	LEU	Oaxaca	16.50N	95.03W		J77-48	225e
391	LEU	Oaxaca	16.51N	95.02W		J77-49	225e
392	LEU	Oaxaca	16.52N	95.02W		J77-50	225e
394	LEU	Oaxaca	16.34N	94.38W		J77-52	120e
395	LEU	Oaxaca	16.22N	95.22W		J77-53	240e
397	LEU	Oaxaca	16.29N	95.55W		J77-55	750e
400	LEU	Cameroons	No orig. locale				
403	LEU	Indonesia	No orig. locale				
404	LEU	Indonesia	No orig. locale				
415	LEU	El Salvador	13.36N	88.29W	443478	J78-10c	750e
416	LEU	El Salvador	13.36N	88.29W	443479	J78-11c	750e
417	LEU	El Salvador	13.26N	88.42W	443480	J78-12c	120e
418	LEU	El Salvador	13.21N	88.29W	443481	J78-13c	275e
419	LEU	El Salvador	13.21N	88.28W	443482	J78-14c	275e
420	LEU	El Salvador	13.37N	88.01W	443483	J78-15c	275e
421	LEU	El Salvador	13.52N	89.28W	443484	J78-16	1000

424	LEU	Belize	17.30N	88.12W	443467	J78-19c	60e
425	LEU	Belize	17.15N	88.47W	443468	J78-20	45e
426	LEU	Yucatan	21.00N	89.36W	443555	J78-21c	30e
427	LEU	Yucatan	21.05N	89.36W	443556	J78-22c	25e
428	LEU	Yucatan	21.00N	89.36W	443557	J78-23c	25e
429	LEU	Yucatan	20.04N	89.03W	443558	J78-24	70e
430	LEU	Yucatan	20.02N	89.00W	443559	J78-25c	75e
431	LEU	Yucatan	20.57N	89.37W	443560	J78-26c	30e
432	LEU	Yucatan	20.53N	89.45W	443561	J78-27c	25e
433	LEU	Yucatan	20.51N	89.47W	443562	J78-28c	25e
434	LEU	Yucatan	20.26N	89.46W	443563	J78-29c	60e
435	LEU	Campeche	20.15N	89.40W	443564	J78-30c	100e
436	LEU	Campeche	19.44N	89.55W	443565	J78-31c	75e
437	LEU	Campeche	19.48N	90.15W	443566	J78-32c	60e
438	LEU	Campeche	19.48N	90.16W	443567	J78-33c	60e
439	LEU	Campeche	19.49N	90.20W	443568	J78-34c	30e
440	LEU	Campeche	19.50N	90.25W	443569	J78-35c	25e
442	LEU	Campeche	19.46N	90.32W	443570	J78-37c	10e
443	LEU	Campeche	19.45N	90.33W	443571	J78-38c	10e
446	LEU	Campeche	19.39N	90.40W	443572	J78-41c	10e
448	LEU	Campeche	19.20N	90.44W	443573	J78-43c	10e
449	LEU	Campeche	19.50N	90.24W	443574	J78-44c	25e
452	LEU	Oaxaca	16.20N	95.14W	443575	J78-47c	100e
453	LEU	Oaxaca	16.20N	95.14W		J78-48c	100e
455	LEU	Chiapas	16.45N	93.07W	443576	J78-50	750e
458	LEU	Chiapas	16.14N	93.14W	443577	J78-54c	725e
460	LEU	Chiapas	16.42N	93.00W	443578	J78-56	500e
467	LEU	Chiapas	15.40N	93.11W	443579	J78-64c	150e
469	LEU	Chiapas	16.14N	93.54W	443580	J78-66c	125e
481	LEU?	Honduras	14.25N	87.40W	443503	J78-78	100e
482	LEU	Honduras	14.00N	86.23W	443502	J78-79	1100e
484	LEU	Colombia	7.27N	77.07W	443469	J78-81	35e
485	LEU	Nicaragua	12.16N	86.34W	443473	J78-82	50e
486	LEU	Nicaragua	12.09N	86.17W	443474	J78-83c	75e
488	LEU	Colombia	3.32N	76.16W	443470	J78-85c	950e
492	LEU	Philippines	No orig.	locale	442831		
493	LEU	Philippines	No orig.	locale	442833	<=K8?>	
494	LEU	Philippines	No orig.	locale	442832		
495	LEU?	Thailand	No orig.	locale	442829		
497	LEU	Hawaii	No orig.	locale	442830		
498	LEU	Bolivia	No orig.	locale	442827		
499	LEU	Quintana Roo	18.30N	88.18W			60e
500	LEU	Australia	No orig.	locale			
507	LEU	Quintana Roo	18.30N	88.18W	443581	Oak3179	10e
508	LEU	Yucatan	21.00N	89.36W	443582	Oak3183	25e
509	LEU	Yucatan	21.00N	89.36W	443583	Oak3184	25e
510	LEU	Yucatan	21.03N	89.35W	443584	Oak3185	25e
511	LEU	Yucatan	21.06N	89.31W	443585	Oak3186	20e
512	LEU	Yucatan	20.45N	89.27W	443586	Oak3188	30e
513	LEU	Yucatan	20.55N	89.27W	443587	Oak3189	25e
514	LEU	Yucatan	20.52N	89.20W	443588	Oak3190	25e
515	LEU	Yucatan	20.52N	89.12W	443589	Oak3191	25e

516	LEU	Yucatan	20.40N	89.01W	443590	Oak3192	35e
517	LEU	Merida	20.45N	89.00W	443591	Oak3193	30e
518	LEU	Mexico	20.45N	88.54W	443592	Oak3194	30e
519	LEU	Merida	20.40N	88.18W	443593	Oak3195	30e
520	LEU	Yucatan	20.39N	88.13W	443594	Oak3196	30e
521	LEU	Quintana Roo	21.05N	86.46W	443595	Oak3197	5e
522	LEU	Yucatan	20.40N	88.11W	443596	Oak3198	10e
523	LEU	Quintana Roo	20.57N	86.51W	443597	Oak3199	10e
524	LEU	Quintana Roo	20.58N	86.51W	443598	Oak3200	10e
525	LEU	Quintana Roo	20.04N	87.28W	443599	Oak3201	5e
526	LEU	Quintana Roo	20.03N	87.28W	443600	Oak3202	5e
527	LEU	Quintana Roo			443601	Oak3203	
528	LEU	Quintana Roo			443602	Oak3204	
529	LEU	Quintana Roo			443603	Oak3205	
530	LEU	Quintana Roo			443604	Oak3206	
531	LEU	Quintana Roo			443605	Oak3207	
532	LEU	Yucatan	20.00N	88.52W	443606	Oak3208	60e
533	LEU	Yucatan	20.58N	88.36W	443607	Oak3209	30e
536	LEU	Guerrero			443608	Oak3214	
537	LEU	Morelos	18.39N	99.12W	443609	Oak3215	850e
538	LEU	Morelos	18.44N	99.16W	443610	Oak3216	1100e
539	LEU	Guerrero	18.20N	100.40W	443612	Oak3223	400e
540	LEU	Guerrero	18.20N	100.40W	443613	Oak3224	400e
541	LEU	Guerrero	18.20N	100.40W	443614	Oak3225	400e
542	LEU	Guerrero	18.20N	100.40W	443615	Oak3226	400e
543	LEU	Guerrero	18.20N	100.40W	443616	Oak3227	400e
544	LEU	Guerrero	18.09N	100.29W	443617	Oak3228	450e
548	LEU	Guerrero	17.31N	101.16W	443619	Oak3234	100e
549	LEU	Guerrero	16.50W	99.53W	443620	Oak3235	50e
550	LEU	Guerrero	16.50N	99.53W	443621	Oak3236	50e
551	LEU	Guerrero	17.09N	100.24W	443622	Oak3237	125e
552	LEU	Guerrero	16.52N	99.58W	443623	Oak3238	50e
553	LEU	Guerrero	17.13N	100.41W	443624	Oak3239	135e
554	LEU	Guerrero	16.51N	99.59W	443625	Oak3241	50e
555	LEU	Guerrero	17.45N	101.40W	443547	Oak3242	75e
558	LEU	Michoacan	18.30N	102.05W	443627	Oak3247	525e
559	LEU	Michoacan	19.01N	102.05W	443628	Oak3248	375e
562	LEU	Colima	19.12N	103.48W	443629	Oak3249	450e
564	LEU	Colima	19.12N	103.48W	443630	Oak3250	450e
565	LEU	Colima	19.13N	103.42W	443631	Oak3256	485e
568	LEU	Veracruz	18.49N	96.23W	443632	Oak3262	100e
569	LEU	Veracruz	18.49N	96.23W	443633	Oak3263	100e
570	LEU	Veracruz	18.44N	96.30W	443634	Oak3264	150e
571	LEU	Veracruz	18.50N	96.23W	443635	Oak3265	100e
572	LEU	Veracruz	18.44N	96.32W	443636	Oak3266	150e
573	LEU	Veracruz	18.49N	96.43W	443637	Oak3267	400e
574	LEU	Veracruz			443638	Oak3268	
575	LEU	Veracruz	19.00N	96.10W	443639	Oak3269	50e
576	LEU	Veracruz	19.20N	96.18W	443640	Oak3272	5e
578	LEU	Veracruz	19.25N	96.24W	443641	Oak3274	5e
582	LEU	Veracruz	19.20N	96.25W	443642	Oak3278	5e
584	LEU	Veracruz	19.46N	96.25W	443643	Oak3280	25e

586	LEU	Veracruz	21.31N	98.23W	443644	Oak3282	125e
587	LEU	Veracruz	22.00N	98.18W		Oak3283	50e
588	LEU	Veracruz	21.31N	98.23W	443645	Oak3285	125e
589	LEU	S.L. Potosi	21.56N	98.55W	443646	Oak3286	125e
590	LEU	S.L. Potosi	21.57N	98.58W	443647	Oak3287	125e
591	LEU	Veracruz	22.03N	98.10W	443648	Oak3288	25e
592	LEU	Tamaulipas	22.12N	97.53W		Oak3289	25e
593	LEU	Veracruz	21.53N	98.20W	443649	Oak3290	25e
594	LEU	Veracruz	21.31N	98.23W	443650	Oak3291	25e
595	LEU	S.L. Potosi	22.01N	99.02W	443651	Oak3292	110e
596	LEU	S.L. Potosi	22.02N	98.59W	443653	Oak3294	110e
597	LEU	Tamaulipas	22.24N	97.55W	443654	Oak3295	10e
598	LEU	Tamaulipas	22.24N	97.55W	443655	Oak3296	10e
599	LEU	Tamaulipas	22.24N	97.55W	443656	Oak3297	10e
600	LEU	Tamaulipas	22.24N	97.55W	443739	Oak3298	10e
601	LEU	Tamaulipas	24.24N	98.12W	443657	Oak3299	125e
602	LEU	Tamaulipas	23.46N	98.13W	443658	Oak3300	120e
603	LEU	Tamaulipas			443659	Oak3301	
604	LEU	Tamaulipas			443660	Oak3302	
605	LEU	Tamaulipas			443661	Oak3303	
606	LEU	Tamaulipas			443662	Oak3304	
607	LEU	Tamaulipas			443663	Oak3305	
608	LEU	Tamaulipas	24.51N	98.10W	443664	Oak3306	60e
609	LEU	Tamaulipas	24.33N	98.29W	443665	Oak3307	225e
610	LEU	Tamaulipas			443666	Oak3308	
611	LEU	Tamaulipas	24.52N	98.08W	443667	Oak3309	150e
612	LEU	Tamaulipas	25.32N	97.43W	443668	Oak3310	15e
613	LEU	Tamaulipas	25.54N	97.32W	443669	Oak3313	15e
614	LEU	Tamaulipas	25.55N	97.35W	443670	Oak3314	15e
615	LEU	Tamaulipas	25.58N	97.42W	443671	Oak3315	10e
616	LEU	Tamaulipas	25.57N	97.40W	443672	Oak3316	5e
617	LEU	Tamaulipas	25.58N	98.00W	443673	Oak3317	25e
618	LEU	Tamaulipas	26.26N	99.09W	443674	Oak3318	25e
619	LEU	Tamaulipas	26.32N	99.00We	443675	Oak3319	100e
620	LEU	Tamaulipas	26.06N	98.17W	443676	Oak3320	25e
621	LEU	Tamaulipas	25.53N	97.30W	443677	Oak3321	15e
622	LEU	Tamaulipas	26.09N	98.25W		Oak3322	50e
623	LEU	Tamaulipas	27.30N	99.31W	443678	Oak3323	125e
624	LEU	Tamaulipas	27.30N	99.31W	443679	Oak3324	125e
625	LEU	Tamaulipas	27.30N	99.31W	443680	Oak3325	125e
626	LEU	Nuevo Leon	26.04N	100.08W	443681	Oak3326	450e
627	LEU	Nuevo Leon	26.30N	100.10W	443682	Oak3327	275e
628	LEU	Nuevo Leon	25.48N	100.16W	443683	Oak3328	450e
629	LEU	Nuevo Leon	25.40N	100.19W	443684	Oak3329	550e
630	LEU	Coahuila	26.54N	101.25W	443685	Oak3330	550e
631	LEU	Coahuila	26.54N	101.25W	443686	Oak3331	550e
632	LEU	Nuevo Leon	26.01N	100.32W	443687	Oak3332	650e
633	LEU	Coahuila	25.33N	100.58W	443688	Oak3333	1400e
634	LEU	Coahuila	26.54N	101.25W	443689	Oak3334	550e
635	LEU	Coahuila	25.25N	101.00W	443690	Oak3335	1575e
636	LEU	Coahuila	25.25N	101.00W	443740	Oak3336	1575e
637	LEU	Coahuila	26.54N	101.25W	443691	Oak3337	550e

638	LEU	Nuevo Leon	25.40N	100.15W	443692	Oak3338	500e
639	LEU	Nuevo Leon	25.40N	100.09W	443693	Oak3339	350e
640	LEU	Nuevo Leon	25.25N	100.00W	443694	Oak3340	400e
641	LEU	Nuevo Leon			443695	Oak3341	
645	LEU?	Zacatecas	21.34N	103.05W		Oak3346	1350e
647	LEU	Zacatecas	21.16N	103.12W	443696	Oak3348	1125e
648	LEU	Jalisco	20.13N	104.00W	443697	Oak3349	1125e
652	LEU	S.L. Potosi	22.00N	99.03W	443698	Oak3354	110e
653	LEU	S.L. Potosi	21.58N	99.12W	443699	Oak3355	100e
654	LEU	S.L. Potosi	22.14N	97.52W	443700	Oak3356	10e
655	LEU	Tamaulipas	22.57N	99.02W	443701	Oak3357	110e
656	LEU	Tamaulipas	23.45N	99.08W	443702	Oak3358	300e
657	LEU	Tamaulipas	23.46N	99.08W	443703	Oak3359	300e
658	LEU	Tamaulipas	23.49N	99.01W	443704	Oak3360	200e
659	LEU	Tamaulipas	23.49N	99.06W	443705	Oak3361	225e
660	LEU	Tamaulipas	24.05N	98.38W	443706	Oak3362	250e
661	LEU	Tamaulipas	24.01N	98.47W	443707	Oak3363	150e
662	LEU	Tamaulipas	24.03N	98.44W	443708	Oak3364	150e
663	LEU	Tamaulipas	24.13N	98.28W	443709	Oak3365	125e
664	LEU	Tamaulipas			443710	Oak3366	
665	LEU	Nuevo Leon	25.12N	99.49W	443711	Oak3368	275e
666	LEU	Nuevo Leon	25.12N	99.53W	443712	Oak3369	300e
667	LEU	Nuevo Leon	25.15N	99.54W	443713	Oak3370	300e
668	LEU	Nuevo Leon	25.17N	99.58W	443714	Oak3371	300e
669	LEU	Yucatan	20.58N	89.36We	443715	Oak3372	25e
670	LEU	Yucatan	20.58N	89.36We	443716	Oak3373	25e
671	LEU	Yucatan	20.58N	89.36We	443717	Oak3374	25e
672	LEU	Yucatan	20.58N	89.36We	443718	Oak3375	25e
673	LEU	Yucatan	20.58N	89.36We	443719	Oak3376	25e
674	LEU	Yucatan	20.58N	89.36We	443720	Oak3377	25e
675	LEU	Zacatecas	21.37N	102.59W	443721	Oak3378	1350e
676	LEU	Malaysia	No orig.	locale			
677	LEU	Philippines	No orig.	locale			
678	LEU	Thailand	No orig.	locale			
696	LEU	Brazil	No orig.	locale	164061		
697	LEU	Philippines	No orig.	locale	282397		
698	LEU	Philippines	No orig.	locale			
700	LEU	Ghana	No orig.	locale		NU61429	
701	LEU	India	No orig.	locale		NU62127	
702	LEU	India	No orig.	locale		NU61027	
703	LEU	Kenya	No orig.	locale		NU33053	
704	LEU	Nuevo Leon	No locale			NU49378	
705	LEU	Yucatan	20.58N	89.36We		CPY426	30e
706	LEU	Yucatan	20.58N	89.36We		CPY645	30e
707	LEU	Yucatan	20.58N	89.36We		CPY658	30e
708	LEU	Yucatan	20.58N	89.36We		CPY966	30e
709	LEU	Yucatan	20.58N	89.36We		CPY1002	30e
710	LEU	Yucatan	20.58N	89.36We		CPY1051	30e
711	LEU	Yucatan	20.58N	89.36We		NU40714	30e
715	LEU	Sonora	No locale			NU48505	
717	LEU	Sonora	27.55N	110.54W		NU48500	200e
720	LEU	Texas	26.10N	98.00W			50e

721	LEU	Texas	25.44N 97.29W		NU40791	10e
722	LEU	Texas	26.10N 98.00W			50e
723	LEU	Texas	26.10N 98.00W			50e
724	LEU	China	No orig. locale		CPI35541	
725	LEU	Honduras	13.38N 86.49We			1050e
739	LEU	China	No orig. locale			
742	LEU	Honduras	13.38N 86.49W		CEH19/81	1050e
754	LEU	Australia	No orig. locale		CPI58391	
766	LEU?	Veracruz	19.15N 96.19W			75e
767	LEU	Veracruz	19.20N 96.28W			50e
770	LEU	Baja Calif.	23.25N 110.19W			50e
771	LEU	Veracruz	19.20N 96.19W		J85-1	40e
800	LEU	Veracruz	19.30N 96.55W		J85-32	1400e
801	LEU	Veracruz	19.30N 96.55W		J85-33	1400e
809	LEU	Puebla	18.25N 97.25W		J85-41	1575e
813	LEU	Puebla	18.15N 97.10W		J85-46	1075e
814	LEU	Oaxaca	18.10N 97.05W		J85-47	975e
839	LEU	Guerrero	16.49N 99.23W		J85-72	200e
840	LEU	Baja Calif.	24.20N 110.20W		J85-73	25e
841	LEU	Baja Calif.	24.20N 110.20W		J85-74c	25e
842	LEU	Baja Calif.	24.20N 110.20W		J85-75	25e
843	LEU	Baja Calif.	23.25N 109.40W		J85-76	225e
861	LEU	Coahuila	25.30N 100.55W		V85-15	450e
865	LEU	Nuevo Leon	26.12N 100.28W		V85-19	640e
875	LEU	Sonora	25.45N 108.57W			30e
876	LEU	Australia	No orig. locale			
882	LEU	Sonora	30.12N 106.26W		CPI84511	680
883	LEU	Sinaloa	25.47N 109.05W		CPI84512	25
884	LEU	Sinaloa	25.40N 109.05W		CPI84513	5
885	LEU	Sinaloa	25.40N 109.05W		CPI84514	15
886	LEU	Baja Calif.	26.52N 112.00W		CPI84958	35
887	LEU	Coahuila	27.51N 101.07W		CPI85176	370
888	LEU	Nuevo Leon	27.14N 100.09W		CPI85180	200
889	LEU	Tamaulipas	25.53N 98.50W		CPI85183	35
890	LEU	Sonora	27.56N 110.54W		CPI90329	220
891	LEU	Sinaloa	25.44N 109.03W		CPI90814	25
892	LEU	Sinaloa	26.41N 108.27W		CPI90840	300
893	LEU	Sonora	27.29N 109.56W		CPI90861	300

L. macrophylla

K#	SPECIES	ORIGIN	LAT/LONG	PI#	ID#	ELEV
113	MAC?	Veracruz	18.28N 95.19W			250e
114	MAC?	Veracruz	18.28N 95.19W			250e
158	MAC	Veracruz	18.25N 95.17W	324382	J77-37	150e
826	MAC	Jalisco	19.31N 103.30W		J85-59	1375e
827	MAC?	Jalisco	19.30N 103.28W		J85-60	1275e
828	MAC	Mexico D.F.	18.55N 100.08W		J85-61	1525e
831	MAC	Morelos	18.39N 99.31W		J85-64	1450e
832	MAC	Morelos	18.40N 99.31W		J85-65	1525e
833	MAC	Morelos	18.43N 99.24W		J85-66	1050e
834	MAC	Morelos	18.57N 99.14W		J85-67	1800e

835	MAC	Morelos	18.57N 99.14W		J85-68	1800e
836	MAC	Morelos	18.54N 98.58W		J85-69c	1400e
837	MAC	Guerrero	17.20N 99.28W		J85-70	1160e
902	MAC?	Oaxaca	15.59N 97.16W		CEH47/85	10

L. pallida

K#	SPECIES	ORIGIN	LAT/LONG	PI#	ID#	ELEV
174	PAL	Oaxaca	17.08N 96.47W	324364		1675e
175	PAL	Oaxaca	17.11N 96.47W	324365		1750e
176	PAL	Oaxaca	17.15N 96.51W	324380		1750e
177	PAL	Oaxaca	17.15N 96.51W	324366		1750e
178	PAL	Oaxaca	17.15N 96.51W	324367		1750e
376	PAL	Oaxaca	17.08N 96.46W		J77-33c	1675e
748	PAL	Australia	No orig. locale		CPI84581	
807	PAL	Veracruz	19.30N 96.55W		J85-39	1400e
815	PAL	Oaxaca	17.05N 96.38W		J85-48c	1800e
816	PAL	Oaxaca	17.05N 96.38W		J85-49	1875e
817	PAL	Oaxaca	17.15N 96.50W		J85-50c	1800e
818	PAL	Oaxaca	17.21N 96.50W		J85-51	1925e
819	PAL	Oaxaca	17.21N 96.50W		J85-52	1925e
820	PAL	Oaxaca	17.21N 96.50W		J85-53c	1925e
824	PAL	Oaxaca	17.21N 96.25W		J85-57c	1925e

Pulverulenta

K#	SPECIES	ORIGIN	LAT/LONG	PI#	ID#	ELEV
14	PUL	Congo	No orig. locale	247683		
19	PUL	Texas	26.10N 98.10We	286223		60e
20	PUL	Indonesia	No orig. locale	288010		
75	PUL	S.L. Potosi		294093		1710
340	PUL	Oahu	No orig. locale			
753	PUL	Australia	No orig. locale		CPI23145	
755	PUL	Australia	No orig. locale		CPI85193	
847	PUL	Nuevo Leon	24.50N 99.28W		V85-1c	300e
869	PUL	Texas	26.25N 98.50W		V85-23c	75e
870	PUL	Texas	26.15N 98.15W		V85-24	60e
871	PUL	Texas	26.15N 98.10W		V85-25	50e
872	PUL	Texas	25.55N 97.30W		V85-26	10e
873	PUL	Texas	25.55N 97.25W		V85-27	5e
874	PUL	Texas	25.55N 97.30W		V85-28	10e
881	PUL	Australia	No orig. locale			

L. retusa

K#	SPECIES	ORIGIN	LAT/LONG	PI#	ID#	ELEV
270	RET	Texas	29.28N 101.22W	321025		400e
280	RET	Texas	No orig. locale	321631		
343	RET	Texas	No orig. locale			
501	RET	Texas	29.18N 103.16W	435919	J79-1	1460

502	RET	Texas	29.33N 103.05W	435920	J79-2	915
503	RET	Texas	29.33N 103.05W	435921	J79-3	1005
504	RET	Texas	29.34N 103.07W	435922	J79-4	800
505	RET	Texas	29.48N 102.46W	435923	J79-5	760
506	RET	Texas	29.51N 102.48W	435924	J79-6	800
679	RET	Texas?	No orig. locale			
680	RET	Texas	No orig. locale			
699	RET	Texas	No orig. locale		A79830	
718	RET	Texas	No locale		PMT63277	
719	RET	Texas	No locale		NU40036	
768	RET	Texas	No locale			
899	RET	Texas	29.44N 102.43W		Kirmse	
900	RET	Texas	30.37N 104.03W		Kirmse	
901	RET	Texas	30.40N 103.48W		Kirmse	

L. shannoni

K#	SPECIES	ORIGIN	LAT/LONG	PI#	ID#	ELEV
243	SHA	El Salvador	14.04N 89.32W	324336		450e
244	SHA	Guatemala	14.21N 89.50W	324339		900e
245	SHA	Guatemala	14.21N 89.49W	324339		900e
246	SHA	Guatemala	14.21N 89.50W	324340		900e
247	SHA	Guatemala	14.21N 89.50W	324341		900e
405	SHA	Oahu	No orig.locale			
414	SHA	El Salvador	14.05N 89.31W	443485	J78-9	450e
441	SHA	Campeche	19.47N 90.30W	443728	J78-36c	15e
444	SHA	Campeche	19.44N 90.36W	443729	J78-39c	15e
445	SHA	Campeche	19.41N 90.40W	443730	J78-40c	5e
447	SHA	Campeche	19.38N 90.40W	443731	J78-42c	5e
451	SHA	Chiapas	16.48N 93.16W	443732	J78-46c	800e
471	SHA	Chiapas	16.27N 93.08W	443733	J78-68c	900e
472	SHA	Chiapas	16.27N 93.08W	443734	J78-69	900e
473	SHA	Chiapas	16.39N 93.46W	443735	J78-70c	750e
474	SHA	Chiapas	16.42N 93.42W	443736	J78-71c	600e
475	SHA	Chiapas	16.41N 93.41W	443737	J78-72c	600e
477	SHA	Campeche	19.51N 90.32W	443738	J78-74	5e
487	SHA	El Salvador	13.33N 88.30W	443486	J78-84	750e
741	SHA	Honduras	14.22N 87.39W		Oxford	650

L. trichodes

K#	SPECIES	ORIGIN	LAT/LONG	PI#	ID#	ELEV
90	TRI	Venezuela	10.35N 66.56W	317914		750e
187	TRI?	Colombia	4.12N 74.39W	324424		325e
188	TRI?	Colombia	4.15N 74.52W	324425		300e
311	TRI	No locale	No locale		MBG1620448	
489	TRI	Ecuador	10.03S 80.27W	443471	J78-86c	225
490	TRI	Ecuador	2.15S 80.10W	443472	J78-87	150e
491	TRI	Peru	9.08S 75.54W	443475	J78-88	640
726	TRI	Colombia	10.30N 75.25We		H15-1A	125e
727	TRI	Colombia	10.30N 75.25We		H15-2B	125e

728	TRI	Colombia	10.30N	75.25We	H16-1A	125e
729	TRI	Colombia	10.30N	75.25We	H16-1B	125e
730	TRI	Colombia	10.30N	75.25We	H16-1C	125e
731	TRI	Colombia	10.30N	75.25We	H16-1D	125e
732	TRI	Colombia	10.30N	75.25We		125e
733	TRI	Colombia	10.29N	73.15W	H38-1A	150e
734	TRI	Colombia	10.29N	73.15W	H38-1B	150e
735	TRI	Colombia	10.29N	73.15W	H38-1C	150e
736	TRI	Colombia	11.15N	74.02We	CIAT8813	100
737	TRI	Colombia	11.16N	74.04W	CIAT8812	280
738	TRI	Colombia	10.33N	73.12We	CIAT8814	200
750	TRI?	Australia	No orig.	locale	CPI86139	
751	TRI?	Australia	No orig.	locale	CPI86144	
880	TRI	Costa Rica	11.05N	85.37W	BLSF1758	10
903	TRI	Venezuela	9.38N	70.18W	CEH2/86	700

Appendix 2. Pollination Data.

Appendix 2a. Interspecific Crosses and Selfs, Sorted Alphabetically by Species Used as Female.

This appendix lists all 1604 pollinations, both species crosses and self, which were reported in this study. The abbreviations for species, used under the heading **CROSS**, were explained in Table 11.

Explanations of other headings are as follows: **FEMALE** and **MALE** refers to K accessions, which were listed in Appendix 1. **EMAS** denotes whether the flower head was emasculated, "emas" means it was, and "no e" means it was not. **XQUAL** is whether the pollination was of the highest quality ("high"), or not ("med" for medium quality; low quality crosses were not reported). **XFERT** are compatibility classes, "f" means at least one viable-appearing seed was harvested, "no f" means the cross did not produce viable-appearing seeds, and "no f?" pollinations gave inconclusive results. **XDATE** is the month, day and number of cross of the day for the pollination. **OBS** is the earliest date when the number of pods set on the flower head could be counted. **DAYS** are the days between the date of pollination ("XDATE") and harvest, or pod abortion (**PICKDT**). The numbers of stigmas on a head to which pollen was applied was **ST#**. **POD** is the number of pods which developed following pollination, **DRP** was the number of pods dropped between the **XDATE** and **PICKDT**, and **PIK** was the number of pods harvested. **OK**, **BUG** and **ABT** are seed classes; those seeds appearing viable ("OK"), those attacked by insects and/or fungi ("BUG"), and abortive seeds ("ABT"). **CM** are the mean length in cm of the harvested pods. **WHO** indicates the pollinator; "CS" (Charles Sorensson), "PAN" (Dr. Fuh-Jiunn Pan) and "BOO" (James Booman). **NOTES** are notes indicating unusual circumstances or observations surrounding the pollination. "GLY" indicates glycerin was used to help the pollen stick to the stigma. "ABT" means the cross aborted surprisingly early, or there were an strikingly high number of aborted seeds. Similarly "PDROP" denotes an unusually heavy or early abortion of pods. "2 DAY FLWR" means the flower head was pollinated one day after anthesis. "PSYLLIDS" means that psyllids damaged the pods or the female tree used in the cross. "REFRIG POLLEN" means the pollen was refrigerated (at 5^{o}C) for 4-24 hours.

COLLINSII (FEMALE) CROSSES

collinsii selfs

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
c83	K450-1:H	same	no e	hi q	no f	8/11-6/83	--	4	8/15/83	15	0							CS	SLY
c83	K450-1:H	same	no e	hi q	no f	8/16-5/83	--	5	8/21/83	15	0							CS	
c83	K450-1:H	same	no e	hi q	no f	8/9-4/83	--	6	8/15/83	12	0							CS	
c83	K450-1:H	same	no e	hi q	no f	8/9-1/83	--	6	8/15/83	15	0							CS	
c83	K450-1:H	same	no e	hi q	no f	8/9-5/83	--	6	8/15/83	10	0							CS	SLY
c83	K450-1:H	same	no e	hi q	no f	8/16-6/83	--	5	8/21/83	15	0							CS	
c83	K450-1:H	same	no e	hi q	no f	8/9-6/83	--	6	8/15/83	10	0							CS	SLY
c83	K450-1:H	same	no e	hi q	no f	8/26-18/83	--	5	8/31/83	15	0							CS	
c83	K450-1:H	same	no e	hi q	no f	8/26-19/83	--	5	8/31/83	15	0							CS	
c83	K450-1:H	same	no e	hi q	no f	8/16-8/83	--	5	8/21/83	15	0							CS	
c83	K450-1:H	same	no e	hi q	no f	8/11-3/83	--	4	8/15/83	15	0							CS	SLY
c83	K450-1:H	same	no e	hi q	no f	8/16-4/83	--	5	8/21/83	15	0							CS	
c83	K450-1:H	same	no e	hi q	no f	8/26-21/83	--	5	8/31/83	15	0							CS	
c83	K450-1:H	same	no e	hi q	no f	8/9-12/83	--	6	8/15/83	10	0							CS	SLY
c83	K450-1:H	same	no e	hi q	no f	8/11-2a/83	--	4	8/15/83	15	0							CS	
c83	K450-1:H	same	no e	hi q	no f	8/9-13/83	8/15	232	3/29/84	15	1	0	1	0	0	14	14.5	CS	STRAY POLLEN?
c83	K450-1:N	same	no e	hi q	no f	8/26-20/83	--	5	8/31/83	15	0							CS	
c83	K450-1:H	same	no e	hi q	no f	8/11-5/83	--	4	8/15/83	15	0							CS	SLY
c83	K450-1:H	same	emas	hi q	no f	8/11-2b/83	--	4	8/15/83	20	0							CS	
c83	K450-1:H	same	no e	hi q	no f	8/9-11/83	--	6	8/15/83	10	0							CS	SLY
c83	K450-1:H	same	no e	hi q	no f	8/9-2/83	--	6	8/15/83	10	0							CS	
c83	K450-1:H	same	no e	hi q	no f	8/26-17/83	--	5	8/31/83	20	0							CS	
c83	K450-1:H	same	no e	hi q	no f	8/16-7/83	--	5	8/21/83	15	0							CS	
c83	K450-1:H	same	no e	hi q	no f	8/9-9/83	--	6	8/15/83	10	0							CS	SLY
c83	K450-1:H	same	no e	hi q	no f	8/11-4/83	--	4	8/15/83	15	0							CS	SLY
c83	K450-1:H	same	no e	med q	no f	8/9-8/83	--	6	8/15/83	10	0							CS	
c83	K450-1:I	same	no e	med q	no f	8/3-1/83	--	12	8/15/83	15	0							CS	
c83	K450-1:H	same	no e	med q	no f	8/9-10/83	--	6	8/15/83	5	0							CS	
c83	K450-1:H	same	no e	med q	no f	8/11-13/83	--	4	8/15/83	15	0							CS	SMALL STIGMA
c83	K450-1:H	same	no e	med q	no f	8/11-15/83	--	4	8/15/83	15	0							CS	SMALL STIGMA
c83	K450-1:H	same	no e	med q	no f	8/11-16/83	--	4	8/15/83	10	0							CS	SMALL STIGMA
c83	K450-1:H	same	no e	med q	no f	8/3-2/83	--	12	8/15/83	10	0							CS	
c83	K450-1:H	same	no e	med q	no f	8/11-14/83	--	4	8/15/83	15	0							CS	SMALL STIGMA
c83	K450-1:H	same	no e	med q	no f	8/9-3/83	--	6	8/15/83	5	0							CS	
c83	K450-1:H	same	no e	med q	no f	8/11-12/83	--	4	8/15/83	15	0							CS	SMALL STIGMA

collinsii x diversifolia ssp. diversifolia

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
cd84	K450-1:H	K156-1:H	no e	hi q	no f	10/1-22/84	10/8	279	7/14/85	15	1	0	1	0	0	19	15.5	CS	SEED ABT
cd84	K450-1:H	K156-1:H	no e	hi q	no f	10/18-3/84	--	3	10/21/84	14	0							CS	POLLEN POOR
cd85	K450-1:H	K156-1:H	no e	hi q	no f	9/14-11/85	9/26	167	2/28/86	15	14	0	14	0	0	191	13.5	CS	EARLY ABT
cd85	K450-1:H	K156-1:H	no e	hi q	no f	11/12-3/85	--	9	11/21/85	8	0							CS	
cd85	K450-1:H	K156-1:H	no e	hi q	no f	11/12-4/85	11/21	108	2/28/86	8	5	2	3	0	0	31	10.5	CS	EARLY ABT
cd85	K450-1:H	K156-1:H	no e	hi q	no f	11/12-5/85	11/21	108	2/28/86	8	6	2	4	0	0	62	6.5	CS	EARLY ABT
cd85	K450-1:H	K156-1:H	no e	hi q	no f	9/14-12/85	10/4	167	2/28/86	25	23	6	17	0	0	291	13.5	CS	EARLY ABT

collinsii x leucocephala

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
cl83	K450-1:H	K8-10:A2	no e	hi q	no f	8/10-3/83	10/5	231	3/29/84	15	3	0	3	0	0	25	11.5	CS	
cl83	K450-1:H	K8-10:A2	no e	hi q	no f	8/10-5/83	10/5	231	3/29/84	15	3	0	3	0	0	16	10.0	CS	SEED ABT
cl83	K450-1:H	K8-10:A2	no e	hi q	no f	8/10-2/83	10/5	231	3/29/84	15	5	0	5	0	0	41	11.5	CS	NO F
cl83	K450-1:H	K8-10:A2	no e	hi q	no f	8/10-1/83	--	56	10/5/83	20	0							CS	
cl83	K450-1:H	K8-10:A2	no e	med q	no f	8/10-4/83	10/5	231	3/29/84	15	10	0	10	0	0	73	10.0	CS	

collinsii x macrophylla

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ca83	K450-1:H	K158-2:I	no e	hi q	no f	7/7-4/83	--	4	7/11/83	15	0							CS	
ca83	K450-1:H	K158-2:I	no e	hi q	f	7/7-1a/83	7/22	245	3/29/84	15	4	0	4	44	6	2	13.0	CS	NICE SEED
ca83	K450-1:H	K158-2:I	no e	med q	f	7/7-1b/83	7/22	245	3/29/84	10	2	0	2	11	2	4	11.5	CS	
ca85	K450-1:H	K158-1:H	no e	hi q	no f	11/19-1/85	--	6	11/25/85	15	0							CS	GLY

collinsii x pallida

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
cy84	K450-1:H	K376-10:I	no e	hi q	no f	10/4-5/84	--	4	10/8/84	19	0							CS	
cy84	K450-1:I	K376-10:I	no e	hi q	no f	10/4-6/84	--	4	10/8/84	20	0							CS	
cy84	K450-1:H	K376-10:I	no e	hi q	no f	10/4-4/84	--	4	10/8/84	22	0							CS	
cy85	K450-1:H	K178-1:I	no e	hi q	no f	9/1-1/85	--	4	9/5/85	15	0							CS	
cy85	K450-1:H	K178-1:I	no e	hi q	no f	9/1-2/85	--	4	9/5/85	15	0							CS	
cy85	K450-1:H	K178-1:I	no e	hi q	no f	9/1-3/85	--	4	9/5/85	16	0							CS	
cy85	K450-1:H	K178-1:I	no e	hi q	no f	9/1-4/85	--	4	9/5/85	12	0							CS	
cy85	K450-1:H	K178-1:I	no e	hi q	no f	9/1-5/85	--	4	9/5/85	15	0							CS	
cy85	K450-1:H	K178-1:I	no e	hi q	no f	9/1-6/85	--	4	9/5/85	15	0							CS	
cy85	K450-1:H	K178-1:I	no e	hi q	no f	9/1-7/85	--	4	9/5/85	15	0							CS	
cy85	K450-1:H	K178-1:I	no e	hi q	no f	9/1-8/85	--	4	9/5/85	8	0							CS	

collinsii x pulverulenta

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
cp83	K450-1:H	K340-2:Y2	no e	med q	no f	7/29-4/83	--	4	8/2/83	5	0							CS	LOW ST#

collinsii x retusa

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
cr83	K450-1:H	K280-1:H	emas	hi q	no f	8/26-2a/83	--	5	8/31/83	15	0							CS	
cr83	K450-1:H	K280-1:H	emas	hi q	no f	8/26-1/83	--	5	8/31/83	15	0							CS	
cr83	K450-1:H	K280-1:H	emas	hi q	no f	8/26-3/83	--	5	8/31/83	15	0							CS	
cr83	K450-1:H	K280-1:H	emas	hi q	no f	8/26-4/83	--	5	8/31/83	15	0							CS	
cr83	K450-1:H	K280-1:H	emas	med q	no f	8/26-6/83	--	5	8/31/83	15	0							CS	POLLEN OLD?
cr83	K450-1:H	K280-1:H	emas	med q	no f	8/26-5/83	--	5	8/31/83	15	0							CS	BLY
cr83	K450-1:H	K280-1:H	no e	med q	no f	8/21-2/83	--	10	8/31/83	20	0							CS	
cr83	K450-1:H	K280-1:H	no e	med q	no f	8/21-1/83	--	10	8/31/83	15	0							CS	2 DAY FLOWER
cr84	K450-1:H	K502-2:H	no e	hi q	no f	6/26-2b/84	--	23	7/19/84	15	0							CS	
cr84	K450-1:H	K502-2:H	no e	hi q	no f	6/24-5/84	--	25	7/19/84	10	0							CS	
cr84	K450-1:H	K502-1:H	no e	hi q	no f	6/25-4/84	--	24	7/19/84	10	0							CS	
cr84	K450-1:H	K502-2:H	no e	hi q	no f	6/25-3/84	--	24	7/19/84	15	0							CS	
cr84	K450-1:H	K502-2:H	no e	med q	no f	6/28-9/84	--	21	7/19/84	5	0							CS	
cr84	K450-1:H	K502-2:H	no e	med q	no f	6/28-7/84	--	21	7/19/84	5	0							CS	
cr84	K450-1:H	K502-2:H	no e	med q	no f	6/28-8/84	--	21	7/19/84	5	0							CS	

collinsii x diversifolia ssp. trichandra

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
cz83	K450-1:H	K409-8:I	emas	hi q	no f	8/16-12/83	--	5	8/21/83	15	0							CS	BLY
cz83	K450-1:H	K409-8:I	emas	hi q	no f	8/16-13/83	--	5	8/21/83	15	0							CS	BLY
cz83	K450-1:H	K409-8:I	emas	hi q	no f	8/16-11/83	--	5	8/21/83	15	0							CS	BLY
cz83	K450-1:H	K409-8:I	emas	med q	no f	8/16-14/83	--	5	8/21/83	10	0							CS	BLY
cz83	K450-1:H	K409-8:I	emas	med q	no f	8/16-9/83	--	5	8/21/83	10	0							CS	BLY
cz83	K450-1:H	K409-8:I	emas	med q	no f	8/16-10/83	--	5	8/21/83	10	0							CS	SLY
cz85	K450-1:H	B85-?:B2	no e	hi q	no f	11/12-4/85	--	13	11/25/85	14	0							CS	

collinsii x esculenta

CROS8	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	DBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUS	ABT	CM	WHO	NOTES
ce84	K450-1:H	K138-6:I	no e	hi q	no f	7/12-7/84	--	7	7/19/84	10	0							CS	
ce85	K450-1:H	K138-1:H	no e	hi q	no f?	11/4-4/85	11/11	106	2/28/86	19	19	0	19	0	0	214	12.5	CS	EARLY ABT
ce86	K450-1:H	K:UH	no e	med q	no f	5/6-2/86	--	3	5/9/86	4	0							CS	
ce86	K450-1:H	K:UH	no e	med q	no f	5/6-3/86	--	3	5/9/86	4	0							CS	
ce86	K450-1:H	K:UH	no e	med q	no f	5/6-4/86	--	3	5/9/86	4	0							CS	
ce86	K450-1:H	K:UH	no e	med q	no f	7/5-8/86	--	5	7/10/86	5	0							CS	
ce86	K450-1:H	K:UH	no e	hi q	no f	7/5-1/86	--	5	7/10/86	17	0							CS	
ce86	K450-1:H	K:UH	no e	hi q	no f	7/5-6/86	--	5	7/10/86	12	0							CS	

collinsii x lanceolata ssp. lancemlata

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
cn81	K185-4:I	K264-1:I	no e	hi q	f	8/26a/81	--	218	7/21/82	15	8	0	8	36	0	54	--	BOO	
cn81	K185-4:I	K264-1:I	no e	hi q	f	8/26b/81	--	218	7/21/82	15	10	0	10	6	0	31	--	BOO	
cn81	K185-4:I	K264-10:I	no e	med q	f	8/26c/81	--	218	7/21/82	15	2	0	2	0	0	4	--	BOO	
cn85	K450-1:H	K10-2:H	no e	hi q	no f	11/12-20/85	--	9	11/21/85	11	0							CS	
cn85	K450-1:H	K10-2:H	no e	hi q	f	11/12-23/85	11/21	108	2/28/86	21	10	3	7	0	0	145	16.5	CS	EARLY ABT
cn85	K450-1:H	K10-2:H	no e	hi q	f	11/12-21/85	11/21	108	2/28/86	17	5	2	3	0	0	30	5.5	CS	EARLY ABT
cn85	K450-1:H	K10-2:H	no e	hi q	f	9/3-1/85	9/13	178	2/28/86	20	13	0	13	0	0	190	13.0	CS	ABT
cn85	K450-1:H	K10-2:H	no e	hi q	f	11/13-10/85	11/21	107	2/28/86	17	17	13	4	0	0	79	15.0	CS	EARLY ABT

collinsii x lanceolata ssp. sousae

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
cm83	K450-1:H	K393-1:H	no e	hi q	no f	8/26-16/83	--	5	8/31/83	15	0							CS	
cm83	K450-1:H	K393-1:H	no e	hi q	no f	8/22-7/83	8/31	219	3/29/84	15	8	1	7	0	0	97	13.5	CS	SEED ABT
cm83	K450-1:H	K393-1:H	no e	hi q	no f	8/26-14/83	--	5	8/31/83	15	11	11	0					CS	
cm83	K450-1:H	K393-1:H	no e	hi q	no f	10/5-7/83	10/17	175	3/29/84	15	5	0	5	0	0	69	14.0	CS	SEED ABT
cm83	K450-1:H	K393-1:H	emas	hi q	no f	8/26-13/83	--	5	8/31/83	15	15	15	0					CS	FAST PDROP
cm83	K450-1:H	K393-1:H	emas	hi q	no f	8/16-15/83	--	5	8/21/83	15	0							CS	
cm83	K450-1:H	K393-1:H	emas	hi q	no f	8/16-19/83	--	5	8/21/83	25	10	10	0					CS	LOTS PDROP'
cm83	K450-1:H	K393-1:H	no e	hi q	no f	8/22-10/83	--	9	8/31/83	15	0							CS	
cm83	K450-1:H	K393-1:H	emas	hi q	no f	8/16-16/83	--	5	8/21/83	20	0							CS	
cm83	K450-1:H	K393-1:H	no e	hi q	no f	8/22-8/83	10/5	219	3/29/84	15	2	0	2	0	0	26	14.0	CS	SEED ABT
cm83	K450-1:H	K393-1:H	no e	hi q	no f	8/16-17/83	8/21	225	3/29/84	15	14	7	7	0	0	101	13.5	CS	SEED ABT
cm83	K450-1:H	K393-1:H	emas	hi q	no f	8/22-9/83	8/31	219	3/29/84	15	12	4	8	0	0	76	13.0	CS	CYGON, NO F
cm83	K450-1:H	K393-1:H	no e	hi q	no f	8/26-15/83	8/31	215	3/29/84	15	11	1	10	0	0	52	10.5	CS	ABT, NO WEEVIL
cm83	K450-1:H	K393-1:H	no e	med q	no f	8/22-16/83	--	9	8/31/83	15	0							CS	
cm83	K450-1:H	K393-1:H	no e	med q	no f	8/22-17/83	--	9	8/31/83	15	0							CS	
cm83	K450-1:H	K393-1:H	emas	med q?	no f	8/16-8/83	--	5	8/21/83	18	0							CS	

collinsii x shannoni

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
cs83	K450-1:H	K445-2:H	no e	hi q	no f	8/26-9/83	8/31	215	3/29/84	15	4	0	4	0	0	47	13.5	CS	SEED ABT
cs83	K450-1:H	K445-2:H	no e	hi q	no f	8/26-8/83	8/31	215	3/29/84	15	4	0	4	0	0	36	12.5	CS	SEED ABT
cs83	K450-1:H	K445-2:H	no e	hi q	no f	8/26-10/83	8/31	215	3/29/84	15	1	0	1	0	0	17	18.0	CS	SEED ABT
cs83	K450-1:H	K445-2:H	no e	hi q	no f	8/26-7/83	8/31	215	3/29/84	15	6	0	6	0	0	69	13.0	CS	ABT
cs83	K450-1:H	K445-1:H	emas	med q	no f	8/26-11/83	--	5	8/31/83	20	0							CS	GLY
cs85	K450-1:H	K445-1:H	no e	hi q	no f	10/7-1/85	10/11	143	2/28/86	20	20	0	20	0	0	226	12.0	CS	EARLY ABT
cs85	K450-1:H	K445-1:H	no e	med q	no f	10/7-2/85	10/11	25	11/1/85	10	10	9	1	0	0	19	12.5	CS	EARLY ABT
cs85	K450-1:H	K445-1:H	no e	med q	no f	10/7-3/85	10/11	25	11/1/85	10	10	7	3	0	0	48	13.0	CS	EARLY ABT
cs85	K450-1:H	K445-1:H	no e	med q	no f	10/7-4/85	10/11	25	11/1/85	10	10	7	3	0	0	62	13.0	CS	EARLY ABT
cs85	K450-1:H	K445-1:H	no e	med q	no f	10/7-5/85	10/11	25	11/1/85	10	10	4	6	0	0	105	12.0	CS	EARLY ABT
cs85	K450-1:H	K445-1:H	no e	med q	no f	10/7-6/85	10/11	24	11/1/85	10	10	10	0					CS	EARLY ABT
cs85	K450-1:H	K445-1:H	no e	med q	no f	10/7-7/85	10/11	25	11/1/85	10	10	8	2	0	0	39	12.5	CS	EARLY ABT

collinsii x trichodes

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ct84	K450-1:H	K738-1:H	no e	hi q	no f	10/4-8/84	--	4	10/8/84	13	0							CS	
ct84	K450-1:H	K738-1:H	no e	hi q?	no f	10/4-7/84	--	4	10/8/84	8	0							CS	
ct85	K450-1:H	K738-1:H	no e	hi q	no f	10/4-3/85	10/11	146	2/28/86	17	1	0	1	0	0	19	18.0	CS	ABT
ct85	K450-1:H	K738-1:H	no e	hi q	no f	10/4-2/85	10/11	146	2/28/86	18	4	0	4	0	0	32	11.0	CS	ABT, GLY

DIVERSIFOLIA SSP. DIVERSIFOLIA (FEMALE) CROSSES

diversifolia ssp. diversifolia selfs

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
d82	K156-1:H	same	emas	hi q	no f	6/30-7a/82	7/5	10	7/9/82	15	8	8	0					CS	PDROP
d82	K156-1:H	same	emas	hi q	no f	6/30-2/82	--	6	7/5/82	15	6	6	0					CS	PDROP
d82	K156-1:H	same	emas	hi q	f	6/30-15/82	7/9	100	10/7/82	15	9	5	4	68	0	2	12.5	CS	Tree died 10/7
d82	K156-1:H	same	emas	hi q	f	6/30-9/82	7/9	100	10/7/82	20	16	10	6	91	1	2	15.0	CS	PDROP
d82	K156-1:H	same	emas	hi q	f	6/30-5/82	7/9	100	10/7/82	15	10	1	9	154	0	4	12.5	CS	Tree died 10/7
d82	K156-1:H	same	emas	hi q	no f	6/30-13/82	7/4	6	7/5/82	15	7	7	0					CS	FAST PDROP
d82	K156-1:H	same	emas	hi q	f	6/30-7b/82	7/9	100	10/7/82	15	13	9	4	68	6	0	13.0	CS	Tree died 10/7
d82	K156-1:H	same	emas	hi q	f	6/30-4a/82	7/9	100	10/7/83	15	6	5	1	8	0	0	5.7	CS	Tree died 10/7
d82	K156-1:H	same	emas	hi q	f	6/30-18/82	7/9	100	10/7/82	15	8	3	5	75	14	3	11.0	CS	GSEED =75?
d82	K156-1:H	same	emas	hi q	f	7/2-22/82	7/9	97	10/7/82	20	19	0	19	317	3	4	12.0	CS	Tree died 10/7
d82	K156-1:H	same	emas	med q	no f?	6/30-8/82	--	5	7/5/82	15	0							CS	
d82	K156-1:H	same	emas	med q	no f?	6/30-16/82	--	9	7/9/82	15	0							CS	
d82	K156-1:H	same	emas	med q	no f	6/30-11/82	--	9	7/9/82	15	0							CS	
d82	K156-1!H	same	emas	med q	no f?	6/26-7/82	--	4	6/30/82	13	0							CS	
d82	K156-1:H	same	emas	med q	no f?	6/30-4b/82	--	9	7/9/82	15	0							CS	
d82	K156-1:H	same	emas	med q	no f?	6/30-12/82	--	5	7/5/82	15	0							CS	
d82	K156-1:H	same	emas	med q	no f?	6/30-3/82	--	9	7/9/82	15	0							CS	
d82	K156-1:H	same	emas	med q	no f?	6/30-6/82	--	9	7/9/82	15	0							CS	
d82	K156-1:H	same	emas	med q	no f	6/30-10/82	--	9	7/9/82	15	0							CS	
d82	K156-1:H	same	emas	med q	no f?	6/30-1/82	--	9	7/9/82	13	0							CS	
d83	K156-8:S	same	no e	med q?	no f?	6/30-12/83	7/5	22	7/22/83	15	15	15	0					CS	HUH?
d83	K156-28:S	same	no e	med q?	f	6/30-18/83	7/5	22	7/22/83	15	15	15	0					CS	HUH?
d83	K156-2:H	same	no e	med q?	no f?	7/2-3/83	7/6	29	8/31/83	15	15	15	0					CS	HUH?
d83	K156-10:S	same	no e	med q?	no f?	6/28-9/83	7/22	30	8/21/83	15	12	12	0					CS	HUH?
d83	K156-17:S	same	no e	med q?	no f?	7/1-7/83	7/6	21	7/22/83	15	10	10	0					CS	HUH? =DROUGHT?
d83	K156-3:S	same	no e	med q?	no f?	6/30-9/83	7/5	22	7/22/83	10	1	1	0					CS	HUH?

d83	K156-34:S	same	no e	sed q?	no f?	6/30-5/83	7/5	22	7/22/83	15	15	15	0					CS	HUH?
d83	K156-1:S	same	no e	sed q?	no f	6/28-6/83	7/5	24	7/22/83	15	1	1	0					CS	POOR FLOWER
d84	K156-1:H	same	no e	hi q	no f	10/10-11/84	—	5	10/15/84	15	0							CS	HUH?
d84	K156-1:H	same	no e	hi q	no f?	10/10-10/84	—	5	10/15/84	15	0							CS	HUH?
d84	K156-1:H	same	no e	hi q	no f?	10/10-12/84	—	5	10/15/84	20	0							CS	HUH?

diversifolia ssp. diversifolia x collinsii

CROSS	FEMALE	MALE	EMAS	IQUAL	IFERT	IDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
dc83	K156-1:H	K450-1:H	emas	hi q	no f	8/15-2/83	8/21	16	8/31/83	15	15	15	0					CS	
dc83	K156-1:H	K450-1:H	emas	hi q	no f	7/27-2/83	8/2	13	8/9/83	35	18	15	0					CS	BIG PDROP
dc83	K156-1:H	K450-1:H	emas	hi q	no f	7/27-1/83	8/2	13	8/9/83	15	20	15	0					CS	BIG PDROP
dc94	K156-1:H	K450-1:H	emas	hi q?	no f?	6/28-12/84	—	12	7/10/84	15	6	6	0					CS	PSYLLID?
dc84	K156-1:H	K450-1:H	emas	hi q?	no f?	6/28-13/84	—	12	7/10/84	15	10	10	0					CS	WIND?
dc84	K156-1:H	K450-1:H	emas	hi q?	no f?	6/28-10/84	—	12	7/10/84	9	1	1	0					CS	PSYLLID?
dc84	K156-1:H	K450-1:H	emas	sed q?	no f?	6/28-11/83	—	21	7/19/83	15	12	12	0					CS	PSYLLID?
dc85	K156-2:H	K450-1:H	emas	hi q	no f	11/12-11/85	—	9	11/21/85	8	0							CS	
dc86	K156-1:H	K450-1:H	emas	sed q	no f?	5/7-2/86	5/13	37	6/13/86	20	17	17	0					CS	WHY?
dc86	K156-1:H	K450-1:H	emas	sed q	no f?	5/7-1/86	5/13	37	6/13/86	25	22	22	0					CS	WHY?

diversifolia ssp. diversifolia x diversifolia ssp. trichandra

CROSS	FEMALE	MALE	EMAS	IQUAL	IFERT	IDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
dz82	K156-1:H	K409-10:I	no e	sed q	no f	7/14-3/82	—	5	7/19/82	15	0							PAN	
dz83	K156-1:H	K406-5:I	emas	hi q	no f	7/20-11/83	—	4	7/24/83	15	0							PAN	
dz83	K156-1:H	K399-9:I	emas	hi q	no f	7/10-14/83	—	14	7/24/83	15	0							PAN	
dz83	K156-2:H	K411-9:I	emas	hi q	no f	8/11-9/83	—	5	8/16/83	15	0							PAN	
dz83	K156-1:H	K480-4:I	emas	hi q	no f	7/22-14/83	—	5	7/27/83	15	0							PAN	
dz83	K156-2:H	K409-8:I	emas	hi q	no f	6/24-7/83	—	3	6/27/83	15	0							PAN	
dz83	K156-1:H	K465-4:I	emas	hi q	no f	7/10-16/83	—	14	7/24/83	15	0							PAN	
dz83	K156-2:H	K465-5:I	emas	hi q	no f	8/2-8/83	—	2	8/4/83	15	0							PAN	
dz83	K156-1:H	K465-5:I	emas	hi q	no f	7/22-13/83	—	5	7/27/83	15	0							PAN	
dz83	K156-2:H	K411-9:I	emas	hi q	no f	8/11-10/83	—	5	8/16/83	15	0							PAN	
dz83	K156-1:H	K409-8:I	emas	hi q	no f	7/22-15/83	—	5	7/27/83	15	0							PAN	
dz83	K165-5:I	K478-4:I	emas	hi q	no f	8/3-1/83	—	5	8/8/83	15	0							PAN	
dz83	K156-1:H	K409-10:I	emas	hi q	no f	7/29-20/83	—	3	8/1/83	15	0							PAN	
dz83	K156-1:H	K465-5:I	emas	hi q	no f	7/22-9/83	—	5	7/27/83	15	0							PAN	
dz83	K156-1:H	K409-10:I	emas	hi q	no f	7/29-22/83	—	3	8/1/83	15	0							PAN	
dz83	K156-1:H	K409-10:I	emas	hi q	no f	7/29-21/83	—	3	8/1/83	15	0							PAN	
dz83	K156-1:H	K409-10:I	emas	hi q	no f	6/8-13/83	—	5	6/13/83	10	0							PAN	
dz83	K156-1:H	K411-9:I	emas	hi q	no f	8/11-12/83	—	5	8/16/83	15	0							PAN	
dz83	K156-1:H	K465-4:I	emas	hi q	no f	7/10-15/83	—	14	7/24/83	15	0							PAN	
dz83	K156-2:H	K409-8:I	emas	hi q	no f	7/9-3/83	—	5	7/14/83	15	0							PAN	
dz83	K156-2:H	K411-9:I	emas	hi q	no f	8/11-8/83	—	5	8/16/83	15	0							PAN	
dz83	K156-1:H	K411-9:I	emas	hi q	no f	8/11-11/83	—	5	8/16/83	15	0							PAN	
dz83	K156-1:H	K409-8:I	emas	hi q	no f	6/24-6/83	—	3	6/27/83	15	0							PAN	
dz85	K156-1:H	B85-1:H	emas	hi q	no f	10/7-1/85	—	4	10/11/85	15	0							CS	

diversifolia ssp. diversifolia x esculenta

CROSS	FEMALE	MALE	EMAS	IQUAL	IFERT	IDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUS	ABT	CM	WHO	NOTES
de84	K156-1:H	K138-6:I	emas	hi q	no f	7/16-6/84	—	3	7/19/84	10	0							CS	
de84	K156-1:H	K138-6:I	emas	hi q	no f	7/12-6/84	—	7	7/19/84	15	0							CS	

diversifolia ssp. diversifolia x lanceolata ssp. lanceolata

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
dn84	K156-1:H	K10-2:H	emas	med q	no f?	9/29-2/84	--	4	10/3/84	8	0							CS	
dn85	K156-1:H	K10-2:H	emas	hi q	f?	9/30-9/85	10/4	93	1/1/86	20	19	6	13	119	6	36	13.0	CS	
dn85	K156-2:H	K10-2:H	emas	hi q	f	11/3-5/85	11/21	65	12/15/85	15	2	2	0					CS	
dn85	K156-2:H	K10-2:H	emas	hi q	f	11/14-1/85	11/21	48	1/1/86	15	2	2	0					CS	
dn85	K156-2:H	K10-2:H	emas	hi q	no f	11/3-6/85	--	17	11/21/85	15	0							CS	
dn85	K156-2:H	K10-2:H	emas	med q	no f	11/4-8/85	--	17	11/21/85	4	0							CS	
dn85	K156-2:H	K10-2:H	emas	med q?	no f	11/13-4/85	--	8	11/21/85	16	0							CS	SMALL STIGMA
dn85	K156-1:H	K10-2:H	emas	hi q	f?	9/30-8/85	--	93	1/11/86	15	15	14	1	3	0	1	8.0	CS	

diversifolia ssp. diversifolia x lanceolata ssp. sousae

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
dm82	K156-1:H	K385-10:I	no e	med q	no f	6/17-13/82	--	9	6/26/82	15	0							CS	
dm82	K156-1:H	K385-10:I	no e	med q	no f	6/17-10/82	--	8	6/25/82	15	0							CS	
dm82	K156-1:H	K385-10:I	no e	med q	no f	6/17-9/82	--	8	6/25/82	15	0							CS	
dm82	K156-1:H	K385-10:I	no e	med q	no f	6/17-7/82	--	8	6/25/82	15	0							CS	
dm82	K156-1:H	K385-10:I	no e	med q	no f	6/17-14/82	--	8	6/25/82	15	0							CS	
dm83	K156-1:H	K393-1:H	no e	hi q	no f	6/28-2/83	--	2	6/30/83	15	0							CS	
dm83	K156-1:H	K393-1:H	emas	hi q	no f	6/28-1/83	--	2	6/30/83	15	0							CS	

diverifolia ssp. diversifolia x leucocephala

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
dl83	K156-2:H	K8-15:A2	emas	hi q	f	9/23-2/83	9/28	118	1/19/84	15	5	2	3	30	1	2	9.0	CS	
dl83	K156-2:H	K500-14:Y1	emas	hi q	f	7/8-4/83	7/14	152	12/7/83	16	15	12	3	29	0	1	10.5	CS	7/22 LOST 5P
dl83	K156-2:H	K8-15:A2	emas	hi q	f	9/23-1/83	9/28	118	1/19/84	25	15	9	6	73	2	2	9.5	CS	

diversifolia ssp. diversifolia x macrophylla

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUS	ABT	CM	WHO	NOTES
da83	K156-2:H	K158-2:I	emas	hi q	no f?	7/8-6/83	--	42	8/19/83	15	2	2	0					CS	WINDY
da83	K156-1:H	K158-2:I	emas	med q	no f	7/6-5/83	--	5	7/11/83	15	0							CS	WINDY
da83	K156-1:H	K158-2:I	emas	med q	no f	7/6-3/83	7/11	56	8/31/83	15	1	1	0					CS	
da83	K156-1:H	K158-2:I	emas	med q	no f	7/6-4/83	--	5	7/11/83	15	0							CS	

diversifolia ssp. diversifolia x pallida

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
dy82	K156-1:H	K376-7:I	no e	med q	no f	7/20-12/82	--	6	7/26/82	15	0							PAN	
dy82	K156-1:H	K376-7:I	no e	med q	no f?	7/20-11/82	7/26	21	8/10/82	15	1	1	0					PAN	
dy83	K156-2:H	K177-1:I	emas	hi q	f	8/2-11/83	8/6	116	11/26/83	15	7	3	4	52	0	8	--	PAN	
dy83	K156-1:H	K174-10:I	emas	hi q	no f	7/29-4/83	--	3	8/1/83	15	0							PAN	
dy83	K160-6:I	K174-10:I	emas	hi q	no f	8/3-9/83	--	5	8/8/83	15	0							PAN	
dy83	K156-1:H	K376-10:I	emas	hi q	f	6/1-11/83	6/7	98	9/8/83	15	5	0	5	70	0	1	--	PAN	
dy83	K156-1:H	K376-9:I	emas	hi q	no f	7/30-21/83	--	2	8/1/83	15	0							PAN	
dy83	K156-1:H	K376-10:I	emas	hi q	f	6/1-10/83	6/7	107	9/17/83	15	8	4	4	65	0	4	--	PAN	
dy83	K156-2:H	K174-10:I	emas	hi q	no f	7/29-1/83	--	3	8/1/83	15	0							PAN	
dy83	K156-1:H	K376-9:I	emas	hi q	no f	7/30-17/83	--	2	8/1/83	15	0							PAN	
dy83	K156-1:H	K174-10:I	emas	hi q	no f	7/30-24/83	--	2	8/1/83	15	0							PAN	
dy83	K156-2:H	K177-1:H	emas	hi q	f	8/17-10/83	9/2	130	12/25/83	15	12	0	12	194	0	19	--	PAN	
dv83	K156-1:H	K376-9:I	emas	hi q	f	7/30-18/83	8/1	151	12/28/83	15	11	8	3	39	0	8	--	PAN	
dy83	K156-2:H	K174-10:I	emas	hi q	no f	6/24-42/83	--	5	6/29/83	15	0							PAN	
dy83	K156-2:H	K177-1:I	emas	hi q	f	8/2-10/83	8/6	116	11/26/83	15	10	3	7	79	0	20	--	PAN	

dy83	K156-1:H	K174-10:I	emas	hi q	no f	7/30-23/83	--	2	8/1/83	15	0							PAN	
dy83	K156-2:H	K177-1:I	emas	hi q	f	8/17-9/83	9/2	120	12/15/83	15	12	3	9	110	0	33	--	PAN	
dy83	K156-1:H	K376-10:I	emas	hi q	f	6/1-9/83	6/7	108	9/17/83	15	8	4	4	65	0	4	--	PAN	
dy83	K156-2:I	K177-1:I	emas	hi q	f	8/17-8/83	9/2	133	12/28/83	15	5	1	4	52	0	20	--	PAN	
dy83	K156-1:H	K376-9:I	emas	hi q	no f	7/29-45/83	--	6	8/4/83	15	0							PAN	
dy83	K156-2:H	K177-1:I	emas	hi q	f	8/2-9/83	8/6	111	11/21/83	15	6	0	6	65	0	17	--	PAN	
dy83	K156-1:H	K174-10:I	emas	hi q	no f	7/30-22/83	--	2	8/1/83	15	0							PAN	
dy83	K165-5:I	K174-10:I	emas	hi q	no f	8/3-4/83	--	5	8/8/83	15	0							PAN	
dy83	K160-6:I	K174-10:I	emas	hi q	no f?	8/3-8/83	--	5	8/8/83	15	3	3	0					PAN	
dy83	K156-1:H	K376-9:I	emas	hi q	no f	7/30-20/83	--	2	8/1/83	15	0							PAN	
dy83	K156-1:H	K174-10:I	emas	hi q	no f	7/29-3/83	--	3	8/1/83	15	0							PAN	
dy83	K156-1:H	K376-9:I	emas	hi q	no f	7/30-19/83	--	2	8/1/83	15	0							PAN	

diversifolia ssp. diversifolia x pulverulenta

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUS	ABT	CM	WHO	NOTES
dp82	K156-1:H	K340-2:Y2	no e	med q	no f	6/15-38/82	--	3	6/18/82	15	0							CS	
dp82	K156-2:H	K340-2:Y2	no s	med q	no f	6/15-32/82	--	3	6/18/82	15	0							CS	
dp82	K156-1:H	K340-2:Y2	no e	med q	no f	6/15-39/82	--	3	6/18/82	15	0							CS	
dp82	K156-2:H	K340-2:Y2	no e	med q	no f	6/15-31/82	--	3	6/18/82	15	0							CS	
dp82	K156-1:H	K340-2:Y2	no e	med q	no f	6/15-37/82	--	3	6/18/82	15	0							CS	
dp82	K156-2:H	K340-2:Y2	no e	med q	no f	6/15-34/82	--	3	6/18/82	15	0							CS	
dp82	K156-1:H	K340-2:Y2	no e	med q	no f	6/15-40/82	--	2	6/17/82	15	0							CS	
dp82	K156-2:H	K340-2:Y2	no e	med q	no f	6/15-33/82	--	3	6/18/82	15	0							CS	
dp82	K156-1:H	K340-2:Y2	no e	med q	no f	6/15-35/82	--	3	6/18/82	15	0							CS	
dp83	K156-1:H	K340-2:Y2	no e	med q	no f	7/29-3/83	--	4	8/2/83	5	0							CS	LOW ST#

diversifolia ssp. diversifolia x retusa

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
dr83	K165-?:6H	K280-1:H	emas	hi q	no f	8/22-4/83	--	9	8/31/83	15	0							CS	
dr83	K156-1:H	K280-1:H	emas	hi q	no f	8/22-1/83	--	9	8/31/83	20	0							CS	
dr83	K156-1:H	K280-1:H	emas	med q	no f	8/22-2/83	--	9	8/31/83	10	0							CS	
dr83	K156-1:H	K280-1:H	emas	med q	no f	8/22-3/83	--	9	8/31/83	15	0							CS	
dr84	K156-1:H	K280-1:H	no e	hi q	no f	10/1-4/84	--	6	10/7/84	20	0							CS	

diversifolia ssp. diversifolia x shannoni

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ds83	K156-1:H	K445-2:H	emas	hi q	f	6/24-1/83	8/31	115	10/17/83	20	15	9	6	29	0	36	11.0	CS	CYSDN DMG
ds83	K156-1:H	K445-2:H	emas	med q	f	6/24-3/83	6/27	68	8/31/83	15	15	8	7	1	0	114	12.0	CS	CYSDN DMG
ds85	K156-2:H	K445-1:H	emas	hi q	no f	10/8-1/85	--	16	10/24/85	15	0							CS	

diversifolia ssp. diversifolia x trichodes

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUS	ABT	CM	WHO	NOTES
dt83	K156-1:H	K90-2:Y2	emas	hi q	no f	9/2-3/83	--	5	9/7/83	15	0							CS	
dt83	K156-1:H	K90-2:Y2	emas	hi q	no f	9/2-1/83	--	5	9/7/83	15	0							CS	

DIVERSIFOLIA SSP. TRICHANDRA (FEMALE) CROSSES

diversifolia ssp. trichandra selfs

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
z81	K409-7:I	same	no e	hi q	no f	8/18a/81	--	4	8/22/81	15	0							BOO	
z81	K409-7:I	same	no e	hi q	no f	8/18b/81	--	4	8/22/81	15	0							BOO	
z81	K409-8:I	same	no e	hi q	no f	8/18c/81	--	4	8/22/81	15	0							BOO	
z81	K409-8:I	same	no e	hi q	no f	8/18d/81	--	4	8/22/81	15	0							BOO	
z81	K409-8:I	same	no e	hi q	no f	8/18e/81	--	4	8/22/81	15	0							BOO	
z81	K409-8:I	same	no e	med q	no f	8/18f/81	--	4	8/22/81	15	0							BOO	
z81	K409-7:I	same	no e	hi q	no f	8/18g/8	--	4	8/22/81	15	0							BOO	
z81	K409-7:I	same	no e	med q	no f	8/26a/81	--	4	8/30/81	15	0							BOO	
z81	K409-8:I	same	no e	med q	no f	8/26b/81	--	4	8/30/81	15	0							BOO	
z81	K409-8:I	same	no e	med q	no f	8/26c/81	--	4	8/30/81	15	0							BOO	
z81	K409-8:I	same	no e	med q	no f	8/26d/81	--	4	8/30/81	15	0							BOO	
z81	K409-8:I	same	no e	med q	no f	8/26e/81	--	4	8/30/81	15	1	1	0					BOO	ABTed
z83	K409-8:I	same	no e	hi q	no f	7/16-2/83	--	3	7/19/83	15	0							CS	
z83	K409-9:I	same	no e	hi q	no f	7/12-1/83	--	7	7/19/83	15	0							CS	
z83	K409-8:I	same	no e	hi q	no f	7/16-3/83	--	3	7/19/83	20	0							CS	
z83	K409-8:I	same	no e	hi q	no f	7/9-2/83	--	4	7/13/83	15	3	3	0					CS	ABT PODS
z83	K409-8:I	same	no e	hi q	no f	7/16-1/83	--	3	7/19/83	20	0							CS	
z83	K409-8:I	same	no e	hi q	no f	7/16-5/83	--	3	7/19/83	15	0							CS	
z83	K409-8:I	same	no e	hi q	no f	7/9-1/83	--	5	7/14/83	15	0							CS	

diversifolia ssp. trichandra x collinsii

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUS	ABT	CM	WHO	NOTES
zc81	K409-8:I	K185-4:I	no e	hi q	no f?	7/15a/81	--	407	8/20/82	15	14	1	13	133	--	--	--	BOO	
zc81	K409-8:I	K185-4:I	no e	hi q	f?	7/15b/81	--	407	8/12/82	18	16	6	10	100	--	--	--	BOO	
zc82	K423-9:I	K183-1:I	no e	hi q?	f	7/14-17/82	7/20	122	11/14/82	15	21	5	16	175	2	0	15.0	PAN	
zc82	K423-9:I	K183-1:I	no e	hi q?	no f?	7/14-19/82	7/20	85	10/7/82	15	10	10	0					PAN	
zc84	B85-3:B2	K450-1:H	no e	hi q	no f	10/15-23/84	--	14	10/29/84	15	0							CS	
zc84	B85-3:B2	K450-1:H	no e	hi q	no f	10/15-24/84	--	14	10/29/84	15	0							CS	
zc84	B85-3:B2	K450-1:H	no e	hi q	f	10/15-21/84	--	144	2/28/86	20	11	2	9	51	33	5	11.5	CS	GLY, SMALL SDS
zc85	B85-?:B2	K450-1:H	no e	hi q	f	10/8-6/85	10/24	142	2/26/86	28	25	22	3	34	3	2	11.0	CS	
zc85	B85-8:B2	K450-1:H	no e	hi q	f	10/7-3/85	10/24	142	2/26/86	23	23	14	9	61	6	4	6.5	CS	
zc85	B85-?:B2	K450-1:H	no e	hi q	f	10/8-2/85	10/24	142	2/26/86	20	20	5	15	112	16	13	8.0	CS	
zc85	B85-1:B2	K450-1:H	no e	hi q	no f	10/8-10/85	--	16	10/24/85	15	0							CS	
zc85	B85-2:B2	K450-1:H	no e	hi q	f	10/7-2/85	10/24	142	2/26/86	22	7	0	7	100	25	0	9.0	CS	
zc85	B85-2:B2	K450-1:H	no e	hi q	no f?	10/7-1/85	--	16	10/24/85	22	3	3	0					CS	
zc85	B85-?:B2	K450-1:H	no e	hi q	no f	10/8-5/85	--	16	10/24/85	15	0							CS	
zc85	B85-?:B2	K450-1:H	no e	hi q	no f	10/8-3/85	--	3	10/11/85	15	0							CS	
zc85	B85-8:B2	K450-1:H	no e	hi q	no f?	10/8-4/85	10/24	28	11/5/85	22	20	20	0					CS	
zc85	B85-1:B2	K450-1:H	no e	hi q	f	10/8-7/85	10/24	143	2/28/86	25	25	21	4	63	2	6	14.0	CS	PODS GREEN
zc85	B85-?:B2	K450-1:H	no e	med q	no f	10/8-8/85	--	16	10/24/85	10	0							CS	

diversifolia ssp. trichandra x diversifolia ssp. diversifolia

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
zd81	K409-8:I	K156-1:F	no e	med q	f	7/17g/81	--	260	4/5/82	15	2	0	2	20	0	4	--	BOO	
zd82	K409-5:I	K164-7:I	no e	hi q	no f	7/9-2/82	7/19	41	8/19/82	15	15	15	0					CS	
zd82	K409-5:I	K164-7:I	no e	hi q	no f	7/9-1/82	7/19	41	8/19/82	15	10	10	0					CS	
zd83	K409-8:I	K165-5:I	no e	hi q	no f	7/7-10/83	--	7	7/14/83	15	0							PAN	
zd83	K409-10:I	K156-1:H	no e	hi q	no f	6/15-1/83	--	5	6/20/83	15	0							PAN	
zd83	K409-10:I	K164-1:I	no e	hi q	no f	7/30-28/83	--	4	8/3/83	15	0							PAN	

zd83	K465-5:I	K156-1:H	no e	hi q	no f	7/17-18/83	--	3	7/20/83	15	0							PAN	
zd83	K409-7:I	K165-5:I	no e	hi q	no f	7/1-3/83	--	4	7/5/83	15	0							PAN	
zd83	K409-8:I	K159-9:I	no e	hi q	f	7/20-3/83	8/3	278	4/24/84	15	8	5	3	23	0	37	--	PAN	SLOW TO HRVST
zd83	K409-7:I	K165-5:I	no e	hi q	no f	7/1-5/83	--	4	7/5/83	15	0							PAN	
zd83	K409-10:I	K160-6:I	no e	hi q	no f	8/7-50/83	--	16	8/23/83	15	0							PAN	
zd83	K409-8:I	K165-5:I	no e	hi q	no f?	8/12-28/83	--	18	8/20/83	15	12	12	0					PAN	PODS LOST
zd83	K409-8:I	K160-6:I	no e	hi q	f	7/27-16/83	8/3	271	4/24/84	15	7	5	2	16	0	12	--	PAN	
zd83	K409-10:I	K156-1:H	eaes	hi q	no f	6/8-1/83	--	5	6/13/83	15	0							PAN	
zd83	K478-3:I	K165-5:I	no e	hi q	no f	7/21-21/83	--	5	7/26/83	15	0							PAN	
zd83	K409-10:I	K156-1:H	no e	hi q	no f?	6/30-27/83	7/5	42	8/11/83	15	6	6	0					PAN	DRP BEFORE 8/11
zd83	K478-3:I	K166-8:I	no e	hi q	no f	7/15-15/83	--	4	7/19/83	15	0							PAN	
zd83	K409-10:I	K160-6:I	no e	hi q	no f	8/7-49/83	--	16	8/23/83	15	0							PAN	
zd83	K409-7:I	K165-5:I	no e	hi q	no f	7/1-4/83	--	4	7/5/83	15	0							PAN	
zd83	K409-10:I	K156-1:F	no e	hi q	no f	6/15-2/83	--	5	6/20/83	15	0							PAN	
zd83	K409-10:I	K156-1:H	no e	hi q	no f	6/30-26/83	--	5	7/5/83	15	0							PAN	
zd83	K409-8:I	K164-7:I	no e	hi q	f	8/11-49/83	8/23	256	4/24/83	15	7	2	5	50	0	28	--	PAN	SLOW TO HRVST
zd83	K423-6:I	K156-1:H	no e	hi q	no f	7/20/35/83	--	5	7/25/83	10	0							PAN	
zd83	K409-8:I	K160-6:I	no e	hi q	f	8/4-16/83	8/23	242	4/3/84	22	18	15	3	11	0	34	--	PAN	SLOW TO HRVST
zd83	K423-6:I	K165-5:I	no e	hi q	no f	7/17-20/83	--	8	7/25/83	15	0							PAN	
zd83	K406-5:I	K156-1:H	no e	hi q	no f	7/20-3/83	--	7	7/27/83	15	0							PAN	
zd83	K409-8:I	K165-5:I	no e	hi q	no f	7/25-33/83	--	9	8/3/83	15	0							PAN	
zd83	K409-8:I	K160-6:I	no e	hi q	f	7/27-17/83	8/3	271	4/24/84	15	4	2	2	12	0	14	--	PAN	
zd83	K409-8:I	K160-6:I	no e	hi q	no f	8/4-17/83	--	19	8/23/83	10	0							PAN	
zd83	K478-3:I	K156-1:H	no e	hi q	no f	6/24-1/83	--	3	6/27/83	15	0							PAN	
zd83	K409-10:I	K156-1:H	e	hi q	no f	6/8-2/83	--	5	6/13/83	15	0							PAN	
zd83	K478-3:I	K155-4:I	no e	hi q	no f	7/21-18/83	--	5	7/26/83	15	0							PAN	
zd83	K423-6:I	K156-1:H	no e	hi q	no f	7/7-8/83	--	7	7/14/83	15	0							PAN	
zd83	K409-8:I	K166-8:I	no e	hi q	no f	7/22-33/83	--	12	8/3/83	15	0							PAN	
zd83	K423-6:I	K156-1:H	no e	hi q	no f	8/17-3/83	--	7	8/24/83	15	0							PAN	
zd83	K408-9:I	K156-1:H	no e	hi q	f	7/20-6/83	--	238	7/27/83	15	8	3	5	65	0	0	--	PAN	
zd83	K478-4:I	K160-6:I	no e	hi q	no f	8/3-13/83	--	5	8/8/83	15	0							PAN	
zd83	K409-8:I	K160-6:I	no e	hi q	no f	7/27-18/83	--	7	8/3/83	15	0							PAN	
zd83	K408-9:I	K156-1:H	no e	hi q	no f	7/17-25/83	--	10	7/27/83	15	0							PAN	
zd83	K409-10:I	K164-1:I	no e	hi q	no f	7/30-26/83	8/3	18	8/17/83	22	18	18	0					PAN	PODS LOST
zd83	K478-3:I	K165-5:I	no e	hi q	no f	7/21-19/83	--	5	7/26/83	15	0							PAN	
zd83	K409-8:I	K164-1:I	no e	hi q	f	7/20-30/83	8/3	278	4/24/84	15	10	2	8	76	0	54	--	PAN	SLOW TO HRVST
zd83	K409-8:I	K164-7:I	no e	hi q	f	8/11-51/83	8/23	256	4/24/84	15	10	0	10	66	0	34	--	PAN	SLOW TO HRVST
zd83	K409-10:I	K160-6:I	no e	hi q	f	8/7-47/83	8/23	276	5/10/84	15	8	5	3	9	0	26	--	PAN	SLOW TO HRVST
zd83	K478-3:I	K165-5:I	no e	hi q	no f	7/8-4/83	--	6	7/14/83	15	0							PAN	
zd83	K409-10:I	K160-6:I	no e	hi q	no f	8/7-48/83	--	16	8/23/83	15	0							PAN	
zd83	K409-10:I	K160-1:I	no e	hi q	no f	8/12-38/83	--	11	8/23/83	15	0							PAN	
zd93	K408-9:I	K165-5:I	no e	hi q	no f	7/17-24/83	--	10	7/27/83	15	0							PAN	
zd83	K409-8:I	K164-7:I	no e	hi q	f	8/11-52	8/25	256	4/24/84	15	14	0	14	146	0	102	--	PAN	SLOW TO HRVST
zd83	K409-10:I	K160-1:I	no e	hi q	no f	8/12-37/83	--	11	8/23/83	15	0							PAN	
zd83	K409-8:I	K160-6:I	no e	hi q	f	8/4-18/83	8/20	263	4/24/84	15	3	2	1	11	0	4	--	PAN	SLOW TO HRVST
zd83	K406-5:I	K156-1:H	no e	hi q	no f	7/14-10/83	--	5	7/19/83	15	0							PAN	
zd83	K409-8:I	K159-9:I	no e	hi q	no f	7/20-32/83	--	6	7/26/83	15	0							PAN	
zd83	K409-8:I	K164-7:I	no e	hi q	f	8/11-50/83	8/23	256	4/24/84	15	14	1	13	85	0	89	--	PAN	SLOW TO HRVST
zd83	K409-10:I	K164-1:I	no e	hi q	f	7/30-28/83	8/3	284	5/10/84	15	12	8	4	5	0	49	--	PAN	SLOW TO HRVST
zd83	K406-5:I	K156-1:H	no e	hi q	no f	7/8-3/83	--	6	7/14/83	15	0							PAN	
zd83	K478-3:I	K160-6:I	no e	hi q	no f	7/21-4/83	--	6	7/27/83	15	0							PAN	
zd83	K409-10:I	K160-6:I	no e	hi q	f	8/7-46/83	8/23	276	5/10/84	15	8	5	3	7	0	39	--	PAN	SLOW TO HRVST
zd83	K406-5:I	K160-6:I	no e	hi q	no f	7/21-1/83	--	6	7/27/83	15	0							PAN	
zd83	K423-8:I	K156-1:H	no e	hi q	no f	7/15-1/83	--	4	7/19/83	15	0							PAN	
zd83	K408-9:I	K165-5:I	no e	hi q	no f	8/12-27/83	--	11	8/23/83	15	0							PAN	
zd93	K406-5:I	K165-5:I	no e	hi q	no f	7/17-23/83	--	3	7/20/83	15	0							PAN	

CROSS	FEMALE	MALE	EMAS	IQUAL	IFERT	IDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
zd83	K478-3:I	K156-1:H	no e	hi q	no f	7/8-10/83	—	7	7/15/83	15	0							PAN	
zd83	K478-4:I	K156-1:H	no e	hi q	no f	7/8-11/83	—	8	7/16/83	15	0							PAN	
zd83	K423-6:I	K155-4:I	no e	hi q	no f	7/22-24/83	—	3	7/25/83	15	0							PAN	
zd83	K409-8:I	K165-5:I	no e	hi q	no f?	7/1-2/83	—	50	7/5/83	15	6	6	0					PAN	8/20 WIND?
zd83	K423-6:I	K166-8:I	no e	hi q	no f	7/22-27/83	—	3	7/25/83	15	0							PAN	
zd83	K409-10:I	K164-1:I	no e	hi q	no f	7/30-27/83	8/3	18	8/17/83	22	17	17	0					PAN	
zd83	K478-3:I	K156-1:H	no e	hi q	no f	6/24-2/83	—	3	6/27/83	15	0							PAN	
zd83	K478-3:I	K165-5:I	no e	hi q	no f	7/21-20/83	—	5	7/26/83	15	0							PAN	
zd83	K423-6:I	K165-5:I	no e	hi q	no f	7/20-38/83	—	5	7/25/83	10	0							PAN	

diversifolia ssp. trichandra x esculenta

CROSS	FEMALE	MALE	EMAS	IQUAL	IFERT	IDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ze84	K409-8:I	K138-6:I	no e	hi q	no f	7/12-3/84	—	7	7/19/84	15	0							CS	
ze84	K409-8:I	K138-6:I	no e	hi q	no f	7/12-9/84	—	7	7/19/84	10	0							CS	
ze84	K409-8:I	K138-6:I	no e	hi q	no f	7/16-13/84	7/19	10	7/26/84	15	0							CS	
ze84	K409-8:I	K138-6:I	no e	hi q	no f	7/16-11/84	—	3	7/19/84	18	0							CS	
ze84	K409-8:I	K138-6:I	no e	hi q	no f	7/16-12/84	7/19	59	9/13/84	20	0							CS	PODS?
ze84	K409-8:I	K138-6:I	no e	hi q	no f	7/12-5/84	—	7	7/19/84	10	0							CS	
ze84	K409-8:I	K138-6:I	no e	hi q	no f	7/16-10/84	—	3	7/19/84	12	0							CS	
ze84	K409-8:I	K138-6:I	no e	hi q	no f	7/12-2/84	7/19	63	9/13/84	10	0							CS	PODS?
ze84	B85-3:B2	K138-1:H	no e	hi q	no f	10/15-5/84	—	14	10/29/84	15	0							CS	
ze84	K409-8:I	K138-6:I	no e	hi q	no f	7/12-1/84	—	7	7/19/84	15	0							CS	

diversifolia ssp. trichandra x lanceolata ssp. lanceolata

CROSS	FEMALE	MALE	EMAS	IQUAL	IFERT	IDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
zn81	K409-8:I	K401-?:I	no e	hi q	f	6/23/81	—	294	4/15/82	15	1	0	1	7	0	0	—	BOO	
zn81	K409-8:I	K401-?:I	no e	hi q	f	7/15a/81	—	272	4/15/82	15	42	0	42	417	0	52	—	BOO	ALSO 22 SIBS
zn81	K409-8:I	K401-?:I	no e	hi q	f	6/17/81	—	300	4/15/82	15	3	0	3	28	0	4	—	BOO	
zn81	K409-7:I	K401-1:I	no e	med q	no f?	7/15e/81	—	390	8/10/82	15	10	10	0					BOO	
zn85	B85-?:B2	K10-2:H	no e	hi q	no f	11/12-31/85	—	7	11/21/85	15	0							CS	
zn85	B85-?:B2	K10-2:H	no e	hi q	no f	11/12-32/85	—	9	11/21/85	15	0							CS	
zn85	B85-?:B2	K10-1:H	no e	hi q	f	10/4-1/85	10/24	147	2/28/86	20	7	3	4	36	4	8	12.0	CS	
zn85	B85-?:B2	K10-2:H	no e	med q	no f?	11/12-30/85	—	9	11/21/85	21	1	1	0					CS	

diversifolia ssp. trichandra x lanceolata ssp. sousae

CROSS	FEMALE	MALE	EMAS	IQUAL	IFERT	IDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
zm84	B85-3:B2	K393-1:H	no e	hi q	no f	10/13-6a/84	—	16	10/29/84	13	0							CS	
zm84	B85-3:B2	K393-1:H	no e	hi q	no f	10/13-7/84	—	16	10/29/84	13	0							CS	
zm84	B85-3:B2	K393-1:H	no e	hi q	no f	10/13-8/84	—	16	10/29/84	13	0							CS	
zm84	B85-3:B2	K393-1:H	no e	hi q	f	10/13-4/84	—	336	9/14/85	15	12	0	12	121	26	4	11.5	CS	TINY SDS
zm84	B85-3:B2	K393-1:H	no e	hi q	no f	10/13-6b/84	—	16	10/29/84	15	0							CS	
zm84	B85-3:B2	K393-1:H	no e	hi q	no f	10/13-1/84	—	16	10/29/84	20	0							CS	
zm84	K411-9:I	K393-1:H	no e	med q	no f	10/7-1/84	—	8	10/15/84	10	0							CS	
zm85	B85-3:B2	K393-1:H	no e	hi q	f	10/13-2/84	—	336	9/14/85	13	8	1	7	68	13	1	11.0	CS	TINY SDS
zm85	B85-3:B2	K393-1:H	no e	hi q	f	10/13-3/84	—	336	9/14/85	13	7	6	1	13	2	0	11.5	CS	TINY SDS

diversifolia ssp. trichandra x leucocephala

CROSS	FEMALE	MALE	EMAS	IQUAL	IFERT	IDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
zl81	K409-7:I	K8-?:?	no e	hi q	no f?	7/8/81	—	47	8/25/81	15	0							BOO	
zl83	K409-8:I	K8-?:A2	no e	hi q	no f	10/5-3/83	—	12	10/17/83	15	0							CS	
zl83	K409-8:I	K8-?:A2	no e	hi q	no f	10/5-2/83	—	12	10/17/83	15	0							CS	
zl84	K411-9:I	K45-?:HD6	no e	hi q	no f?	10/10-4/84	10/15	15	10/25/84	23	0							CS	DROUGHT
zl84	K411-9:I	K45-?:HD6	no e	hi q	no f?	10/10-3/84	10/15	15	10/25/84	17	0							CS	DROUGHT

zl85	B85-?:B2	K8? wild	no e	hi q	no f	10/4-2/85	--	20	10/24/85	22	0							CS	
zl85	B85-?:B2	K8? wild	no e	hi q	f	10/4-1/85	10/24	137	2/28/86	25	25	20	5	4	2	25	7.0	CS	VARYING ABT
zl85	B85-1:B2	K8? wild	no e	hi q	f	10/4-3/85	10/24	137	2/28/86	25	25	23	2	8	0	7	9.0	CS	GREEN PODS

diversifolia ssp. trichandra x macrophylla

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
za83	K409-7:I	K158-2:I	no e	hi q	no f	7/7-19/83	--	9	7/16/83	15	0							CS	
za83	K409-7:I	K158-2:I	no e	hi q	no f	7/7-18/83	--	9	7/16/83	15	0							CS	
za85	B85-?:B2	K158-1:I	no e	hi q	no f	11/19-1/85	--	6	11/25	15	0							CS	

diversifolia ssp. trichandra x pallida

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
zy83	K409-8:I	K174-10:I	no e	hi q	no f	7/22-30/83	--	5	7/27/83	15	0							PAN	
zy83	K409-8:I	K174-10:I	no e	hi q	no f	7/8-16/83	--	6	7/14/83	15	0							PAN	
zy83	K160-6:I	K174-10:I	emas	hi q	no f	8/3-9/83	--	5	8/8/83	15	0							PAN	
zy83	K409-8:I	K376-9:I	no e	hi q	no f	8/11-3/83	--	12	8/23/83	15	0							PAN	
zy83	K409-8:I	K376-5:I	no e	hi q	no f	6/8-11/83	--	5	6/13/83	15	0							PAN	
zy83	K409-8:I	K174-10:I	no e	hi q	no f	7/8-14/83	--	8	7/19/83	15	0							PAN	
zy83	K480-7:I	K174-10:I	no e	hi q	no f	7/25-26/83	--	8	8/2/83	15	0							PAN	
zy83	K409-8:I	K376-9:I	no e	hi q	no f	8/11-2/83	--	12	8/23/83	15	0							PAN	
zy83	K409-10:I	K376-10:I	no e	hi q	no f	6/15-4/83	--	5	6/20/83	15	0							PAN	
zy83	K409-8:I	K376-5:I	no e	hi q	no f	7/8-14/83	--	6	7/14/83	15	0							PAN	
zy83	K409-8:I	K376-10:I	no e	hi q	no f	7/29-44/83	--	6	8/4/83	15	0							PAN	
zy83	K423-6:I	K174-10:I	no e	hi q	no f	7/22-25/83	--	3	7/25/83	15	0							PAN	
zy83	K409-10:I	K376-5:I	emas	hi q	no f	5/26/83	--	12	6/7/83	15	0							PAN	
zy83	K409-8:I	K376-5:I	emas	med q	no f	6/8-12/83	--	5	6/13/83	10	0							PAN	

diversifolia ssp. trichandra x pulverulenta

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
zp83	K409-8:I	K75-1:H	no e	hi q	f	7/19b/83	7/24	258	4/3/84	17	10	5	5	31	0	46	--	PAN	
zp83	K409-8:I	K75-1:H	no e	hi q	f	7/17/83	7/24	260	4/3/84	22	20	15	5	29	0	47	--	PAN	
zp83	K409-8:I	K75-1:H	no e	hi q	f	7/19a/83	7/24	258	4/3/84	18	15	5	10	47	0	53	--	PAN	
zp83	K423-8:I	K75-1:H	no e	hi q	no f	7/17-11/83	--	7	7/24/83	15	0							PAN	

diversifolia ssp. trichandra x retusa

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
zr84	K411-9:I	K280-1:H	no e	hi q	no f	10/3-22/84	--	5	10/8/84	19	0							CS	DROUGHT
zr84	K411-9:I	K280-1:H	no e	hi q	no f	10/3-2/84	--	5	10/8/84	8	0							CS	DROUGHT
zr84	B85-3:B2	K280-1:H	no e	hi q	no f	10/13-10/84	--	16	10/29/84	20	0							CS	
zr84	K411-9:I	K280-1:H	no e	med q?	no f?	10/3-20/84	--	5	10/8/84	10	0							CS	DROUGHT
zr84	K411-9:I	K280-1:H	no e	med q?	no f	10/3-21/84	--	5	10/8/84	10	0							CS	POOR FLOWER
zr84	K411-9:I	K280-1:H	no e	med q?	no f?	10/3-19/84	--	5	10/8/84	10	0							CS	POOR FLOWER
zr85	B85-?:B2	K280-1:H	no e	hi q	no f	11/4-44/85	--	7	11/11/85	15	0							CS	GLY
zr85	B85-?:B2	K280-1:H	no e	hi q	no f	11/4-45/85	--	7	11/11/85	15	0							CS	GLY
zr85	B85-?:B2	K280-1:H	no e	hi q	no f	11/4-41/85	11/11	21	11/25/85	15	5	5	0					CS	PODS ABTed
zr85	B85-?:B2	K280-1:H	no e	hi q	no f	11/4-42/85	--	7	11/11/85	15	0							CS	GLY
zr85	B85-?:B2	K280-1:H	no e	hi q	no f	11/4-43/85	--	7	11/11/85	15	0							CS	GLY

diversifolia ssp. trichandra x shannoni

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
zs81	K409-8:I	K405-?:Y2	no e	hi q	f?	7/10a/81	8/12	407	8/12/82	25	24	0	24	238	0	0	--	800	

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
zs81	K409-8:I	K405-?:Y2	no e	hi q	f	7/9a/81	--	279	4/5/82	15	4	0	4	7	10	4	--	BOO	
zs81	K409-8:I	K405-?:Y2	no e	hi q	f	7/8a/81	--	279	4/5/82	15	10	0	10	29	20	0	--	BOO	
zs81	K409-8:I	K405-?:Y2	no e	hi q	f	7/9c/81	--	279	4/5/82	15	14	0	14	93	15	26	--	BOO	
zs81	K409-7:I	K405-?:Y2	no e	hi q	f?	7/8b/81	--	19	7/27/81	15	13	13	0					BOO	
zs81	K409-7:I	K405-?:Y2	no e	med q	no f	7/8d/81	--	19	7/27/81	15	0							BOO	
zs81	K409-8:I	K405-?:Y2	no e	med q	no f?	7/10b/81	--	31	8/12/81	15	16	16	0					BOO	
zs81	K409-8:I	K405-?:Y2	no e	med q	no f?	7/9b/81	--	22	8/1/81	15	8	8	0					BOO	
zs85	B85-?:B2	K445-1:H	no e	hi q	f	11/4-3/85	11/11	116	2/28/86	15	11	3	8	48	1	3	7.5	CS	
zs85	B85-?:B2	K445-1:H	no e	hi q	no f	11/4-2/85	--	7	11/11/85	15	0							CS	
zs85	B85-?:B2	K445-1:H	no e	hi q	f	11/4-5/85	11/11	116	2/28/86	16	8	1	7	45	6	3	8.0	CS	

diversifolia ssp. trichandra x trichodes

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
zt84	K409-8:I	K738-1:H	no e	hi q	no f	6/18-7/84	--	30	7/19/84	12	0							CS	
zt84	K409-8:I	K738-1:H	no e	hi q	no f	6/22-3/84	--	26	7/19/84	12	0							CS	
zt84	K409-8:I	K738-1:H	no e	hi q	no f	6/22-4/84	--	26	7/19/84	15	0							CS	
zt84	K409-8:I	K90-1:H	no e	hi q	no f	6/18-3/84	--	31	7/19/84	15	0							CS	
zt84	K409-8:I	K738-1:H	no e	hi q?	f?	6/18-2/84	7/19	109	10/5/84	15	5	5	0					CS	DROUGHT?
zt84	K409-8:I	K738-1:H	no e	med q?	?	6/12-4/84	7/19	115	10/5/84	15	5	5	0					CS	DROUGHT?
zt85	B85-?:B2	K738-1:H	no e	hi q	no f	11/4-46/85	--	7	11/11/85	15	0							CS	BLY
zt85	B85-?:B2	K738-1:H	no e	hi q	no f	10/8-1/85	--	16	10/24/85	20	0							CS	
zt85	B85-?:B2	K738-1:H	no e	med q	no f	10/7-1/85	--	14	10/24	10	0							CS	

ESCULENTA (FEMALE) CROSSES

esculenta selfs

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
e83	K138-7:I	same	no e	hi q	no f	9/28-9/83	--	9	10/7/83	10	0							CS	
e83	K138-7:I	same	no e	hi q	no f	9/21-6/83	--	7	9/28/83	20	0							CS	
e83	K138-7:I	same	no e	hi q	no f	9/21-7/83	--	7	9/28/83	10	0							CS	
a84	K138-1:H	same	no e	med q?	no f	10/10-1/84	--	15	10/25/84	10	0							CS	
e85	K138-1:H	same	no e	hi q	no f	11/14-33/85	--	7	11/21/85	15	0							CS	
e85	K138-1:H	same	no e	hi q	no f	11/14-31/85	--	7	11/21/85	20	0							CS	
e85	K138-2:H	same	no e	hi q	no f	11/6-37/85	--	6	11/12/85	30	0							CS	
e85	K138-1:H	same	no e	hi q	no f	11/14-30/85	--	7	11/21/85	15	0							CS	
e85	K138-1:H	same	no e	med q	no f	10/10-2/85	--	15	10/25/85	15	0							CS	

esculenta x collinsii

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ec84	K138-1:H	K450-1:H	no e	hi q	no f	10/15-6/84	--	13	10/25/84	20	0							CS	
ec84	K138-1:H	K450-1:H	no e	hi q	no f	10/15-9/84	--	10	10/25/84	15	0							CS	SMALL STYLE
ec84	K138-1:H	K450-1:H	no e	hi q	no f	10/15-8/84	--	10	10/25/84	19	0							CS	
ec84	K138-1:H	K450-1:H	no e	hi q	no f	10/15-7/84	--	13	10/25/84	16	0							CS	
ec85	K138-2:I	K450-1:H	no e	hi q	no f	11/12-8/85	--	9	11/21/85	15	0							CS	
ec85	K138-2:I	K450-1:H	no e	hi q	no f	11/12-9/85	--	9	11/21/85	15	0							CS	
ec85	K138-2:I	K450-1:H	no e	med q	no f	11/12-10/85	--	9	11/21/85	13	0							CS	

esculenta x diversifolia ssp. diversifolia

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ed83	K138-2:H	K156-2:H	no e	hi q	no f	11/16-1/83	12/7	133	3/29/84	15	11	10	1	0	0	15	18.5	CS	BIG PDROP
ed83	K138-7:I	K156-1:H	no e	hi q	no f	9/19-1/83	--	4	9/23/83	25	0							CS	

ed83	K138-2:H	K156-1:H	no e	hi q	no f	11/16-2/83	12/7	133	3/29/84	15	4	0	4	0	0	62	21.0	CS	ABT
ed83	K138-7:I	K156-1:H	no e	hi q?	no f	9/14-1/83	—	6	9/20/83	30	0							CS	2 DAY FLWR, GLY
ed84	K138-6:I	K156-1:H	no e	hi q	no f	7/16-5/84	7/19	6	7/25/84	15	0							CS	
ed84	K138-1:H	K156-1:H	no e	hi q	no f	11/22-2/84	—	?	?	10	2	0	2	0	0	30	--	PAN	ALL ABT
ed84	K138-6:I	K156-1:H	no e	hi q	no f	7/16-4b/84	7/19	6	7/25/84	15	0							CS	
ed84	K138-1:H	K156-1:H	no e	hi q	no f	11/22-4/84	—	6	11/28/84	10	0							PAN	
ed84	K138-6:I	K156-1:H	no e	hi q	no f	7/16-2/84	—	3	7/19/84	15	0							CS	SUMMER FLWR
ed84	K138-1:H	K156-1:H	no e	hi q	no f	11/22-5/84	—	6	11/28/84	10	0							PAN	
ed84	K138-6:I	K156-1:H	no e	hi q	no f	7/16-4a/84	—	3	7/19/84	15	0							CS	SUMMER FLWR
ed84	K138-6:I	K156-1:H	no e	hi q	no f	7/16-3/84	—	3	7/19/84	15	0							CS	SUMMER FLWR
ed84	K138-6:I	K156-1:H	no e	hi q	no f	7/16-6/84	7/19	59	9/13/84	15	0							CS	
ed84	K138-6:I	K156-1:H	no e	hi q	no f	7/16-1/84	—	3	7/19/84	15	0							CS	SUMMER FLWR

esculenta x diversifolia ssp. trichandra

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ez84	K138-1:H	B85-1:B2	no e	med q?	no f	10/12-7a/84	--	3	10/15/84	30	0							CS	FLWR DMG?
ez84	K138-1:I	K411-9:I	no e	med q	no f	10/4-15/84	--	4	10/8/84	15	0							CS	KINK STLYE
ez84	K138-1:H	B85-1:B2	no e	med q?	no f	10/12-7b/84	--	13	10/25/84	30	0							CS	
ez85	K138-1:H	B85-?:B2	no e	hi q	no f	10/31-10/85	--	11	11/11/85	13	0							CS	
ez85	K138-2:I	K483-9:I	no e	hi q	no f	11/13-3/85	--	8	11/21/85	15	0							CS	

esculenta x lanceolata ssp. lanceolata

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
en85	K138-2:I	K566-2:I	no e	hi q	no f	11/4-34/85	--	8	11/12/85	20	0							CS	
en85	K695-11:B2	K10-2:H	no e	hi q	no f	11/12-38/85	--	9	11/21/85	15	0							CS	
en85	K138-2:I	K566-2:I	no e	hi q	no f	11/4-35/85	--	8	11/12/85	23	0							CS	
en85	K139-2:I	K566-2:I	no e	hi q	no f	11/4-33/85	--	8	11/12/85	15	0							CS	
en85	K695-11:B2	K10-2:H	no e	hi q	no f	11/12-36/85	--	9	11/21/85	15	0							CS	
en85	K138-2:H	K10-2:H	no e	hi q	no f	11/14-18/85	--	11	11/25/85	25	0							CS	
en85	K682-?:B2	K10-2:H	no e	med q	no f	11/12-39/85	--	9	11/21/85	12	0							CS	
en85	K689-20:B2	K10-2:H	no e	med q	no f	11/12-35/85	--	9	11/21/85	10	0							CS	
en85	K695-11:B2	K10-2:H	no e	med q	no f	11/12-42/85	--	9	11/21/85	15	0							CS	
en85	K682-?:B2	K10-2:H	no e	med q	no f	11/12-40/85	--	9	11/21/85	20	0							CS	

esculenta x lanceolata ssp. sousae

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
em84	K138-1:H	K393-1:H	no e	hi q	no f	10/13-17/84	10/15	12	10/25/84	20	0							CS	
em84	K138-1:H	K393-1:H	no e	hi q	no f	10/13-15/84	--	12	10/25/84	17	0							CS	
em84	K138-1:H	K393-1:H	no e	hi q	no f	10/13-16/84	10/15	12	10/25/84	20	0							CS	
em85	K695-10:B2	K393-1:H	no e	hi q	no f	11/13-15/85	--	8	11/21/85	15	0							CS	
em85	K695-10:B2	K393-1:H	no e	hi q	no f	11/13-13/85	--	8	11/21/85	16	0							CS	
em85	K695-10:B2	K393-1:H	no e	hi q	no f	11/13-17/85	--	8	11/21/85	15	0							CS	
em85	K139-2:H	K393-1:H	no e	hi q	no f	11/4-22/85	--	8	11/12/85	15	0							CS	
em85	K138-2:I	K393-1:H	no e	hi q	no f	11/4-20/85	--	8	11/12/85	15	0							CS	
em85	K695-10:B2	K393-1:H	no e	hi q	no f	11/13-14/85	--	8	11/21/85	15	0							CS	
em85	K695-10:B2	K393-:H	no e	hi q	no f	11/13-16/85	--	8	11/21/85	15	0							CS	
em85	K695-10:B2	K393-1:H	no e	hi q	no f	11/13-12/85	--	8	11/21/85	20	0							CS	
em85	K138-2:I	K393-1:H	no e	hi q	no f	11/4-21/85	--	8	11/12/85	20	0							CS	

esculenta x leucocephala

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
el83	K138-2:H	K500-10:Y1	no e	hi q	no f	11/28-4/83	12/7	122	3/29/84	15	14	10	4	0	0	50	18.0	CS	SEED RESCUE

el83	K138-2:H	K500-10:Yl	no e	hi q	no f	11/28-2/83	12/17	121	3/29/84	15	15	12	3	0	0	35	20.0	CS	ABT
el83	K138-2:H	K500-10:Yl	no e	hi q	no f	11/28-3/83	12/7	122	3/29/84	20	16	12	4	0	0	18	10.0	CS	LOOPER DMG
el83	K138-2:H	K500-10:Yl	no e	med q	no f	12/3-9/83	12/10	115	3/29/84	15	1	0	1	0	0	11	13.0	CS	POOR POLLEN

esculenta x pallida

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ey84	K138-1:I	K376-5:I	no e	hi q	no f	10/2-22/84	—	6	10/8/84	15	0							CS	
ey84	K138-1:H	K174-10:I	no e	hi q?	no f	11/22-9/84	—	6	11/28/84	15	0							PAN	
ey84	K138-1:H	K174-10:I	no e	hi q?	no f	11/22-8/84	—	?	?	15	4	0	4	0	0	40	—	PAN	ALL ABT

esculenta x retusa

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
er83	K138-7:I	K280-1:H	no e	hi q	no f	9/24-4/83	10/7	122	1/24/84	20	6	0	6	0	0	40	8.0	CS	
er84	K138-1:H	K280-1:H	no e	hi q	no f	10/15-25/84	--	10	10/25/84	15	0							CS	
er84	K138-1:H	K280-1:H	no e	hi q	no f	10/15-24/84	—	10	10/25/84	15	0							CS	
er84	K138-1:H	K280-1:H	no e	hi q	no f	10/15-23/84	—	10	10/25/84	15	0							CS	
er84	K138-1:I	K280-1:I	no e	hi q	no f	10/1-5/84	—	7	10/8/84	25	0							CS	

esculenta x shannoni

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
es84	K138-1:I	K445-1:H	no e	hi q	f	10/13-15/84	10/15	138	2/28/85	20	1	0	1	2	8	4	19.5	CS	

esculenta x trichodes

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
et84	K138-6:I	K738-1:H	no e	hi q	no f	7/12-8/84	--	7	7/19/84	20	0							CS	
et84	K138-1:H	K738-1:H	no e	hi q	no f	11/16-22/84	—	7	11/23/84	6	0							CS	
et85	K138-1:H	K738-1:H	no e	hi q	no f	10/31-8/85	--	11	11/11/85	16	0							CS	GLY

LANCEOLATA SSP. LANCEOLATA (FEMALE) CROSSES

lanceolata ssp. lanceolata selfs

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
n82	K401-1:I	same	no e	med q	no f	8/12-2/82	—	18	8/30/82	15	0							CS	
n82	K401-1:I	same	no e	hi q	no f	8/12-3/82	--	7	8/19/82	15	0							CS	
n82	K401-1:I	same	no e	hi q	no f	8/12-4/82	--	7	8/19/82	15	0							CS	
n83	K10-2:H	same	no e	med q	no f	7/13-3/83	—	9	7/22/83	15	0							CS	LON ST#
n83	K10-2:H	same	no e	med q	no f	7/15-3/83	—	7	7/22/83	15	0							CS	
n84	K10-2:H	same	no e	hi q	no f	9/26-6/84	—	8	10/4/84	15	0							CS	
n84	K10-2:H	same	no e	hi q	no f	9/29-7/84	—	5	10/4/84	15	0							CS	
n84	K10-2:H	same	no e	hi q	no f	9/29-8/84	—	5	10/4/84	15	0							CS	
n84	K10-2:H	same	no e	hi q	no f	9/29-9/84	--	2	10/1/84	15	0							CS	
n85	K10-2:H	same	no e	hi q	no f	10/5-50/85	--	6	10/11/85	13	0							CS	
n85	K10-2:H	same	no e	hi q	no f?	10/6-50/85	—	?	?	13	1	0	1	0	0	5	6.5	CS	ABORT
n85	K10-2:H	same	no e	hi q	no f	9/30-20/85	--	5	10/4/85	15	0							CS	

lanceolata ssp. lanceolata x collinsii

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
nc84	K10-1:H	K450-1:H	no e	hi q	f	6/28-1/84	7/19	77	9/13/84	15	3	0	3	40	0	1	10.5	CS	TINY SEEDS
nc84	K10-1:H	K450-1:H	no e	hi q	f	6/28-15/84	7/19	77	9/13/84	15	5	0	5	77	0	2	12.5	CS	TINY SEEDS

nc84	K10-1:H	K450-1:H	no e	hi q	f	6/28-16/84	7/19	77	9/13/84	10	3	1	2	17	0	0	9.5	CS	TINY SEEDS
nc84	K10-2:H	K450-1:H	no e	hi q	f	9/26-3/84	10/8	85	12/20/84	15	18	11	7	123	2	7	16.0	CS	
nc84	K10-2:H	K450-1:H	no e	hi q	no f	9/26-4/84	--	8	10/4/84	15	0							CS	
nc84	K10-2:H	K450-1:H	no e	hi q	f	9/26-5/84	10/8	85	12/20/84	15	1	0	1	10	2	0	16.0	CS	
nc84	K10-1:H	K450-1:H	no e	hi q?	no f	9/26-6/84	--	29	10/25/84	15	0							CS	
nc84	K10-2:H	K450-1:H	no e	hi q	no f	9/26-8/84	--	11	10/8/84	15	0							CS	
nc84	K10-2:H	K450-1:H	no e	hi q	no f	9/26-9/84	--	11	10/8/84	15	0							CS	
nc84	K10-2:H	K450-1:H	no e	hi q	no f	9/29-10/84	--	9	10/8/84	15	0							CS	
nc84	K10-2:H	K450-1:H	no e	hi q	no f	9/26-2/86	--	8	10/4/86	15	14	14	0					CS	HUH?
nc86	K162-1:I	K450-1:H	no e	hi q	f	5/6-5/86	6/19	137	9/20/86	20	18	1	17	169	182	15	28.0	CS	

lanceolata ssp. lanceolata x diversifolia ssp. diversifolia

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
nd83	K10-1:H	K156-2:H	no e	hi q	f	10/7-2/83	10/17	104	1/19/84	13	13	11	2	2	2	17	12.0	CS	
nd85	K10-1:H	K156-1:H	no e	hi q	no f	10/4-5/85	10/11	62	12/12/85	15	8	4	4	0	0	79	11.0	CS	ALL ABT?
nd85	K10-1:H	K156-1:H	no e	hi q	no f	10/7-3/85	--	4	10/11/85	15	0							CS	
nd85	K10-1:H	K156-1:H	no e	hi q	no f	10/8-2/85	--	3	10/11/85	10	0							CS	
nd85	K10-2:H	K156-1:H	no e	hi q	no f	9/3-4/85	--	10	9/13/85	13	0							CS	
nd85	K10-1:H	K156-1:H	emas	hi q	no f	9/30-1/85	--	5	10/4/85	20	0							CS	
nd85	K10-1:H	K156-1:H	no e	hi q	no f	9/30-2/85	--	10	10/9/85	15	0							CS	
nd85	K10-1:H	K156-1:H	no e	hi q	no f	9/30-3/85	--	5	10/4/85	20	0							CS	
nd85	K10-1:H	K156-1:H	no e	hi q	no f	9/30-4/85	--	5	10/4/85	20	0							CS	
nd85	K10-1:H	K156-1:H	no e	med q	no f	9/30-5/85	--	5	10/4/85	10	0							CS	
nd85	K10-1:H	K156-1:H	no e	hi q	no f	9/30-6/85	--	5	10/4/85	10	0							CS	
nd85	K10-1:H	K156-1:H	no e	hi q	no f	9/30-7/85	--	5	10/4/85	10	0							CS	

lanceolata ssp. lanceolata x diversifolia ssp. trichandra

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
nz84	K10-2:H	K411-9:I	no e	hi q	no f	10/5-16/84	--	3	10/8/84	18	0							CS	
nz84	K10-2:H	K411-9:I	no e	hi q	no f	10/5-17/84	--	3	10/8/84	15	0							CS	
nz84	K10-1:H	K409-8:I	no e	hi q	no f	6/25-1/84	--	24	7/19/84	15	0							CS	
nz84	K10-1:H	K409-8:I	no e	hi	no f	6/25-1/84	--	24	7/19/84	15	0							CS	
nz85	K10-1:H	B85-1:B2	no e	med q	no f	10/4-4/85	--	7	10/11/85	3	0							CS	
nz85	K10-1:H	B85-1:B2	no e	hi q	f	10/7-11/85	10/11	66	12/12/85	12	5	0	5	21	20	7	12.0	CS	
nz85	K10-1:H	B85-1:B2	no e	hi q	f	10/7-1/85	10/11	66	12/12/85	15	5	0	5	35	13	0	11.0	CS	
nz85	K10-1:H	B85-1:B2	no e	hi q	f	10/7-2/85	10/11	66	12/12/85	15	10	6	4	28	13	0	12.0	CS	
nz85	K10-1:H	B85-2:B2	no e	hi q	no f	10/7-3/85	--	4	10/11/85	15	0							CS	
nz85	K10-1:H	B85-1:B2	no e	hi q	no f	10/7-4/85	--	4	10/11/85	20	0							CS	

lanceolata ssp. lanceolata x esculenta

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ne84	K10-2:H	K138-1:I	no e	hi q	no f	10/1-14/84	--	3	10/4/84	15	0							CS	BLY
ne84	K10-2:H	K138-1:I	no e	hi q	no f	10/1-15/84	--	4	10/5/84	15	0							CS	
ne84	K10-2:H	K138-1:I	no e	med q	no f	10/2-23/84	--	3	10/5/84	10	0							CS	
ne85	K566-?:I	K138-1:H	no e	med q	no e	10/31-6/85	--	6	11/6/85	6	0							CS	SMALL STYLE
ne85	K545-1:I	K138-1:H	no e	med q	no f	10/31-7/85	--	6	11/6/85	6	0							CS	BLY
ne85	K566-5:I	K138-2:I	no e	med q	no f	11/6-30/85	--	6	11/12/85	20	0							CS	
ne85	K566-?:I	K138-2:I	no e	med q	no f	11/6-31b/85	--	6	11/12/85	20	0							CS	2 DAY FLWR
ne85	K566-2:I	K138-2:I	no e	hi q	no f	11/6-31a/85	--	6	11/12/85	13	0							CS	
ne85	K545-5:I	k138-2:I	no e	med q	no f	11/6-32/85	--	6	11/12/85	15	0							CS	

lanceolata ssp. lanceolata x lanceolata ssp. sousae

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ne82	K401-1:I	K393-1:H	no e	med q	no f	8/11-3/82	--	49	9/30/82	15	0							CS	
ne82	K401-1:I	K393-1:H	no e	med q	no f	8/11-4/82	--	1	8/12/82	15	0							CS	
ne82	K401-1:I	K393-1:H	no e	hi q	no f	8/13-2/82	--	17	8/30/82	15	0							CS	
ne85	K10-2:H	K393-1:H	no e	hi q	f	9/27-1/85	10/4	67	12/3/85	15	15	13	2	17	15	0	15.0	CS	
ne85	K10-2:H	K393-1:H	no e	hi q	f	9/27-10/85	10/4	67	12/3/85	15	9	8	1	6	4	1	16.0	CS	
ne85	K10-2:H	K393-1:H	no e	hi q	f	9/27-11/85	10/4	67	12/3/85	15	17	10	7	45	50	3	14.0	CS	
ne85	K10-2:H	K393-1:H	no e	hi q	f	9/27-12/85	10/4	67	12/3/85	20	18	14	4	33	27	1	11.5	CS	
ne85	K10-2:H	K393-1:H	no e	med q	f	9/27-13/85	10/4	67	12/3/85	10	10	7	3	12	30	0	13.0	CS	
ne85	K10-2:H	K393-1:H	no e	hi q	f	9/27-2/85	10/4	67	12/3/85	15	15	10	5	40	14	1	14.0	CS	
ne85	K10-2:H	K393-1:H	no e	hi q	f	9/27-3/85	10/4	67	12/3/85	25	25	17	8	70	38	0	15.5	CS	
ne85	K10-2:H	K393-1:H	no e	med q	f	9/27-4/85	10/4	67	12/3/85	15	14	11	3	25	17	1	15.0	CS	
ne85	K10-2:H	K393-1:H	no e	hi q	f	9/27-5/85	10/4	67	12/3/85	25	23	8	15	201	58	1	15.0	CS	
ne85	K10-2:H	K393-1:H	no e	med q	f	9/27-6/85	10/4	67	12/3/85	20	16	10	6	57	29	1	15.5	CS	
ne85	K10-2:H	K393-1:H	no e	hi q	f	9/27-7/85	10/4	67	12/3/85	20	18	14	4	53	9	0	15.5	CS	
ne85	K10-2:H	K393-1:H	no e	hi q	f	9/27-9/85	10/4	67	12/3/85	15	14	10	4	54	10	0	15.0	CS	
ne85	K10-2:H	K393-1:H	no e	hi q	f	9/27-8/85	10/4	67	12/3/85	30	28	24	4	34	20	0	14.0	CS	

lanceolata ssp. lanceolata x leucocephala

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
nl84	K10-2:H	K?:HGeast	no e	hi q	no f	10/3-24/84	--	5	10/8/84	13	0							CS	
nl84	K10-2:H	K?:HGeast	no e	hi q	no f	10/3-26/84	--	5	10/8/84	15	0							CS	
nl85	K10-1:H	K8?-?:BH	no e	hi q	f?	10/4-1/85	10/11	69	12/12/85	15	15	2	13	1	0	180	14.0	CS	CROSS?
nl85	K10-1:H	K8?:BHG	no e	hi q	f	10/4-2/85	10/11	69	12/12/85	30	30	0	30	3	9	316	12.0	CS	
nl85	K10-1:H	K8?-?:BH	no e	hi q	f	10/4-3/85	10/11	69	12/12/85	15	20	0	20	4	1	232	12.5	CS	VIABLE?
nl85	K10-2:H	K8?-?:BH	no e	med q	no f	10/7-1/85	10/24	66	12/12/85	15	12	5	7	0	0	88	12.0	CS	ALL ABT SD

lanceolata ssp. lanceolata x pallida

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ny84	K10-2:H	K376-5:I	no e	hi q	no f	10/2-24/84	--	2	10/4/84	15	0							CS	
ny84	K10-2:H	K376-5:I	no e	hi q	no f	10/2-25/84	--	2	10/4/84	15	0							CS	
ny84	K10-2:H	K376-5:I	no e	hi q	no f	10/4-1/84	--	4	10/8/84	20	0							CS	
ny84	K10-2:H	K376-5:I	no e	hi q	no f	10/4-2/84	--	4	10/8/84	22	0							CS	
ny84	K10-2:H	K376-5:I	no e	med q?	no f	10/4-3/84	--	1	10/5/84	12	0							CS	FLWR DAMAGE
ny85	K10-2:H	K376-2:I2	no e	hi q	no f	9/14-10/85	--	12	9/26/85	20	0							CS	
ny85	K10-2:H	K376-2:I2	no e	med q	no f	9/14-6/85	--	12	9/26/85	10	0							CS	
ny85	K10-2:H	K376-2:I2	no e	hi q	no f	9/14-7/85	--	12	9/26/85	15	0							CS	
ny85	K10-2:H	K376-2:I2	no e	hi q	no f	9/14-8/85	--	12	9/26/85	15	0							CS	
ny85	K10-2:H	K376-2:I2	no e	med q	no f	9/14-9/85	--	12	9/26/85	20	0							CS	

lanceolata ssp. lanceolata x retusa

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
nr84	K10-1:H	K502-1:H	no e	no f	no f	6/26-1/84	--	23	7/19/84	15	0							CS	
nr84	K10-1:H	K502-1:H	no e	hi q	no f	6/26-1/84	--	23	7/19/84	15	0							CS	
nr84	K10-2:H	K502-1:H	no e	hi q	no f	6/26-2/84	--	23	7/19/84	15	0							CS	
nr84	K10-1:H	K502-1:H	no e	hi q	no f	6/26-2/84	--	23	7/19/84	15	0							CS	
nr85	K10-2:H	K502-2:H	no e	hi q	no f	11/14-44/85	--	7	11/21/85	10	0							CS	

lanceolata ssp. lanceolata x shannoni

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ns83	K10-1:H	K445-2:H	no e	hi q	f	10-5-11/83	10/17	62	12/7/83	17	17	0	17	140	30	4	14.0	CS	WEIRD SEED
ns83	K10-1:H	K445-2:H	no e	hi q	f	10/5-10/83	10/17	62	12/7/83	15	15	3	12	193	10	4	13.0	CS	
ns85	K10-2:H	K445-1:H	no e	med q	no f	9/3-3/85	--	10	9/13/85	15	0							CS	
ns85	K10-2:H	K445-1:H	no e	med q	no f	9/3-5/85	--	10	9/13/85	15	0							CS	
ns85	K10-2:H	K445-1:H	no e	med q	no f	9/3-6/85	--	10	9/13/85	10	0							CS	
ns85	K10-2:H	K445-1:H	no e	med q	no f	9/3-7/85	--	10	9/13/85	10	0							CS	

lanceolata ssp. lanceolata x trichodes

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
nt84	K10-2:H	K738-1:H	no e	no f	no f	10/5-23/84	--	20	10/25/84	15	0							CS	
nt84	K10-2:H	K738-1:H	no e	hi q	no f	10/5-23/84	--	20	10/25/84	15	0							CS	
nt84	K10-2:H	K738-1:H	no e	hi q?	no f	10/5-24/84	--	3	10/8/84	12	0							CS	
nt84	K10-1:H	K738-1:H	no e	med q?	no f	11/24/84	--	6	11/30/84	10	0							ND	
nt84	K10-1:H	K738-1:H	no e	med q?	no f	11/24/84	--	6	11/30/84	10	0							ND	
nt84	K10-1:H	K738-1:H	no e	med q?	no f	11/24/84	--	6	11/30/84	10	0							ND	
nt85	K10-1:H	K738-1:H	no e	hi q	no f	10/4-1/85	--	11	10/11/85	15	0							CS	
nt85	K10-1:H	K738-1:H	no e	hi q	no f	10/4-2/85	--	7	10/11/85	15	0							CS	
nt85	K10-1:H	K738-1:H	no e	med q	no f	10/7-1/85	--	4	10/11/85	8	0							CS	
nt85	K10-1:H	K738-1:H	no e	hi q	no f	10/7-2/85	--	4	10/11/85	15	0							CS	
nt85	K10-1:H	K738-1:H	no e	hi q	f	10/7-3/85	10/11	66	12/12/85	15	2	0	2	2	18	7	13.0	CS	

LANCEOLATA SSP. SOUSAE (FEMALE) CROSSES

lanceolata ssp. sousae selfs

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
m82	K385-10:I	same	no e	hi q	no f	7/16-3/82	--	3	7/19/82	20	0							CS	
m82	K385-10:I	same	no e	hi q	no f	7/20-35/82	--	9	7/29/82	20	0							CS	
m82	K393-1:H	same	no e	hi q	no f	7/26-1/82	--	3	7/29/82	20	0							CS	
m82	K393-1:H	same	no e	med q	no f	8/11-2/82	--	8	8/19/82	15	0							CS	
m82	K385-10:I	same	no e	hi q	no f	8/13-1/82	--	6	8/19/82	20	0							CS	
m83	K385-10:I	same	no e	hi q	no f	6/26-14/83	--	11	7/6/83	20	0							CS	
m83	K393-1:H	same	no e	hi q	no f	6/28-3/83	--	5	7/3/83	15	0							CS	2nd DAY FLWR
m85	K393-1:H	same	no e	hi q	no f	11/12-43/85	--	9	11/21/85	15	0							CS	
m85	K393-1:H	same	no e	hi q	no f	11/12-44/85	--	9	11/21/85	20	0							CS	

lanceolata ssp. sousae x collinsii

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
mc83	K393-1:H	K450-1:H	no e	med q	f	10/5-14/83	10/17	111	1/24/84	25	20	8	12	0	73	3	17.0	CS	2 DAY FLWR
mc83	K393-1:H	K450-1:H	no e	hi q	f	10/5-15/83	10/17	111	1/24/84	25	20	12	8	0	69	0	15.0	CS	YUK SEEDS
mc83	K393-1:H	K450-1:H	no e	hi q	f	10/5-16/83	10/17	111	1/24/84	25	20	12	8	0	69	0	16.0	CS	1 DAY FLWR
mc83	K393-1:H	K450-1:H	no e	med q	no f	10/5-4/83	--	12	10/17/83	15	0							CS	
mc83	K393-1:H	K450-1:H	no e	hi q	f	10/5-5/83	10/17	111	1/24/84	20	5	0	5	5	45	1	16.5	CS	
mc83	K393-1:H	K450-1:H	no e	hi q	f	9/28-5/83	10/5	118	1/24/84	20	18	2	16	86	184	4	19.0	CS	
mc83	K393-1:H	K450-1:H	no e	hi q	f	9/28-6/83	10/5	118	1/24/84	30	30	23	7	27	78	0	17.0	CS	
mc85	K393-1:H	K450-1:H	no e	hi q	f	11/12-13/85	11/21	108	2/28/86	14	13	0	13	181	4	3	19.5	CS	EARLY HRVST

lanceolata ssp. sousae x diversifolia ssp. diversifolia

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
md84	K393-1:H	K156-1:H	no e	hi q	no f	10/10-13/84	--	5	10/15/84	30	0							CS	GLY
md84	K393-1:H	K156-1:H	no e	med q?	no f	10/3-26/84	--	5	10/8/84	3	0							CS	LOW ST#
md84	K393-1:H	K156-1:H	no e	hi q	no f	10/3-28/84	--	5	10/8/84	30	0							CS	
md84	K393-1:H	K156-1:H	no e	hi q	no f	10/3-29/84	--	5	10/8/84	30	0							CS	
md84	K393-1:H	K156-1:H	no e	hi q	no f	10/5-26a/84	--	3	10/8/84	35	0							CS	
md84	K393-1:H	K156-1:H	no e	hi q	no f	10/5-26b/84	--	3	10/8/84	15	0							CS	
md84	K393-1:H	K156-1:H	no e	hi q	no f	10/5-27/84	10/27	146	2/28/86	15	13	0	13	0	0	119	16.0	CS	ALL ABT SD
md84	K393-1:H	K156-1:H	no e	hi q	no f	10/5-7/84	--	3	10/8/84	40	0							CS	

lanceolata ssp. sousae x diversifolia ssp. trichandra

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
mz84	K393-1:H	K411-9:I	no e	hi q	no f	10/10-14/84	--	5	10/15/84	20	0							CS	
mz84	K393-1:H	K411-9:I	no e	med q	no f	10/10-15/84	--	5	10/15/84	10	0							CS	
mz84	K393-1:H	B85-1:B2	no e	med q	no f	10/12-8/84	--	3	10/15/84	18	0							CS	
mz84	K393-1:H	B85-1:B2	no e	hi q	no f	10/12-2/84	--	3	10/15/84	10	0							CS	
mz85	K393-1:H	B85-1:B2	no e	hi q	no f	10/8-1/85	--	3	10/11/85	35	0							CS	2 DAY FLWR, GLY
mz85	K393-1:H	B85-1:B2	no e	hi q	no f	10/8-2/85	--	3	10/11/85	15	0							CS	
mz85	K393-1:H	B85-1:B2	no e	med q	no f	10/8-3/85	--	3	10/11/85	10	0							CS	
mz85	K393-1:H	K483-9:I	no e	hi q	no f	11/13-11/85	--	8	11/21/85	15	0							CS	
mz85	K393-1:H	B85-7:B2	no e	hi q	no f	11/19-10/85	--	6	11/25/85	15	0							CS	
mz85	K393-1:H	B85-1:B2	no e	hi q	no f	10/8-4/85	--	3	10/11/85	35	0							CS	
mz86	K393-1:H	K107-1:I2	no e	med q	no f	5/7-3/86	--	3	5/10/86	7	0							CS	
mz86	K393-1:H	K107-1:I2	no e	med q	no f?	5/7-4/86	--	3	5/10/86	7	2	2	0					CS	BAG BROKE PODS
mz86	K393-1:H	K107-1:I2	no e	hi q	f?	5/7-5/86	5/14	39	6/15/86	10	4	4	0					CS	BRANCH BROKE

lanceolata ssp. sousae x esculenta

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
me83	K393-1:H	K138-7:I	no e	hi q	no f	9/14-3/83	--	6	9/20/83	13	0							CS	OLD FLWR
me83	K393-1:H	K138-7:I	no e	med q	no f	9/24-7/83	10/5	122	1/24/84	13	13	0	13	0	43	28	16.0	CS	
me83	K393-1:H	K138-7:I	no e	med q	no f	9/24-8/83	10/5	122	1/24/84	10	3	0	3	0	27	20	15.5	CS	
me84	K393-1:H	K138-1:H	no e	hi q	no f	10/10-16/84	--	5	10/15/84	25	0							CS	
me84	K393-1:H	K138-1:H	no e	hi q	no f	10/10-17/84	--	30	10/15/84	30	0							CS	
me84	K393-1:H	K138-1:H	no e	hi q	no f	10/12-1/84	--	3	10/15/84	23	0							CS	GLY
me84	K393-1:H	K138-1:H	no e	med q	no f	10/12-13/84	--	3	10/15/84	10	0							CS	LOW ST#

lanceolata ssp sousae x lanceolata ssp lanceolata

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
mn82	K385-10:I	K401-1:I	no e	med q	no f	8/12-5/82	--	18	8/30/82	15	0							CS	
mn85	K393-1:H	K10-2:H	no e	hi q	f	9/29-14/85	10/4	107	1/14/86	65	65	25	40	367	362	10	19.0	CS	
mn85	K393-1:H	K10-2:H	no e	hi q	f	9/29-17/85	10/4	127	2/3/86	65	61	0	61	287	750	50	18.0	CS	HI BUGSD
mn85	K393-1:H	K10-2:H	no e	hi q	f	9/29-18/85	10/4	152	2/28/86	45	45	0	45	82	500	69	18.0	CS	2 PODS LOST
mn85	K393-1:H	K10-2:H	no e	hi q	f	9/30-15/85	10/4	126	2/3/86	15	15	6	9	14	100	2	19.0	CS	
mn85	K393-1:H	K10-2:H	no e	hi q	f	9/30-16/85	10/4	126	2/3/86	15	15	4	11	9	130	11	17.5	CS	
mn85	K393-1:H	K10-2:H	no e	hi q	f	9/30-1/85	10/24	151	2/28/86	30	30	27	3	2	24	1	15.0	CS	

lanceolata ssp. sousae x leucocephala

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ml82	K385-10:I	K500-?:Y1	no e	med q	no f	6/26-13/82	--	3	6/29/82	10	0							CS	
ml82	K385-10:I	K500-?:Y1	no e	med q	no f	6/29-3/82	--	5	7/2/82	15	0							CS	

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ml83	K393-1:H	K8-?:A2	no e	hi q	no f	9/23-3/83	10/5	123	1/24/84	15	4	0	4	0	0	37	16.0	CS	ALL ABT
ml83	K393-1:H	K8-?:A2	no e	hi q	no f	9/24-1a/83	--	123	1/24/84	20	7	5	2	0	0	13	10.5	CS	
ml83	K393-1:H	K8-?:A2	no e	hi q	no f	9/24-1b/83	10/13	122	1/24/84	20	7	0	7	0	0	41	16.0	CS	
ml83	K393-1:H	K8-?:A2	no e	hi q	no f	9/24-2/83	--	4	9/28/83	20	0							CS	
ml84	K393-1:H	K?-?:Heast	no e	hi q	no f	10/5-8/84	--	3	10/8/84	20	0							CS	WEIRD
ml84	K393-1:H	K?-?:Heast	no e	hi q	no f	10/5-9/84	--	3	10/8/84	20	0							CS	

lanceolata ssp. sousae x macrophylla

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ma83	K393-1:H	K158-2:I	no e	med q	no f	7/7-2/83	--	15	7/22/83	15	0							CS	
ma83	K393-1:H	K158-2:I	no e	hi q	no f	7/7-3/83	--	5	7/12/83	15	0							CS	
ma86	K393-1:H	K158-1:H	no e	med q	no f	5/20-1/86	--	9	5/29/86	6	0							CS	BLY

lanceolata ssp. sousae x pallida

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
my84	K393-1:H	K376-10:I	no e	hi q	no f	10/5-1/84	--	3	10/8/84	15	0							CS	
my84	K393-1:H	K376-5:I	no e	hi q	no f	10/5-2/84	--	3	10/8/84	15	0							CS	
my84	K393-1:H	K376-10:I	no e	hi q	no f	10/5-3/84	--	3	10/8/84	20	0							CS	
my84	K393-1:H	K376-10:I	no e	hi q	no f	10/5-4/84	--	3	10/8/84	20	0							CS	
my84	K393-1:H	K376-10:I	no e	hi q	no f	10/5-5/84	--	3	10/8/84	15	0							CS	
my84	K393-1:H	K376-10:I	no e	hi q	no f	10/5-6/84	--	3	10/8/84	15	0							CS	
my84	K393-1:H	K376-10:I	no e	hi q	no f	10/5-7a/84	--	3	10/8/84	25	0							CS	
my84	K393-1:H	K376-10:I	no e	hi q	no f	10/5-7b/84	--	3	10/8/84	40	0							CS	

lanceolata ssp. sousae x pulverulenta

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
mp83	K393-1:H	K19-1:Y2	no e	med q	no f	6/17-1/83	--	7	6/24/83	15	0							CS	FEMALE POOR
mp83	K393-1:H	K19-1:Y2	no e	hi q	no f	6/17-2/83	--	7	6/24/83	40	0							CS	

lanceolata ssp. sousae x retusa

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
mr83	K393-1:H	K280-1:H	no e	med q	no f	9/16-4/83	--	4	9/20/83	15	0							CS	1 DAY FLWR
mr83	K393-1:H	K280-1:H	no e	hi q	no f	9/16-6/83	--	8	9/24/83	20	0							CS	
mr83	K393-1:H	K280-1:H	no e	hi q	no f	9/16-7/83	--	8	9/24/83	15	0							CS	
mr83	K393-1:H	K280-1:H	no e	hi q	no f	9/17-1/83	--	3	9/20/83	15	0							CS	
mr83	K393-1:H	K280-1:H	no e	hi q	no f	9/17-2/83	--	3	9/2-/83	15	0							CS	
mr83	K393-1:H	K280-1:H	no e	hi q	no f	9/17-3/83	--	3	9/20/83	20	0							CS	
mr83	K393-1:H	K280-1:H	no e	hi q	no f	9/17-4/83	--	3	9/20/83	20	0							CS	
mr83	K393-1:H	K280-1:H	no e	hi q	no f	9/24-5/83	--	33	10/17/83	20	0							CS	
mr83	K393-1:H	K280-1:H	no e	hi q?	no f	9/24-6/83	--	4	9/28/83	20	0							CS	2 DAY FLWR

lanceolata ssp. sousae x shannoni

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ms83	K393-1:H	K445-2:H	No e	hi q	f	10/5-12/83	10/28	111	1/24/83	35	35	1	34	166	475	2	19.0	CS	1 DAY FLWR
ms83	K393-1:H	K445:2:H	no e	hi q	f	10/5-13/83	10/17	111	1/24/84	80	80	19	61	41	990	0	16.0	CS	T.C.
ms83	K393-1:H	K445-2:H	no e	hi q	f	9/28-1/83	10/5	118	1/24/84	30	9	0	9	14	61	3	17.5	CS	
ms83	K393-1:H	K445-1:H	no e	hi q	f	9/28-2a/83	10/5	118	1/24/84	20	15	14	1	7	5	0	11.5	CS	2 DAY FLWR
ms83	K393-1:H	K445-2:H	no e	hi q	f	9/28-2b/83	10/5	118	1/24/84	17	8	0	8	1	29	10	8.0	CS	BUG
ms83	K393-1:H	K445-1:H	no e	hi q	f	9/28-3/83	10/5	118	1/24/84	22	20	0	20	15	0	3	12.5	CS	ABT SD?
ms84	K393-1:H	K445-1:H	no e	hi q	no f	10/10-7/84	--	5	10/15/84	30	0							CS	
ms85	K393-1:H	K445-1:H	no e	hi q	f	11/12-50/85	11/21	90	2/3/86	15	13	9	4	47	4	4	17.0	CS	PIK GREEN

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ms85	K393-1:H	K445-1:H	no e	hi q	f	11/12-51/85	11/21	12	11/24/85	20	15	15	0					CS	
ms85	K393-1:H	K445-1:H	no e	hi q	f	11/12-52/85	11/21	90	2/3/86	15	15	8	7	80	10	5	19.0	CS	PIK GREEN

lanceolata ssp. sousae x trichodes

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
mt85	K393-1:H	K90-1:H	no e	hi q	no f	11/12-55/85	--	9	11/21/85	16	0							CS	
mt85	K393-1:H	K90-1:H	no e	hi q	no f	11/12-56/85	--	9	11/21/85	16	0							CS	
mt85	K393-1:H	K90-1:H	no e	hi q	no f	11/12-58/85	--	9	11/21/85	10	0							CS	
mt85	K393-1:H	K90-1:H	no e	hi q	no f	11/12-59/85	--	9	11/21/85	15	0							CS	
mt85	K393-1:H	K90-1:H	no e	hi q	no f	11/12-60/85	--	9	11/21/85	15	0							CS	

LEUCOCEPHALA (FEMALE) CROSSES

leucocephala selfs

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
182	K500-?:Y1	same	emas	hi q	f	7/16-1/82	7/19	90	10/14/82	15	15	2	13	33	314	0	18.0	CS	BUG HI
182	K500-?:Y1	same	emas	hi q	f	7/16-2/82	7/19	81	10/5/82	15	15	1	14	23	336	0	19.5	CS	BUG
182	K500-?:Y1	same	emas	hi q	f	7/2-23/82	--	83	9/23/82	15	15	0	15	126	242	6	24.0	CS	BUG HI
182	K500-?:Y1	same	emas	hi q	f	7/21-14/82	7/26	85	10/14/82	10	9	1	8	26	163	0	27.0	CS	BUG
182	K500-?:Y1	same	emas	hi q	f	7/21-15/82	7/26	76	10/5/82	16	3	1	2	3	38	1	22.0	CS	BUG
182	K500-?:Y1	same	emas	hi q	f	7/21-16/82	--	85	10/14/82	10	1	0	1	2	15	0	21.0	CS	OLD FLWR
182	K500-?:Y1	same	emas	med q	no f	7/21-17/82	--	5	7/26/82	10	0							CS	
186	K614-?:E	same	no e	med q	f	11/10-1/85	--	83	2/1/86	10	2	1	1	3	11	0	11.0	CS	

leucocephala x collinsii

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
lc82	K8?-?:Y2	K183-1:I	emas	hi q	f	7/29-18/82	--	90	10/28/82	15	5	0	5	26	127	2	21.0	CS	
lc82	K8?-?:Y2	K183-1:I	emas	hi q	no f	7/29-19/82	8/2	21	8/19/82	15	5	5	0					CS	PDROP
lc82	K500-?:Y1	K183-1:I	emas	hi q	no f?	7/29-2/82	8/2	84	10/21/82	15	3	2	1	0	1	0	12.0	CS	
lc82	K8?-?:Y2	K183-1:I	emas	hi q	no f	7/29-20/82	8/2	21	8/19/82	15	9	9	0					CS	PDROP
lc82	K8-?:B1	K183-1:I	emas	hi q	no f	7/29-21/82	8/4	21	8/9/82	15	7	7	0					CS	PDROP
lc82	K500-?:Y1	K183-1:I	emas	hi q	f?	7/29-3/82	8/2	90	10/28/82	15	9	1	8	5	48	120	17.0	CS	HI ABT SD
lc82	K8?-?:Y2	K183-1:I	emas	hi q	f?	7/29-5/82	--	90	10/28/82	15	5	3	2	2	2	2	12.5	CS	
lc83	K500-12:Y1	K450-1:H	emas	hi q	no f	7/27-4/83	--	19	8/15/83	15	0							CS	
lc83	K8-?:A2	K450-1:H	emas	hi q	no f?	8/10-7/83	8/15	21	8/31/83	15	10	10	0					CS	
lc83	K8-?:A2	K450-1:H	emas	hi q	f	8/10-8/83	8/31	86	11/4/83	15	15	12	3	2	0	15	15.0	CS	15 SMALL SDS
lc83	K8-?:A2	K450-1:H	emas	med q	no f	8/9-10/83	8/15	11	8/21/83	15	15	15	0					CS	

leucocephala x diversifolia ssp. diversifolia

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ld81	K8-?:B2	K156-?:I	no e	med q	f	7/29/81	--	79	10/13/81	10	2	0	2	34	0	0	--	BDO	91 SELFS ID'D
ld82	K8-1:H	K156-1:H	emas	hi q	f	8/11-1/82	8/16	78	10/28/82	10	3	3	0	65	0	15	21.0	CS	
ld82	K8-?:Y1	K156-1:H	emas	hi q	f	8/6-10/82	--	83	10/28/82	15	11	0	11	104	181	0	25.0	CS	
ld82	K335-4:Y1	K156-1:H	emas	hi q	no f?	8/6-11/82	--	3	8/9/82	10	0							CS	
ld82	K500-?:Y1	K156-1:H	emas	hi q	no f?	8/6-12/82	8/9	6	8/12/82	10	3	3	0					CS	
ld82	K500-?:Y1	K156-1:H	emas	hi q	no f?	8/6-13/82	--	3	8/9/82	10	0							CS	
ld82	K500-?:Y1	K156-1:H	emas	hi q	no f?	8/6-14/82	--	3	8/9/82	10	0							CS	
ld82	K8?-?:Y2	K156-1:H	emas	hi q	f	8/6-6/82	8/19	83	10/28/82	15	11	2	9	129	75	0	20.5	CS	
ld82	K500-?:Y1	K156-1:H	emas	med q	no f?	8/6-7/82	8/9	20	8/26/82	10	0							CS	
ld82	K8?-?:Y2	K156-1:H	emas	hi q	f	8/6-8/82	8/9	83	10/28/82	10	8	2	6	80	70	0	16.0	CS	
ld82	K8?-?:Y2	K156-1:H	emas	hi q	f	8/6-9/82	8/9	90	11/4/82	15	9	3	6	99	39	0	25.0	CS	

1d83	K8-?:A2	K156-1:H	emas	hi q	f	8/11-7/83	8/31	86	11/5/83	20	15	2	13	285	10	0	23.5	CS	GLY
1d83	K8-?:A2	K156-1:H	emas	hi q	f	8/11-8/83	8/31	54	10/4/83	15	15	2	13	306	27	4	23.0	CS	
1d83	K8-?:A2	K165-?:GH	emas	hi q	f	9/8-1/83	9/14	90	12/7/83	15	15	3	12	256	48	4	23.0	CS	
1d86	K636-1:H	K156-1:H	emas	hi q	f	5/15-2/86	5/20	75	7/29/86	17	12	4	8	23	64	16	20.0	CS	
1d86	K636-1:H	K156-1:H	emas	hi q	f	5/15-1/86	5/20	75	7/29/86	17	5	1	4	20	30	2	17.0	CS	LATE EMAS
1d86	K636-1:H	K156-1:H	emas	hi q?	f	5/14-1/86	5/20	76	7/29/86	17	7	0	7	70	82	1	22.5	CS	

leucocephala x diversifolia ssp. trichandra

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
1z81	K8-3:B1	K480-4:I	no e	med q	f	8/11b/81	--	77	10/27/81	15	7	0	7	0	0	60	--	BOO	ALSO 64 SELFS
1z81	K8-3:B1	K480-4:I	no e	med q	f	8/11c/81	--	77	10/27/81	15	2	0	2	0	0	10	--	BOO	ALSO 23 SELFS
1z81	K8-2:B1	K480-4:I	no e	med q	f	8/12a/81	--	76	10/27/81	15	2	0	2	0	0	30	--	BOO	ALSO SELFS
1z81	K8-3:B1	K480-4:I	no e	med q	f	8/12b/81	--	76	10/27/81	15	8	0	8	0	0	71	--	BOO	ALSO 65 SELFS
1z81	K8-3:B1	K480-4:I	no e	med q	f	8/12c/81	--	76	10/27/81	15	2	0	2	0	0	19	--	BOO	ALSO 28 SELFS
1z83	K8-28:Y1	K409-8:I	emas	hi q	no f?	7/9-4/83	7/14	98	10/15/83	15	12	7	5	0	8	33	16.0	CS	ALSO 22 SELFS
1z85	No K:Hg	K483-9:I	emas	hi q	no f	11/12-2/85	--	9	11/21/85	12	0							CS	PSYLLIDS
1z85	No K:Hg	K483-9:I	emas	hi q	no f	11/13-1/85	--	8	11/21/85	25	0							CS	PSYLLIDS
1z85	No K:Hg	K483-9:I	emas	hi q	no f	11/13-2/85	--	8	11/21/85	15	0							CS	PSYLLIDS

leucocephala x esculenta

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
1e83	K500-10:Y1	K138-2:H	emas	med q	f?	11/28-1/83	12/7	9	12/7/83	15	4	4	0					CS	
1e83	K8-?:A2	K138-7:I	emas	hi q?	no f	9/19-2/83	--	15	10/4/83	15	0							CS	
1e83	K8-?:A2	K138-7:I	emas	hi q	f	9/19-3/83	9/28	132	1/19/84	15	5	4	1	0	11	0	19.0	CS	WEIRD PODS
1e83	K8-?:A2	K138-7:I	emas	hi q?	f	9/21-1/83	9/24	130	1/19/84	15	3	0	3	43	22	1	26.5	CS	
1e84	K341-?:Hg	K138-1:H	emas	hi q	f	10/15-2/84	10/27	140	3/4/85	20	3	1	2	18	6	3	21.0	CS	

leucocephala x lanceolata ssp. lanceolata

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
1n81	K42-1:I	K264-1:I	no e	med q	f	7/22a/81	--	76	10/6/81	15	6	0	6	19	--	--	--	BOO	ALSO 28 SELFS
1n81	K42-1:I	K264-6:I	no e	med q	f	7/22b/81	--	69	9/29/81	15	2	0	2	22	--	--	--	BOO	ALSO 8 SELFS
1n81	K42-1:I	K264-1:I	no e	med q	f	7/23c/81	--	68	9/29/81	15	7	0	7	96	--	--	--	BOO	ALSO 20 SELFS
1n81	K42-1:I	K264-6:I	no e	med q	f	7/23d/81	--	75	10/6/81	15	12	0	12	106	--	--	--	BOO	ALSO 30 SELFS
1n81	K42-1:I	K264-1:I	no e	med q	f	7/23e/81	--	75	10/6/81	15	23	0	23	224	--	--	--	BOO	ALSO 18 SELFS
1n81	K8-2:B1	K264-1:I	no e	med q	f	7/24b/81	--	81	10/13/81	15	2	0	2	2	--	--	--	BOO	ALSO 31 SELFS
1n81	K8-2:B1	K264-1:I	no e	med q	f	7/24c/81	--	81	10/13/81	15	4	0	4	2	--	--	--	BOO	ALSO 34 SELFS
1n81	K42-1:I	K264-1:I	no e	med q	f	7/24d/81	--	74	10/6/81	15	5	0	5	46	--	--	--	BOO	ALSO 4 SELFS
1n81	K42-2:I	K264-6:I	no e	med q	f	7/27/81	--	64	9/29/81	15	16	0	16	189	--	--	--	BOO	ALSO 14 SELFS
1n82	K500-?:Y1	K566-10:I	emas	med q?	f	8/4-4/82	--	54	10/28/82	15	2	0	2	6	23	0	17.5	CS	REFRIG POLLEN
1n82	K500-?:Y1	K566-10:I	emas	med q?	f	8/4-5/82	8/9	54	10/28/82	15	8	5	3	3	16	0	17.0	CS	REFRIG POLLEN
1n82	K500-?:Y1	K566-10:I	emas	med q?	f	8/4-6/82	--	54	10/28/82	15	1	0	1	0	24	1	20.5	CS	REFRIG POLLEN
1n82	K8-?:Y1	K401-1:I	emas	hi q	f	8/9-1/82	8/12	49	10/28/82	17	17	7	10	30	2	65	19.0	CS	HI ABT SD
1n82	K500-?:Y1	K401-1:I	emas	hi q	no f?	8/9-4/82	8/12	56	11/4/82	15	10	6	4	0	1	0	14.5	CS	ONLY 1 SEED
1n83	K8-28:Y1	K10-2:H	emas	hi q	no f	7/15-4/83	8/31	94	10/17/83	18	15	3	12	0	0	156	17.5	CS	T.C.
1n83	K8-28:Y1	K10-2:H	emas	hi q	no f	7/15-5/83	7/22	94	10/17/83	15	8	0	8	0	0	117	18.5	CS	
1n83	K8-28:Y1	K10-2:H	emas	med q	no f	7/15-6/83	7/22	94	10/17/83	15	6	3	3	0	0	19	16.0	CS	

leucocephala x lanceolata ssp. sousae

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
1s82	K500-?:Y1	K393-1:H	emas	hi q	no f	7/26-2/82	--	7	8/2/82	15	0							CS	
1s82	K500-?:Y1	K393-1:H	emas	hi q	no f	7/26-3/82	--	7	8/2/82	15	0							CS	
1s82	K500-?:Y1	K393-1:H	emas	hi q	no f	7/26-4/82	--	7	8/2/82	15	0							CS	

1s82	K8-1:H	K405-1:Y2	emas	hi q	f	8/2-3/82	—	82	10/23/82	15	15	0	15	284	0	30	24.0	CS	
1s82	K500-?:Y1	K405-1:Y2	emas	hi q	f	8/3-1/82	—	79	10/21/82	12	2	0	2	10	44	0	27.0	CS	LOW PSET
1s82	K8-?:Y1	K405-1:Y2	emas	hi q	f	8/9-5/82	8/12	80	10/28/82	15	15	2	13	107	8	3	20.5	CS	

leucocephala x trichodes

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
1t83	K8-?:A2	K738-1:H	emas	hi q	f	9/12-1/83	9/16	86	12/7/83	15	4	1	3	15	0	0	17.0	CS	T.C.
1t83	K8-?:A2	K738-1:H	emas	hi q	no f?	9/12-2/83	9/16	86	12/7/83	15	4	3	1	6	0	0	18.5	CS	T.C.
1t83	K8-?:A2	K90-2:Y2	emas	med q	no f	9/12-3/83	—	7	9/19/83	10	0							CS	

PALLIDA (FEMALE) CROSSES

pallida selfs

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
y84	K376-10:I	same	no e	hi q	no f	10/3-3/84	—	12	10/15/84	25	0							CS	
y84	K376-10:I	same	no e	hi q	no f	10/3-5/84	—	5	10/8/84	15	0							CS	
y84	K376-10:I	same	no e	hi q	no f	10/3-1/84	—	5	10/8/84	15	0							CS	
y84	K376-10:I	same	no e	hi q	no f	10/3-2/84	—	5	10/8/84	15	0							CS	
y84	K376-10:I	same	no e	hi q	no f	10/3-6/84	—	25	10/8/84	25	0							CS	
y85	K376-?:I2	same	no e	hi q	no f	10/3-7/85	—	5	10/8/85	15	0							CS	
y85	K376-?:I2	same	no e	hi q	no f	10/3-8/85	—	5	10/8/85	16	0							CS	

pallida x collinsii

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
yc84	K376-5:I	K450-1:H	no e	hi q	no f	10/5-35a/84	—	3	10/8/84	20	0							CS	
yc84	K376-5:I	K450-1:H	no e	hi q	no f	10/5-36/84	—	10	10/15/84	17	0							CS	Ok?
yc84	K376-5:I	K450-1:H	no e	hi q	f	10/5-37/84	10/15	156	2/28/85	16	12	9	3	1	3	1	8.5	CS	2 PODS SMALL
yc84	K376-5:I	K450-1:H	no e	hi q	no f?	10/5-39/84	—	10	10/15/84	20	0							CS	
yc84	K376-5:I	K450-1:H	no e	hi q	no f	10/5-35b/84	—	10	10/15/84	18	0							CS	
yc85	K376-?:I2	K450-1:H	no e	hi q	no f	11/12-6/85	—	9	11/12/85	15	0							CS	
yc85	K376-?:I2	K450-1:H	no e	hi q	no f	10/7-1/85	10/24	17	10/24/85	25	0							CS	
yc85	K376-?:I2	K450-1:H	no e	hi q	no f	10/7-2/85	—	156	2/28/85	20	4	3	1	4	0	7	10.0	CS	LATE HARVEST
yc85	K376-?:I2	K450-1:H	no e	hi q	f	10/7-3/85	10/24	17	10/24/85	20	0							CS	
yc85	K376-?:I2	K450-1:H	no e	hi q	no f	4/16-1/85	—	3	4/19/85	10	0							CS	
yc85	K376-?:I2	K450-1:H	no e	med q	no f	4/16-2/85	—	3	4/19/85	7	0							CS	
yc85	K376-?:I2	K450-1:H	no e	med q	no f	4/18-5/85	—	4	4/22/85	15	0							CS	
yc85	K376-?:I2	K450-1:H	no e	med q	no f	4/18-6/85	—	4	4/22/85	15	0							CS	
yc85	K376-?:I2	K450-1:H	no e	hi q	no f	4/18-7/85	—	4	4/22/85	15	0							CS	GLY

pallida x diversifolia ssp. diversifolia

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
yd83	K376-10:I	K160-6:I	no e	hi q	no f	8/6-33/83	—	9	8/15/83	15	0							PAN	
yd83	K376-5:I	K164-7:I	no e	hi q	no f	8/12-7/83	—	13	8/25/83	16	0							PAN	
yd83	K376-6:I	K165-5:I	no e	hi q	f	7/29-34/83	8/1	115	11/15/83	15	5	4	1	12	0	2	—	PAN	
yd83	K376-9:I	K160-6:I	no e	hi q	no f	8/6-31/83	—	9	8/15/83	15	0							PAN	
yd83	K376-5:I	K165-5:I	no e	hi q	f	7/17-21/83	7/14	121	11/15/83	15	1	0	1	14	0	3	--	PAN	
yd83	K376-10:I	K165-5:I	no e	hi q	no f	7/29-31/83	—	3	8/1/83	15	0							PAN	
yd83	K376-10:I	K160-6:I	no e	hi q	no f	8/6-35/83	—	9	8/15/83	15	0							PAN	
yd83	K376-10:I	K165-5:I	no e	hi q	f	7/25-8/83	8/1	113	11/15/83	15	3	1	2	46	0	0	—	PAN	
yd83	K376-10:I	K156-1:H	no e	hi q	no f	6/30-30/83	—	5	7/5/83	15	0							PAN	
yd83	K376-10:I	K156-1:H	emas	hi q	no f	6/1-4/83	--	6	6/7/83	15	0							PAN	

yd83	K376-10:I	K160-6:I	no e	hi q	no f	8/6-34/83	--	9	8/15/83	15	0							PAN	
yd83	K376-9:I	K155-4:I	no e	hi q	f	8/11-33/83	8/23	117	12/15/83	15	14	11	3	53	0	4	--	PAN	HI PDROP
yd83	K376-10:I	K160-6:I	no e	hi q	no f	8/6-32/83	--	9	8/15/83	15	0							PAN	
yd83	K376-5:I	K164-7:I	no e	hi q	no f	8/12-8/83	--	13	8/25/83	15	0							PAN	
yd83	K376-9:I	K155-4:I	no e	hi q	f	8/11-32/83	8/20	117	12/15/83	15	4	0	4	79	0	3	--	PAN	
yd83	K376-10:I	K156-1:H	emas	hi q	no f	6/1-3/83	--	6	6/7/83	15	0							PAN	
yd83	K376-10:I	K160-6:I	no e	hi q	f	8/6-29/83	8/15	107	11/21/83	15	6	4	2	27	0	4	--	PAN	
yd83	K376-5:I	K160-6:I	no e	hi q	f	8/4-15/83	8/31	109	11/21/83	15	11	9	2	34	0	4	--	PAN	
yd83	K376-9:I	K155-4:I	no e	hi q	f	8/11-3/83	8/20	117	12/15/83	15	2	0	2	2	0	10	--	PAN	
yd83	K376-9:I	K164-7:I	no e	hi q	f	8/12-2/83	8/20	125	12/15/83	15	6	2	4	83	0	1	--	PAN	
yd83	K376-5:I	K165-5:I	no e	hi q	no f	7/29-32/83	--	3	8/1/83	15	0							PAN	
yd83	K376-9:I	K164-7:I	no e	hi q	f	8/12-3/83	8/20	125	12/15/83	15	6	0	6	105	0	2	--	PAN	
yd83	K376-5:I	K156-1:H	emas	hi q	no f	6/1-1/83	--	6	6/7/83	15	0							PAN	
yd83	K376-6:I	K165-5:I	no e	hi q	f	7/29-33/83	8/1	115	11/21/83	15	6	2	4	50	0	4	--	PAN	
yd83	K376-5:I	K156-1:H	no e	hi q	no f	7/7-3/83	--	7	7/14/83	15	0							PAN	
yd83	K376-5:I	K156-1:H	no e	hi q	no f	7/7-2/83	--	7	7/14/83	15	0							PAN	
yd83	K376-5:I	K160-6:I	no e	hi q	no f	8/4-14/83	--	11	8/15/83	15	0							PAN	
yd83	K376-5:I	K156-1:H	no e	hi q	no f	7/8-2/83	--	6	7/14/83	15	0							PAN	
yd83	K376-10:I	K156-1:H	emas	hi q	f	6/8-3/83	6/13	92	9/8/83	18	3	1	2	22	0	3	--	PAN	
yd83	K376-9:I	K164-7:I	no e	hi q	f	8/12-4/83	8/20	125	12/15/84	15	1	0	1	17	0	0	--	PAN	
yd83	K177-1:I	K156-1:H	no e	hi q	no f	7/14-1/83	--	5	7/19/83	15	0							PAN	
yd83	K376-5:I	K155-4:I	no e	hi q	no f	8/11-35/83	--	6	8/17/83	15	0							PAN	
yd83	K376-9:I	K164-7:I	no e	hi q	f	8/12-6/83	8/25	125	12/15/83	15	11	5	6	110	0	5	--	PAN	
yd83	K376-10:I	K156-1:H	emas	hi q	no f	6/8-4/83	--	5	6/13/83	10	0							PAN	
yd83	K376-5:I	K156-1:H	no e	hi q	no f	7/17-17/83	--	7	7/24/83	15	0							PAN	
yd83	K376-5:I	K156-1:H	no e	hi q	no f	7/8-1/83	--	6	7/14/83	15	0							PAN	
yd83	K376-10:I	K156-1:H	emas	hi q	no f	6/8-5/83	--	5	6/13/83	10	0							PAN	
yd83	K376-8:I	K165-5:I	no e	hi q	no f	7/29-14/83	--	3	8/1/83	15	0							PAN	
yd83	K376-9:I	K164-7:I	no e	hi q	f	8/12-5/83	8/20	101	11/21/83	22	18	13	5	99	0	1	--	PAN	
yd83	K376-5:I	K156-1:H	no e	hi q	no f	7/7-1/83	--	7	7/14/83	15	0							PAN	
yd83	K376-9:I	K164-7:I	no e	hi q	f	8/12-1/83	8/20	125	12/15/83	15	12	11	1	20	0	1	--	PAN	
yd83	K376-8:I	K165-5:I	no e	hi q	f	7/29-13/83	8/1	115	11/21/83	15	5	4	1	16	0	0	--	PAN	
yd83	K376-5:I	K156-1:H	emas	hi q	f	6/1-2/83	6/7	92	9/1/83	15	4	2	2	38	0	0	--	PAN	
yd83	K376-10:I	K165-5:I	no e	hi q	no f	7/29-35/83	--	3	8/1/83	15	0							PAN	
yd83	K376-10:I	K165-5:I	no e	hi q	no f	7/28-6/83	--	4	8/1/83	15	0							PAN	
yd83	K174-10:I	K156-1:H	no e	med q?	no f	7/8-15/83	--	6	7/14/83	15	0							PAN	POLLEN POOR
yd83	K174-10:I	K156-1:H	no e	med q?	no f	7/17-19/83	--	7	7/24/83	15	0							PAN	
yd83	K376-5:I	K156-1:H	no e	med q?	no f	6/30/83	--	5	7/5/83	15	0							PAN	

pallida x diversifolia ssp. trichandra

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	SUB	ABT	CM	WHO	NOTES
yz83	K376-5:I	K409-10:I	emas	hi q	no f	5/26-1/83	--	12	6/7/83	15	0							PAN	
yz83	K376-10:I	K409-10:I	no e	hi q	no f	6/15-6/83	--	5	6/20/83	15	0							PAN	
yz83	K376-5:I	K409-10:I	no e	hi q	no f	6/15-7/83	--	5	6/20/83	15	0							PAN	
yz83	K376-5:I	K423-10:I	no e	hi q	no f	6/16-1/83	--	4	6/20/83	15	0							PAN	
yz83	K376-10:I	K409-10:I	emas	med q	no f	6/8-10/83	--	5	6/13/83	10	0							PAN	
yz83	K376-5:I	K409-8:I	emas	med q	no f	6/8-7/83	--	5	6/13/83	8	0							PAN	
yz83	K376-10:I	K409-10:I	emas	med q	no f	6/8-8/83	--	5	6/13/83	7	0							PAN	
yz83	K376-10:I	K478-3:I	no e	hi q	no f	7/21-25/83	--	7	7/28/83	15	0							PAN	
yz83	K376-10:I	K478-3:I	no e	hi q	no f	7/21/24/83	--	24	7/28/83	15	0							PAN	
yz83	K376-10:I	K423-10:I	no e	hi q	no f	7/25-10/83	--	7	8/1/83	15	0							PAN	
yz83	K376-10:I	K465-5:I	no e	hi q	no f	7/25-11/83	--	7	8/1/83	15	0							PAN	
yz83	K376-10:I	K478-3:I	no e	hi q	no f	7/25-27/83	--	7	8/1/83	15	0							PAN	
yz83	K376-10:I	K480-7:I	no e	hi q	no f	7/25-28/83	--	7	8/1/83	15	0							PAN	
yz83	K376-10:I	K409-8:I	no e	hi q	no f	7/25-9/83	--	7	8/1/83	15	0							PAN	

yz83	K376-10:I	K480-7:I	no e	hi q	no f	7/28-10/83	--	4	8/1/83	15	0	PAN
yz83	K376-9:I	K480-7:I	no e	hi q	no f	7/28-11/83	--	4	8/1/83	15	0	PAN
yz83	K376-9:I	K408-10:I	no e	hi q	no f	7/28-12/83	--	4	8/1/83	15	0	PAN
yz83	K376-10:I	K409-10:I	no e	hi q	no f	7/28-7/83	--	4	8/1/83	15	0	PAN
yz83	K376-10:I	K408-10:I	no e	hi q	no f	7/28-9/83	--	4	8/1/83	15	0	PAN
yz83	K376-10:I	K409-10:I	no e	hi q	no f	7/28-6/83	--	4	8/1/83	15	0	PAN
yz83	K376-10:I	K423-6:I	no e	hi q	no f	7/29-10/83	--	3	8/1/83	15	0	PAN
yz83	K376-8:I	K423-6:I	no e	hi q	no f	7/29-11/83	--	3	8/1/83	15	0	PAN
yz83	K376-8:I	K423-6:I	no e	hi q	no f	7/29-12/83	--	3	8/1/83	15	0	PAN
yz83	K376-9:I	K409-10:I	no e	hi q	no f	7/29-23/83	--	3	8/1/83	15	0	PAN
yz83	K376-5:I	K409-10:I	no e	hi q	no f	7/29-24/83	--	9	8/7/83	15	0	PAN
yz83	K376-10:I	K409-8:I	no e	hi q	no f	7/29-29/83	--	3	8/1/83	15	0	PAN
yz83	K376-10:I	K480-7:I	no e	med q	no f	7/29-36/83	--	3	8/1/83	15	0	PAN
yz83	K376-10:I	K480-7:I	no e	hi q	no f	7/29-37/83	--	3	8/1/83	15	0	PAN
yz83	K376-10:I	K480-7:I	no e	hi q	no f	7/29-38/83	--	3	8/1/83	15	0	PAN
yz83	K376-10:I	K480-7:I	no e	hi q	no f	7/29-39/83	--	3	8/1/83	15	0	PAN
yz83	K376-8:I	K478-3:I	no e	hi q	no f	7/29-4/83	--	3	8/1/83	15	0	PAN
yz83	K376-10:I	K480-7:I	no e	hi q	no f	7/29-40/83	--	3	8/1/83	15	0	PAN
yz83	K376-10:I	K478-3:I	no e	hi q	no f	7/29-42/83	--	3	8/1/83	15	0	PAN
yz83	K376-5:I	K423-6:I	no e	hi q	no f	7/29-5/83	--	3	8/1/83	15	0	PAN
yz83	K376-9:I	K423-6:I	no e	hi q	no f	7/29-6/83	--	3	8/1/83	15	0	PAN
yz83	K376-10:I	K423-6:I	no e	hi q	no f	7/29-7/83	--	3	8/1/83	15	0	PAN
yz83	K376-10:I	K423-6:I	no e	hi q	no f	7/29-8/83	--	3	8/1/83	15	0	PAN
yz83	K376-10:I	K423-6:I	no e	hi q	no f	7/29-9/83	--	3	8/1/83	15	0	PAN
yz83	K376-9:I	K408-9:I	no e	hi q	no f	8/4-1/83	--	7	8/11/83	15	0	PAN
yz83	K376-9:I	K406-5:I	no e	hi q	no f	8/4-10/83	--	11	8/15/83	15	0	PAN
yz83	K376-9:I	K406-5:I	no e	hi q	no f	8/4-11/83	--	7	8/11/83	15	0	PAN
yz83	K376-9:I	K408-9:I	no e	hi q	no f	8/4-3/83	--	7	8/11/83	15	0	PAN
yz83	K376-9:I	K408-9:I	no e	hi q	no f	8/4-4/83	--	7	8/11/83	15	0	PAN
yz83	K376-5:I	K408-9:I	no e	hi q	no f	8/4-5/83	--	6	8/10/83	15	0	PAN
yz83	K376-5:I	K408-9:I	no e	hi q	no f	8/4-6/83	--	6	8/10/83	15	0	PAN
yz83	K376-5:I	K406-5:I	no e	hi q	no f	8/4-7/83	--	11	8/15/83	15	0	PAN
yz83	K376-5:I	K406-5:I	no e	hi q	no f	8/4-8/83	--	11	8/15/83	15	0	PAN
yz83	K376-9:I	K406-5:I	no e	hi q	no f	8/4-9/83	--	6	8/10/83	15	0	PAN
yz83	K376-8:I	K480-7:I	no e	hi q	no f	8/6-38/83	--	9	8/15/83	15	0	PAN
yz83	K376-8:I	K480-7:I	no e	hi q	no f	8/6-39/83	--	9	8/15/83	15	0	PAN
yz83	K376-9:I	K411-9:I	no e	hi q	no f	8/6-5/83	--	5	8/11/83	15	0	PAN
yz83	K376-9:I	K406-9:I	no e	hi q	no f	8/6-6/83	--	5	8/11/83	15	0	PAN
yz83	K376-9:I	K406-5:I	no e	hi q	no f	8/6-7/83	--	5	8/11/83	15	0	PAN
yz83	K376-9:I	K406-5:I	no e	hi q	no f	8/6-8/83	--	5	8/11/83	15	0	PAN
yz83	K376-5:I	K406-5:I	no e	hi q	no f	8/6-9/83	--	19	8/25/83	15	0	PAN
yz83	K376-9:I	K411-9:I	no e	hi q	no f	8/7-1/83	--	4	8/11/83	15	0	PAN
yz83	K376-10:I	K483-4:I	no e	hi q	no f	8/7-10/83	--	9	8/16/83	15	0	PAN
yz83	K376-10:I	K465-5:I	no e	hi q	no f	8/7-18/83	--	8	8/15/83	15	0	PAN
yz83	K376-10:I	K465-5:I	no e	hi q	no f	8/7-19/83	--	8	8/15/83	15	0	PAN
yz83	K376-9:I	K411-9:I	no e	hi q	no f	8/7-2/83	--	4	8/11/83	15	0	PAN
yz83	K376-9:I	K465-5:I	no e	hi q	no f	8/7-20/83	--	8	8/15/83	15	0	PAN
yz83	K376-9:I	K465-5:I	no e	hi q	no f	8/7-21/83	--	8	8/15/83	15	0	PAN
yz83	K376-9:I	K411-9:I	no e	hi q	no f	8/7-3/83	--	4	8/11/83	15	0	PAN
yz83	K376-5:I	K411-9:I	no e	hi q	no f	8/7-4/83	--	13	8/20/83	15	0	PAN
yz83	K376-9:I	K483-4:I	no e	hi q	no f	8/7-7/83	--	8	8/15/83	15	0	PAN
yz93	K376-9:I	K483-4:I	no e	hi q	no f	8/7-8/83	--	8	8/15/83	15	0	PAN
yz83	K376-10:I	K483-4:I	no e	hi q	no f	8/7-9/83	--	9	8/16/83	15	0	PAN
yz84	K376-10:I	K411-9:I	no e	hi q	no f	10/4-17/84	--	15	10/8/84	15	0	CS
yz84	K376-10:I	K411-9:I	no e	hi q?	no f	10/4-16/84	--	4	10/8/84	8	0	CS

pallida x esculenta

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ye84	K376-10:I	K138-2:H	no e	hi q	no f	10/10-?/84	10/15	15	10/25/84	20	0							CS	
ye84	K376-10:I	K138-1:H	no e	hi q	no f	10/3-16/84	--	5	10/8/84	30	0							CS	
ye84	K376-5:I	K138-1:H	no e	hi q	no f	10/10-19/84	--	5	10/15/84	20	0							CS	
ye84	K376-10:I	K138-1:I	no e	hi q	no f	10/3-15/84	--	5	10/8/84	30	0							CS	
ye84	K376-5:I	K138-1:H	no e	hi q	no f	10/10-8/84	--	5	10/15/84	20	0							CS	
ye84	K376-10:I	K138-1:I	no e	hi q	no f?	10/1-13/84	10/7	14	10/15/84	20	1	1	0					CS	GLY
ye84	K376-5:I	K138-1:H	no e	hi q?	no f	10/10-13/84	--	5	10/15/84	20	0							CS	BLY
ye85	K376-?:I2	K138-2:I	no e	hi q	no f	11/6-24/85	--	6	11/12/85	15	0							CS	
ye85	K376-?:I2	K138-2:I	no e	hi q	no f	11/6-25/85	--	6	11/12/85	15	0							CS	
ye85	K376-?:I2	K138-2:I	no e	hi q	no f	11/6-23/85	--	6	11/12/85	16	0							CS	
ye85	K376-?:I2	K138-2:I	no e	hi q	no f	11/6-26/85	--	6	11/12/85	15	0							CS	
ye85	K376-?:I2	K138-2:I	no e	hi q	no f	11/6-27/85	--	6	11/12/85	15	0							CS	
ye85	K376-?:I2	K138-2:I	no e	hi q	no f	11/6-28/85	--	6	11/12/85	30	0							CS	

pallida x lanceolata ssp. lanceolata

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
yn84	K376-5:I	K10-2:H	no e	hi q	no f?	10/5-23/84	--	10	10/15/84	20	0							CS	
yn84	K376-5:I	K10-2:H	no e	hi q	no f?	10/5-22/84	--	10	10/15/84	30	1	1	0					CS	HAD 1 POD
yn84	K376-5:I	K10-2:H	no e	hi q	no f	10/5-22/84	--	3	10/8/84	20	0							CS	
yn84	K376-5:I	K10-2:H	no e	hi q	no f	10/5-24/84	--	10	10/15/84	20	0							CS	Ok?
yn84	K376-10:I	K10-2:H	no e	hi q	no f	10/5-17/84	--	10	10/15/84	15	0							CS	DROUGHT
yn84	K376-5:I	K10-2:H	no e	hi q?	no f?	10/5-21/84	--	8	10/13/84	20	0							CS	ABT?
yn84	K376-5:I	K10-2:H	no e	med q	no f?	10/5-19/84	10/15	43	11/17/84	25	3	3	0					CS	
yn84	K376-5:I	K10-2:H	no e	med q	no f?	10/5-21/84	--	43	11/17/84	20	5	5	0					CS	
yn84	K376-5:I	K10-2:H	no e	med q	no f?	10/5-20/84	10/15	21	10/26/84	20	1	1	0					CS	DROUGHT=1 POD
yn85	K376-11:I2	K10-2:H	no e	hi q	no f	9/14-3/85	--	12	9/26/85	20	0							CS	
yn85	K376-11:I2	K10-2:H	no e	hi q	no f	9/14-5/85	--	12	9/26/85	30	0							CS	
yn85	K376-11:I2	K10-2:H	no e	hi q	no f	9/14-1/85	--	12	9/26/85	20	0							CS	
yn85	K376-11:I2	K10-2:H	no e	hi q	no f	9/14-2/85	--	12	9/26/85	20	0							CS	
yn85	K376-11:I2	K10-2:H	no e	hi q	no f	9/14-4/85	--	12	9/26/85	20	0							CS	

pallida x lanceolata ssp. sousae

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ym84	K376-5:I	K393-1:H	no e	hi q	no f	10/4-28/84	--	11	10/15/84	15	0							CS	
ym84	K376-5:I	K393-1:H	no e	hi q	no f	10/4-31/84	--	4	10/8/84	25	0							CS	
ym84	K376-5:I	K393-1:H	no e	hi q	no f	10/4-29/84	--	11	10/15/84	22	0							CS	
ym84	K376-5:I	K393-1:H	no e	med q	f?	10/5-38/84	--	10	10/15/84	30	1	1	0					CS	ONLY 1 POD..
ym84	K376-5:I	K393-1:H	no e	med q	f?	10/4-27/84	10/7	36	11/9/84	15	13	13	0					CS	
ym85	K376-?:I2	K393-1:H	no e	hi q	no f	11/4-27/85	--	8	11/12/85	15	0							CS	
ym85	K376-?:I2	K393-1:H	no e	hi q	no f	11/4-28/85	--	8	11/12/85	15	0							CS	
ye85	K376-?:I2	K393-1:H	no e	hi q	no f	11/4-31/85	--	8	11/12/85	15	0							CS	
ye85	K376-?:I2	K393-1:H	no e	hi q	no f	11/4-24/85	--	8	11/12/85	15	0							CS	
ym85	K376-?:I2	K393-1:H	no e	hi q	no f	11/4-26/85	--	8	11/12/85	20	0							CS	
ym85	K376-?:I2	K393-1:H	no e	hi q	no f	11/4-23/85	--	8	11/12/85	15	0							CS	
ym85	K376-?:I2	K393-1:H	no e	hi q	no f	11/4-29/85	--	8	11/12/85	15	0							CS	
ym85	K376-?:I2	K393-1:H	no e	hi q	no f	11/4-25/85	--	8	11/12/85	15	0							CS	
ym85	K376-?:I2	K393-1:H	no e	hi q	no f	11/4-30/85	--	15	11/12/85	15	0							CS	
ym85	K376-?:I2	K393-1:H	no e	hi q	no f	11/4-33/85	--	8	11/12/85	15	0							CS	
ym85	K376-?:I2	K393-1:H	no e	hi q	no f	11/4-32/85	--	8	11/12/85	15	0							CS	

pallida x leucocephala

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
yl84	K376-5:I	K45?:HDG	no e	hi q	f?	10/2-14/84	10/15	124	2/3/85	15	4	2	2	0	14	2	12.0	CS	2 PODS SHATTR
yl84	K376-10:I	K46?:HDG	no e	hi q	no f	10/2-19/84	--	6	10/8/84	20	0							CS	
yl84	K376-5:I	K45?:HDG	no e	hi q	no f	10/2-11/84	10/7	13	10/15/84	17	1	1	0					CS	
yl84	K376-5:I	K45?:HDG	no e	hi q	f?	10/2-15/84	10/7	124	2/3/85	20	4	2	2	0	17	0	8.0	CS	
yl84	K376-10:I	K46?:HDG	no e	hi q	no f	10/2-21/84	--	6	10/8/84	22	0							CS	
yl84	K376-10:I	K46?:HDG	no e	hi q	no f	10/2-20/84	--	3	10/5/84	20	0							CS	
yl84	K376-10:I	K46?:HDG	no e	hi q	no f	10/2-18/84	--	6	10/8/84	20	0							CS	
yl84	K376-5:I	K45?:HDG	no e	hi q	no f	10/2-16/84	--	6	10/8/84	18	0							CS	
yl84	K376-5:I	K45?:HDG	no e	hi q	no f	10/2-17/84	--	13	10/15/84	17	0							CS	
yl84	K376-5:I	K45?:HDG	no e	lo q	no f?	10/2-13/84	10/7	59	11/30/84	20	4	4	0					CS	
yl84	K376-5:I	K45?:HDG	no e	lo q	no f?	10/2-12/84	10/7	59	11/30/84	15	4	4	0					CS	
yl85	K376-?:I2	K8?wild	no e	hi q	no f	11/13-23/85	--	8	11/21/85	20	0							CS	
yl85	K376-?:I2	K8?wild	no e	hi q	no f	11/13-24/85	--	8	11/21/85	10	0							CS	
yl85	K376-?:I2	K8?wild	no e	med q	no f	11/13-25/85	--	8	11/21/85	20	0							CS	

pallida x retusa

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
yr84	K376-10:I	K280-1:H	no e	hi q	no f	10/1-12/84	--	20	10/8/84	20	0							CS	GLY
yr84	K376-10:I	K280-1:H	no e	hi q	no f	10/1-10/84	--	20	10/8/84	20	0							CS	GLY
yr84	K376-5:I	K280-1:H	no e	hi q	no f	10/1-8/84	--	7	10/8/84	20	0							CS	
yr84	K376-5:I	K280-1:H	no e	hi q	no f	10/1-6/84	--	7	10/8/84	20	0							CS	
yr84	K376-10:I	K280-1:H	no e	hi q	no f	10/1-9/84	--	7	10/8/84	20	0							CS	
yr84	K376-10:I	K280-1:H	no e	hi q	no f	10/1-11/84	--	7	10/8/84	20	0							CS	GLY
yr84	K376-5:I	K280-1:H	no e	hi q	no f	10/1-7/84	--	7	10/8/84	20	0							CS	
yr85	K376-?:I2	K502-2:H	no e	hi q	no f	11/4-39/85	--	8	11/12/85	15	0							CS	
yr85	K376-?:I2	K502-2:H	no e	hi q	no f	11/4-38/85	--	8	11/12/85	15	0							CS	GLY
yr85	K376-?:I2	K502-2:H	no e	hi q	no f	11/4-36/85	--	8	11/12/85	15	0							CS	GLY
yr85	K376-?:I2	K502-2:H	no e	hi q	no f	11/4-40/85	--	8	11/12/85	15	0							CS	

pallida x shannoni

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ys84	K376-5:I	K445-1:H	no e	lo q	no f?	10/4-21/84	10/7	19	10/23/84	18	3	3	0					CS	3 TINY PODS
ys84	K376-5:I	K445-1:H	no e	hi q	no f?	10/4-25/84	--	11	10/15/84	20	0							CS	
ys84	K376-5:I	K445-1:H	no e	hi q	no f?	10/4-23/84	--	11	10/15/84	16	0							CS	DROUGHT
ys84	K376-5:I	K445-1:H	no e	med q	no f?	10/4-22/84	10/15	19	10/23/84	16	6	6	0					CS	
ys85	K376-?:I2	K445-1:H	no e	hi q	f	10/8-4/85	10/24	85	1/1/85	17	2	0	2	20	1	9	15.5	CS	9 CROSSES?
ys85	K376-?:I2	K445-1:H	no e	hi q	no f	10/8-1/85	--	16	10/24/85	16	0							CS	
ys85	K376-?:I2	K445-1:H	no e	hi q	f	10/8-8/85	10/24	85	1/1/85	17	3	2	1	0	0	4	8.0	CS	ABT
ys85	K376-?:I2	K445-1:H	no e	hi q	no f	10/8-2/85	--	16	10/24/85	20	0							CS	
ys85	K376-?:I2	K445-1:H	no e	hi q	f	10/8-3/85	10/24	85	1/1/85	18	3	1	2	8	5	5	15.0	CS	BEST X
ys85	K376-?:I2	K445-1:H	no e	hi q	no f	10/8-5/85	--	16	10/24/85	17	0							CS	
ys85	K376-?:I2	K445-1:H	no e	hi q	no f	10/8-6/85	--	16	10/24/85	17	0							CS	
ys85	K376-?:I2	K445-1:H	no e	hi q	no f	10/8-7/85	--	16	10/24/85	18	0							CS	
ys85	K376-?:I2	K445-1:H	no e	hi q	no f	10/8-8/85	--	16	10/24/85	20	0							CS	
ys85	K376-?:I2	K445-1:H	no e	hi q	f	10/7-1/85	10/24	86	1/1/85	15	6	2	4	1	5	38	11.0	CS	1=SELF?
ys85	K376-?:I2	K445-1:H	no e	hi q	no f?	10/7-3/85	10/24	54	11/30/85	10	1	1	0					CS	
ys85	K376-?:I2	K445-1:H	no e	hi q	no f	10/7-9/85	10/24	18	10/25/85	15	0							CS	
ys85	K376-?:I2	K445-1:H	no e	hi q	no f	10/8-10/85	--	16	10/24/85	20	0							CS	
ys85	K376-?:I2	K445-1:H	no e	hi q	no f	10/8-11/85	--	16	10/24/85	18	0							CS	
ys85	K376-?:I2	K445-1:H	no e	med q	no f	10/8-12/85	--	16	10/24/85	15	0							CS	DRY POLLEN

pallida x trichodes

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
yt84	K376-5:I	K738-1:H	no e	hi q	no f	10/5-33a/84	--	3	10/8/84	15	0							CS	
yt84	K376-5:I	K738-1:H	no e	hi q	no f	10/5-33b/84	--	10	10/15/84	15	0							CS	
yt84	K376-5:I	K738-1:H	no e	hi q	no f	10/4-14/84	--	4	10/8/84	15	0							CS	
yt84	K376-5:I	K738-1:H	no e	hi q	no f	10/4-9/84	--	4	10/8/84	15	0							CS	
yt84	K376-5:I	K738-1:H	no e	hi q	no f	10/5-32/84	--	10	10/15/84	20	0							CS	
yt84	K376-1:I	K738-1:H	no e	hi q	no f	10/4-13/84	--	4	10/8/84	19	0							CS	
yt84	K376-5:I	K738-1:H	no e	hi q	no f	10/5-34/84	--	3	10/8/84	15	0							CS	
yt84	K376-5:I	K738-1:H	no e	hi q	no f	10/5-30/84	--	10	10/15/84	13	0							CS	
yt84	K376-5:I	K738-1:H	no e	hi q	no f	10/5-31a/84	--	10	10/15/84	15	0							CS	GLY
yt84	K376-5:I	K738-1:H	no e	hi q	no f	10/5-31b/84	--	3	10/8/84	15	0							CS	
yt84	K376-9:I	K738-1:H	no e	hi q	no f	10/4-10/84	--	4	10/8/84	15	0							CS	

PULVERULENTA (FEMALE) CROSSES

pulverulenta selfs

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
p82	K340-2:Y2	same	no e	hi q	no f	6/15-27/82	--	3	6/18/82	15	0							CS	
p82	K340-2:Y2	same	no e	hi q	no f	6/16-10/82	--	5	6/21/82	15	0							CS	
p82	K340-2:Y2	same	no e	hi q	no f	6/16-11/82	--	5	6/21/82	15	0							CS	
p82	K340-2:Y2	same	no e	hi q	no f	6/16-12/82	--	5	6/21/82	15	0							CS	
p82	K340-2:Y2	same	no e	hi q	no f	6/16-8/82	--	5	6/21/82	15	0							CS	
p82	K340-2:Y2	same	no e	hi q	no f	6/16-9/82	--	5	6/21/82	15	0							CS	
p82	K19-1:Y2	same	no e	hi q	no f	6/17-24/82	--	4	6/21/82	15	0							CS	
p82	K19-1:Y2	same	no e	hi q	no f	6/17-25/82	--	4	6/21/82	15	0							CS	
p82	K19-1:Y2	same	no e	hi q	no f	6/17-26/82	--	4	6/21/82	15	0							CS	
p82	K19-1:Y2	same	no e	hi q	no f	6/17-27/82	--	4	6/21/82	15	0							CS	
p82	K19-1:Y2	same	no e	hi q	no f	6/17-28/82	--	4	6/21/82	15	0							CS	
p82	K19-1:Y2	same	no e	hi q	no f	6/17-29/82	--	4	6/21/82	15	0							CS	
p83	K75-2:H	same	no e	hi q	no f	7/12-3/83	7/16	10	7/22/83	15	3	3	0					CS	HUH?
p83	K75-2:H	same	no e	hi q	no f	7/13-1/83	7/16	9	7/22/83	15	5	5	0					CS	HUH?
p83	K75-2:H	same	no e	hi q	no f	7/15-2/83	--	4	7/19/83	15	0							CS	

pulverulenta x collinsii

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
pc82	K19-1:Y2	K183-1:I	no e	hi q	f	7/15-15/82	7/19	91	10/14/82	15	15	1	14	186	5	7	13.5	CS	
pc82	K19-1:Y2	K183-1:I	no e	hi q	f	7/15-16/82	7/19	82	10/5/82	15	12	5	7	68	16	6	14.5	CS	
pc82	K19-1:Y2	K183-1:I	no e	hi q	f	7/15-19/82	7/19	82	10/5/82	15	15	4	11	96	66	2	14.0	CS	
pcE2	K19-1:Y2	K183-1:I	no e	hi q	f	7/15-20/82	7/19	82	10/5/82	15	14	7	7	69	30	6	13.5	CS	
pc82	K340-2:Y2	K183-1:I	no e	hi q	f	7/20-29/82	7/26	87	10/14/82	15	5	2	3	10	25	0	10.5	CS	
pc82	K340-2:Y2	K183-1:I	no e	hi q	f	7/20-30/82	7/26	87	10/14/82	15	11	4	7	32	67	0	13.5	CS	
pc82	K340-2:Y2	K183-1:I	no e	hi q	f	7/20-31/82	7/26	87	10/14/82	15	12	2	10	33	137	0	14.5	CS	
pc82	K340-2:Y2	K183-1:I	no e	med q	f	7/20-32/82	7/26	101	10/28/82	15	5	3	2	8	14	0	18.0	CS	
pc82	K340-2:Y2	K183-1:I	no e	hi q	f	7/20-33/82	7/26	87	10/14/82	15	4	0	4	17	35	2	10.0	CS	
pc82	K340-2:Y2	K183-1:I	no e	hi q	f	7/20-34/82	7/26	87	10/14/82	15	3	0	3	6	33	0	14.0	CS	
pc82	K340-2:Y2	K183-1:I	no e	hi q	no f	7/29-13/82	8/2	6	8/4/82	15	4	4	0					CS	
pc83	K75-2:H	K450-1:H	no e	med q	f	7/28-1/83	8/2	94	10/30/83	15	15	3	12	11	0	0	12.5	CS	CYGON DMG
pc84	K75-2:H	K450-1:H	no e	hi q	f	3/27-1a/84	--	77	6/12/84	14	14	0	14	319	0	20	12.0	CS	
pc84	K75-1:H	K450-1:H	no e	hi q	f	3/27-1b/84	--	86	6/21/84	15	17	0	17	229	0	15	12.5	CS	
pc84	K75-1:H	K450-1:H	no e	hi q?	f	3/27-2a/84	--	86	6/21/84	15	4	0	4	94	0	9	13.0	CS	
pc84	K75-1:H	K450-1:H	no e	hi q	f	3/27-2b/84	--	86	6/12/84	17	18	1	17	200	0	0	14.0	CS	WEIRD SEED

pulverulenta x diversifolia ssp. diversifolia

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
pd82	K19-1:Y2	K156-1:H	no e	hi q	f	6/18-1/82	6/21	92	9/14/82	15	2	1	1	7	2	0	14.5	CS	
pd82	K19-1:Y2	K156-1:H	no e	hi q	f	6/18-2/82	6/25	92	9/14/82	15	5	3	2	17	5	0	10.0	CS	
pd82	K19-1:Y2	K156-1:H	no e	hi q	f	6/18-3/82	6/30	92	9/14/82	15	14	4	10	80	55	0	13.0	CS	
pd82	K19-1:Y2	K156-1:H	no e	med q	no f	6/18-4/82	--	3	6/21/82	15	0							CS	
pd82	K19-1:Y2	K156-1:H	no e	hi q	f	6/18-5/82	6/21	92	9/14/82	15	8	3	5	47	2	6	14.0	CS	
pd82	K19-1:Y2	K156-1:H	no e	med q	no f	6/18-6/82	--	3	6/21/82	15	0							CS	
pd82	K19-1:Y2	K156-1:H	no e	hi q	f	6/18-7/82	6/21	88	9/14/82	15	1	0	1	11	0	0	11.5	CS	
pd82	K19-1:Y2	K156-1:H	no e	hi q	no f	6/18-8/82	--	3	6/21/82	15	0							CS	
pd82	K19-1:Y2	K156-1:H	no e	hi q	f	6/23-5/82	6/26	90	9/21/82	15	6	1	5	39	34	2	13.5	CS	
pd82	K19-1:Y2	K156-1:H	no e	hi q	f	6/23-6/82	6/26	90	9/21/82	15	14	5	9	49	69	1	12.5	CS	
pd83	K19-1:Y2	K156-1:H	no e	hi q	no f	7/6-1/83	--	5	7/11/83	15	0							CS	

pulverulenta x diversifolia ssp. trichandra

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
pz82	K340-2:Y2	K409-5:I	no e	hi q?	no f	7/9-6/81	--	5	7/14/83	15	0							CS	
pz83	K75-2:H	K409-6:I	no e	hi q	no f	7/12-2/83	--	4	7/16/83	15	0							CS	DRY POLLEN
pz83	K19-1:Y2	K409-8:I	no e	hi q	no f	7/9-5/83	--	5	7/14/83	15	0							CS	

pulverulenta x esculenta

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
pe83	K75-2:H	K138-7:I	no e	med q	no f	9/14-4/83	--	6	9/20/83	15	0							CS	OLD FLWR?

pulverulenta x lanceolata ssp. lanceolata

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
pn82	K19-1:Y2	K401-1:I	no e	hi q	f	7/20-14/82	7/26	93	10/21/82	15	10	6	4	33	1	12	11.5	CS	HI PDROP
pn82	K340-2:Y2	K401-1:I	no e	hi q	f	7/20-15/82	7/26	77	10/5/82	15	15	1	14	163	86	6	13.5	CS	
pn82	K340-2:Y2	K401-1:I	no e	hi q	f	7/20-16/82	7/26	77	10/5/82	15	15	5	10	86	99	3	12.0	CS	HI ABT SD
pn82	K340-2:Y2	K401-1:I	no e	hi q	f	7/20-17/82	7/26	77	10/5/82	15	15	3	12	116	113	8	13.5	CS	HI PDROP
pn82	K340-2:Y2	K401-1:I	no e	hi q	f	7/20-18/82	7/26	77	10/5/82	15	15	4	11	100	121	5	13.5	CS	HI PDROP
pn82	K340-2:Y2	K401-1:I	no e	hi q	f	7/20-21/82	7/26	86	10/14/82	15	10	0	10	83	184	2	15.5	CS	HI PDROP
pn82	K19-1:Y2	K401-1:I	no e	hi q	f	7/6-1/82	7/14	86	9/30/82	15	8	3	5	14	25	16	13.5	CS	HI ABT SD
pn82	K19-1:Y2	K401-1:I	no e	hi q	f	7/6-2/82	7/14	86	9/30/82	15	15	4	11	113	16	27	13.0	CS	
pn82	K19-1:Y2	K401-1:I	no e	hi q	f	7/6-3/82	7/14	86	9/30/82	15	13	3	10	40	46	18	14.5	CS	
pn82	K340-2:Y2	K566-10:I	no e	hi q	f	8/3-12/82	8/10	86	10/28/82	15	21	0	21	85	289	2	13.0	CS	HI ABT
pn82	K340-2:Y2	K566-10:I	no e	hi q	f	8/3-13/82	8/10	86	10/28/82	15	15	0	15	87	235	7	13.0	CS	HI ABT

pulverulenta x lanceolata ssp. sousae

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ps82	K19-1:Z	K385-10:I	no e	hi q	f	6/17-15/82	6/21	89	9/14/82	15	8	3	5	27	6	24	13.5	CS	
ps82	K19-1:Y2	K385-10:I	no e	hi q	f	6/17-16/82	6/21	89	9/14/82	15	8	3	5	31	15	8	12.5	CS	
ps82	K19-1:Y2	K385-10:I	no e	hi q	f	6/17-17/82	6/21	58	9/14/82	15	3	3	0					CS	
ps82	K19-1:Y2	K385-10:I	no e	med q	f	6/17-18/82	6/21	89	9/14/82	15	4	2	2	6	3	1	10.0	CS	LO PSET
ps82	K19-1:Y2	K385-10:I	no e	hi q	f	6/17-20/82	6/21	89	9/14/82	15	8	1	7	62	7	8	11.5	CS	
ps82	K19-1:Y2	K385-10:I	no e	hi q	f	6/17-21/82	6/21	89	9/14/82	13	4	2	2	14	8	2	11.0	CS	LO PSET
ps82	K19-1:Y2	K385-10:I	no e	hi q	f	6/17-22/82	6/21	89	9/14/82	15	10	6	4	16	10	9	9.5	CS	HI PDROP, ABT
ps82	K19-1:Y2	K385-10:I	no e	med q	f	6/17-23/82	6/21	89	9/14/82	15	5	4	1	3	4	0	9.0	CS	HI PDROP
ps82	K19-1:Y2	K393-1:H	no e	hi q	f	6/25-17/82	6/30	90	9/23/82	15	8	5	3	17	3	3	10.0	CS	HI PDROP
ps82	K19-1:Y2	K393-1:H	no e	hi q	f	6/25-18a/82	6/30	88	9/21/82	15	11	3	8	52	31	16	14.0	CS	

pm82	K19-1:Y2	K393-1:H	no e	hi q	f	6/25-18b/82	6/30	90	9/23/82	15	14	5	9	25	47	22	12.5	CS	
pm82	K19-1:Y2	K393-1:H	no e	hi q	no f?	6/25-19/82	6/30	50	9/14/82	18	8	8	0					CS	
pm83	K75-2:H	K393-1:H	no e	hi q	no f	7/16-6/83	--	3	7/19/83	15	0							CS	
pm83	K75-2:H	K393-1:H	no e	hi q	f	7/16-7/83	7/19	81	10/5/83	25	23	2	21	231	0	25	11.0	CS	
pm83	K75-2:H	K393-1:H	no e	hi q	f	7/16-8/83	7/19	81	10/5/83	12	7	3	4	131	0	15	10.5	CS	
pm83	K19-1:Y2	K393-1:H	no e	hi q	f	7/2-11a/83	7/11	92	10/2/83	15	10	9	1	5	3	0	9.0	CS	5 P DROP
pm83	K19-1:Y2	K393-1:H	no e	med q	f	7/2-11b/83	7/11	97	10/7/83	10	6	4	2	5	0	3	9.0	CS	LO OKSEED
pm83	K19-1:Y2	K393-1:H	no e	hi q	f	7/2-5/83	7/11	97	10/17/83	15	4	2	2	13	0	3	9.0	CS	HI PDROP
pm83	K19-1:Y2	K393-1:H	no e	med q	f	7/2-6/83	7/11	97	10/17/83	10	8	7	1	6	0	4	9.5	CS	
pm83	K19-1:Y2	K393-1:H	no e	hi q	f	7/2-7/83	7/11	97	10/17/83	10	5	4	1	4	0	0	9.0	CS	
pm83	K19-1:Y2	K393-1:H	no e	hi q	f	7/2-8/83	7/11	97	10/17/83	10	7	7	0	4	0	1	8.5	CS	

pulverulenta x leucocephala

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
pl82	K19-1:Y2	K500-?:Y1	no e	hi q	f	6/22-10/82	6/26	92	9/22/82	15	15	3	12	72	50	3	11.0	CS	
pl82	K19-1:Y2	K500-?:Y1	no e	hi q	f	6/22-9/82	6/26	91	9/21/82	15	11	3	8	58	26	2	10.0	CS	
pl82	K19-1:Y2	K500-?:Y1	no e	hi q	f	6/23-3/82	6/26	90	9/21/82	15	9	2	7	30	18	0	10.5	CS	
pl82	K19-1:Y2	K500-?:Y1	no e	hi q	f	6/23-4/82	6/26	90	9/21/82	15	15	9	6	47	29	6	11.5	CS	
pl82	K19-1:Y2	K500-?:Y1	no e	hi q	f	6/26-10/82	6/30	96	9/30/82	15	9	5	4	3	21	3	11.5	CS	
pl82	K19-1:Y2	K500-?:Y1	no e	med q	no f?	6/26-8/82	6/30	13	7/8/82	15	1	1	0					CS	
pl82	K19-1:Y2	K500-?:Y1	no e	hi q	no f	6/26-9/82	6/30	89	9/23/82	15	9	3	6	32	17	2	10.0	CS	
pl82	K19-1:Y2	K500-?:Y1	no e	hi q	f	6/27-7/82	6/30	86	9/21/82	15	12	4	8	63	14	1	11.0	CS	
pl82	K19-1:Y2	K500-?:Y1	no e	hi q	f	6/27-8/82	6/30	86	9/21/82	15	13	0	13	94	22	8	13.0	CS	
pl83	K19-1:Y2	K8-34:Y1	no e	hi q	f	7/12-4/83	7/22	106	10/26/83	15	3	1	2	6	2	2	8.0	CS	
pl83	K19-1:Y2	K8-34:Y1	no e	hi q	no f	7/12-6/83	8/31	106	10/26/83	15	1	0	1	0	0	8	10.5	CS	CY8ON DMG?
pl83	K19-1:Y2	K500-10:Y1	no e	med q	f	7/3-2/83	7/11	71	10/15/83	15	15	13	2	9	0	5	10.5	CS	HI PDROP
pl83	K19-1:Y2	K500-10:Y1	no e	med q	no f	7/3-3/84	7/11	84	10/26/84	15	2	0	2	0	0	7	3.5	CS	T.C.
pl83	K19-1:Y2	K500-10:Y1	no e	med q	no f?	7/3-5/83	7/11	84	10/26/84	10	3	0	3	16	0	2	8.5	CS	T.C.
pl83	K19-1:Y2	K500-10:Y1	no e	med q	no f?	7/3-6/83	7/11	84	10/26/84	10	2	1	1	5	0	3	8.5	CS	T.C.

pulverulenta x macrophylla

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
pa83	K19-1:Y2	K158-2:H	no e	hi q	no f	7/6-7/83	--	5	7/11/83	15	0							CS	
pa83	K19-1:Y2	K158-2:H	no e	hi q	no f	7/6-8/83	--	5	7/11/83	15	0							CS	

pulverulenta x retusa

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
pr83	K75-2:H	K280-1:H	no e	med q	no f?	8/31-2/83	--	15	9/15/82	15	3	3	0					CS	HUH?
pr83	K75-1:H	K280-1:H	no e	hi q	no f	8/31-3/83	--	7	9/7/83	15	0							CS	
pr83	K75-2:H	K280-1:H	no e	med q?	no f	9/8-2/83	--	6	9/14/83	5	0							CS	OLD FLWR
pr83	K75-1:H	K280-1:H	no e	med q?	no f	9/8-2/83	--	6	9/14/83	5	0							CS	
pr84	K75-2:H	K502-1:H	no e	med q?	no f?	6/12-1/84	--	36	7/19/84	20	0							CS	HUH?
pr84	K75-1:H	K502-1:H	no e	med q?	no f?	6/12-2/84	--	28	7/10/84	25	22	22	0					CS	PSYLLID
pr84	K75-2:H	K502-1:H	no e	med q?	no f?	6/12-3/84	--	36	7/19/84	15	6	6	0					CS	PSYLLID
pr84	K75-1:H	K502-1:H	no e	med q?	no f?	6/18-7/84	--	22	7/10/84	15	15	15	0					CS	PSYLLID
pr84	K75-1:H	K502-1:H	no e	med q?	no f?	6/18-7/84	--	22	7/10/84	15	15	15	0					CS	PSYLLID

pulverulenta x shannoni

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ps82	K340-2:Y2	K405-1:Y2	no e	hi q	f	6/15-1/82	6/21	91	9/14/82	15	8	1	7	36	79	6	13.0	CS	
ps82	K340-2:Y2	K405-1:Y2	no e	hi q	f	6/15-10/82	6/21	91	9/14/82	15	8	1	7	27	89	3	13.0	CS	
ps82	K340-2:Y2	K405-1:Y2	no e	med q	no f	6/15-2/82	6/21	30	7/14/82	15	6	6	0					CS	HI PDROP

ps82	K340-2:Y2	K405-1:Y2	no e	med q	no f	6/15-26/82	--	3	6/18/82	15	0							CS	
ps82	K340-2:Y2	K405-1:Y2	no e	hi q	f	6/15-3/82	6/21	91	9/14/82	15	9	5	4	9	79	1	13.5	CS	BUG
ps82	K340-2:Y2	K405-1:Y2	no e	med q	no f	6/15-4/82	6/21	31	7/15/82	15	8	8	0					CS	HI PDROP
ps82	K340-2:Y2	K405-1:Y2	no e	hi q	f	6/15-5/82	6/21	91	9/14/82	15	7	3	4	18	40	21	11.5	CS	
ps82	K340-2:Y2	K405-1:Y2	no e	hi q	f	6/15-6/82	6/21	91	9/14/82	15	11	5	6	48	50	6	12.5	CS	
ps82	K340-2:Y2	K405-1:Y2	no e	hi q	f	6/15-7/82	6/21	91	9/14/82	15	12	7	5	28	42	10	13.0	CS	
ps82	K340-2:Y2	K405-1:Y2	no e	hi q	f	6/15-8/82	6/21	91	9/14/82	15	9	1	8	27	62	3	12.5	CS	BUG
ps82	K340-2:Y2	K405-1:Y2	no e	med q	no f	6/15-9/82	6/21	42	7/26/82	15	1	1	0					CS	

pulverulenta x trichodes

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
pt83	K75-2:H	K90-2:Y2	no e	med q?	f?	9/2-2/83	10/15	144	1/24/84	15	1	0	1	8	0	11	10.0	CS	T.C. + SELF?

RETUSA (FEMALE) CROSSES

retusa selfs

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
r83	K280-1:H	same	no e	hi q	no f	6/9-1/83	--	6	6/15	20	0							CS	
r83	K280-1:H	same	no e	hi q	f	9/2-10/83	9/7	139	1/19/84	15	1	0	1	7	0	1	12.5	CS	
r83	K280-2?:H	same	no e	hi q	no f	9/2-6/83	9/7	10	9/12/83	15	0							CS	EARLY PDROP?
r83	K280-1:H	same	no e	hi q	no f	9/2-8/83	--	5	9/7/83	20	0							CS	
r84	K502-2:H	same	no e	hi q	f	10/10-8/84	--	112	1/30/84	30	2	1	1	12	5	0	15.5	CS	
r84	K280-1:H	same	no e	hi q	no f	10/13-19/84	--	10	10/23/84	15	0							CS	
r84	K280-1:H	same	no e	hi q	no f	10/13-20/84	--	12	10/25/84	30	0							CS	
r84	K280-1:H	same	no e	hi q	no f	10/17-1/84	--	8	10/25/84	20	0							CS	
r84	K280-1:H	same	no e	med q?	no f	10/17-2/84	--	9	10/25/84	15	0							CS	SMALL STYLE
r84	K280-1:H	same	no e	hi q	no f	10/17-3/84	--	8	10/25/84	23	0							CS	
r84	K280-1:H	same	no e	hi q	no f	10/17-4/84	--	8	10/25/84	23	0							CS	
r84	K280-1:H	same	no e	hi q	no f	10/17-5/84	--	8	10/25/84	23	0							CS	
r84	K502-2:H	same	no e	hi q	f	7/8-1/84	7/19	82	9/28/84	25	5	2	3	21	0	0	11.0	CS	9/13 SEEDS
r85	K502-2:H	same	no e	sed q?	no f	10/24-1/85	--	7	10/31/85	15	0							CS	

Bagged Crosses (Lo q):

r84	K280-1:H	same	no e	lo q	no f	10/4-1-12/84	--	5	10/9/84	--	0							CS	BAGGED
r84	K280-1:H	same	no e	lo q	no f	10/8/84	--	7	10/15/84	--	0							CS	BAGGED
r84	K280-1:H	same	no e	lo q	no f	10/10/84	--	5	10/15/84	--	0							CS	BAGGED
r84	K280-1:H	same	no e	lo q	f	10/5/84	--	128	2/10/85	--	1	0	1	2	4	3	14.0	CS	BAGGED
r85	K502-2:H	same	no e	lo q	f	11/13-1/85	11/21	104	2/25/86	--	1	0	1	16	0	0	18.5	CS	BAGGED
r85	K280-1:H	same	no e	lo q	f	11/13-2/85	11/21	104	2/25/86	--	1	0	1	4	6	1	19.5	CS	BAGGED

retusa x collinsii

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
rc83	K280-1:H	K450-1:H	no e	med q?	f?	9/28-7/83	10/17	119	1/19/84	20	9	1	8	74	8	3	14.5	CS	SELF?
rc83	K280-1:H	K450-1:H	no e	med q?	f?	9/28-8/83	10/17	119	1/19/84	20	4	2	2	27	1	0	15.5	CS	SELF?
rc84	K280-1:H	K450-1:H	no e	med q?	f?	6/28-14/84	7/10	93	9/29/84	15	12	1	11	131	0	3	14.5	CS	SELF?

retusa x diversifolia ssp. diversifolia

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
rd83	K280-1:H	K156-2:H	no e	hi q	no f	6/23-1/83	--	7	6/30	15	0								
rd84	K280-1:H	K156-1:H	no e	hi q	no f	10/5-12/84	--	10	10/15/84	22	0							CS	
rd84	K280-1:H	K156-1:H	no e	hi q	no f	10/5-13/84	--	10	10/15	20	0							CS	

rd84	K280-1:H	K156-1:H	no e	hi q	f?	10/5-15/84	--	126	2/8/85	15	4	2	2	6	6	10	15.5	CS	2 P SHATTER
rd85	K502-2:H	K156-2:H	no e	med q?	f?	11/14-6b/85	11/21	103	2/25/86	15	1	0	1	7	0	5	16.0	CS	
rd85	K502-2:H	K156-2:H	no e	hi q	no f	11/4-4/85	--	17	11/21/85	15	0							CS	
rd85	K502-2:H	K156-2:H	n e	hi q	no f	11/4-5a/85	--	17	11/21/85	20	0							CS	
rd85	K502-2:H	K156-1:H	no e	hi q?	no f?	11/4-5b/85	--	14	11/25/85	15	8	8	0					CS	TINY PODS
rd85	K502-2:H	K156-2:H	no e	hi q	no f	11/4-6a/85	--	17	11/21/85	16	0							CS	
rd85	K502-2:H	K156-2:H	no s	hi q	no f	11/4-7/85	--	17	11/21/85	12	0							CS	
rd85	K502-2:H	K156-2:H	no e	hi q	no f	11/4-3/85	--	17	11/21/85	15	0							CS	

retusa x diversifolia ssp. trichandra

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
rz84	K502-2:H	K411-9:I	no e	hiq	no f	10/1-1/84	--	7	10/8/84	15	0							CS	
rz84	K280-1:H	K411-9:I	no e	med q	no f	10/1-2b/84	--	20	10/21/84	15	1	1	0					CS	1 TINY POD
rz84	K280-1:H	K411-9:I	no e	med q	no f	10/1-2a/84	--	7	10/8/84	15	0							CS	
rz84	K280-1:H	K411-9:I	no e	hi q?	no f	10/1-3a/84	--	24	10/25/84	20	0							CS	
rz84	K280-1:H	K411-9:I	no e	hi q	no f	10/1-3b/84	--	7	10/8/84	15	0							CS	
rz84	K280-1:H	K411-9:I	no e	hi q?	f?	11/1-2/84	--	15	11/16/84	10	1	1	0					CS	1 TINY POD
rz84	K502-2:H	K409-8:I	no e	hi q?	f?	6/15-1/84	7/19	90	9/13/84	25	1	0	1	16	0	0	16.0	CS	SELF?
rz85	K502-2:H	B85-7:B2	emas	hi q	no f	11/19-7/85	--	6	11/25/85	10	0							CS	
rz85	K502-2:H	B85-7:B2	emas	hi q	no f	11/19-6/85	--	6	11/25/85	10	0							CS	

retusa x esculenta

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
re83	K280-1:H	K138-7:I	no e	med q?	no f	9/14-5/83	9/23	127	1/19/84	20	17	2	15	190	8	2	19.0	CS	
re84	K280-1:H	K138-1:H	no e	med q	f	10/13-18/84		121	2/11/85	21	21	0	21	82	16	210	19.5	CS	BUGSD=ABT
re84	K280-1:H	K138-1:I	no e	hi q	no f	10/3-17a/84	--	5	10/8/84	20	0							CS	
re84	K280-1:H	K138-1:I	no e	hi q	no f	10/3-17b/84	--	5	10/8/84	16	0							CS	
re84	K280-1:H	K138-1:I	no e	hi q?	no f	10/3-18/84	--	5	10/8/84	20	1	1	0					CS	1 TINY POD
re85	K502-2:H	K138-1:H	no e	med q	no f	11/4-6/85	--	8	11/12/85	15	0							CS	
re85	K502-2:H	K138-1:H	no e!	med q?	f?	11/4-7/85	11/12	113	2/25/86	15	14	9	5	46	10	3	16.0	CS	SELFS?

retusa x lanceolata ssp. lanceolata

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
rn84	K280-1:H	K10-2:H	no e	hi q	f	9/29-3/84	10/8	123	1/31/85	30	8	6	2	12	4	0	10.0	CS	SELFS?
rn84	K502-2:H	K10-1:H	no e	hi q?	f?	6/25-2/84	7/19	80	9/13/84	15	6	4	2	13	0	1	18.0	CS	SF?
rn85	K502-2:H	K10-2:H	emas	hi q	no f	11/13-7/85	--	8	11/21/85	15	0							CS	
rn85	K280-1:H	K10-2:H	emas	hi q	no f?	11/14-10/85	11/21	11	11/25/85	8	5	5	0					CS	TINY PODS
rn85	K280-1:H	K10-2:H	emas	hi q	no f	11/14-11/85	11/21	11	11/25/85	15	1	1	0					CS	1 POD
rn85	K280-1:H	K10-2:H	emas	hi q	no f	11/14-14/85	--	7	11/21/85	14	0							CS	
rn85	K280-1:H	K10-2:H	emas	hi q	no f	11/14-15/85	--	7	11/21/85	25	0							CS	
rn85	K280-1:H	K10-2:H	emas	hi q	no f	11/14-19/85	--	7	11/21/85	15	0							CS	
rn85	K280-1:H	K10-2:H	emas	hi q	no f	11/14-2/85	11/21	7	11/21/85	11	4	4	0					CS	TINY PODS
rn85	K280-1:H	K10-2:H	emas	hi q	no f	11/14-1/85	--	7	11/21/85	16	0							CS	

retusa x lanceolata ssp. sousae

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
rm84	K280-1:H	K393-1:H	no e	hi q	no f	10/4-26/84	--	11	10/8/84	15	0							CS	
rm84	K280-1:H	K393-1:H	no e	med q	f	10/4-27a/84	10/8	4	10/15/84	10	0							CS	
rm94	K280-1:H	K393-1:H	no e	hi q	no f	10/4-27b/84	--	19	10/25/84	40	0							CS	
rm84	K280-1:H	K393-1:H	no e	hi q	no f	10/4-33/84	--	11	10/15/84	20	0							CS	
rm84	K280-1:H	K393-1:H	no e	hi q	no f	10/4-35/84	--	11	10/15/84	40	0							CS	
rm85	K502-2:H	K393-1:H	no e	hi q	no f	11/12-13/85	--	9	11/21/85	21	0							CS	

rm85	K502-2:H	K393-1:H	no e	med q	no f	11/12-15a/85	--	9	11/21/85	22	0							CS	
rm85	K502-2:H	K393-1:H	no e	med q?	no f?	11/12-15b/85	11/21	9	11/21/85	5	1	1	0					CS	1 POD
rm85	K502-2:H	K393-1:H	emas	hi q	no f	11/14-15/85	--	7	11/21/85	15	0							CS	
rm85	K280-1:H	K393-1:H	emas	hi q	no f	11/14-20/85	--	7	11/21/85	18	0							CS	
rm85	K280-1:H	K393-1:H	emas	hi q	no f?	11/14-21/85	11/21	11	11/25/85	18	1	1	0					CS	SELF SET?
rm85	K280-1:H	K393-1:H	emas	hi q	no f	11/14-23/85	--	7	11/21/85	11	0							CS	
rm85	K502-2:H	K393-1:H	emas	hi q	no f	11/4-16/85	--	8	11/12/85	15	0							CS	
rm85	K502-2:H	K393-1:H	emas	hi q	no f	11/4-17/85	--	8	11/12/85	15	0							CS	
rm83	K280-1:H	K393-1:H	no e	hi q	no f	6/20-1/83	--	5	6/25/83	15	0							CS	

retusa x leucocephala

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
rl83	K280-1:H	K500-?:Y1	no e	hi q	f	6/10-1/83	6/25	88	9/7/83	25	24	6	18	221	8	10	20.0	CS	LO-MED Q SEED
rl83	K280-1:H	K8-?:A2	no e	med q?	no f?	9/23-7/83	9/28	118	1/19/84	25	25	1	24	0	10	265	17.0	CS	T.C.?
rl84	K280-1:H	K341-?:H6	no e	hi q	f	10/10-1/84	10/15	119	2/7/85	16	11	9	2	11	5	13	16.5	CS	SEEDS POOR
rl84	K280-1:H	K341-?:H6	no e	hi q	f	10/10-2/84	10/15	119	2/7/85	20	20	9	11	5	16	100	17.5	CS	GOOD SD?
rl84	K280-1:H	K45-?:H6	no e	hi q	no f?	10/3-12/84	10/8	126	2/7/85	10	6	2	4	0	8	21	14.0	CS	
rl84	K280-1:H	K45-?:H6	no e	hi q	f	10/3-13/84	10/7	126	2/7/85	25	25	6	19	16	25	101	16.5	CS	
rl84	K280-1:H	K45-?:H6	no e	hi q	no f	10/5-11/84	10/8	20	10/25/84	22	4	4	0					CS	HUH?
rl84	K280-1:H	K45-?:H8	no e	hi q	no f	10/5-14/84	--	10	10/15/84	23	0							CS	

retusa x pallida

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ry84	K280-1:H	K376-10:I	no e	hi q	no f	10/10-5/84	10/15	123	2/10/85	15	13	6	7	0	0	83	19.0	CS	ALL ABT, SLY
ry84	K280-1:H	K376-5:I	no e	lo q	no f	10/2-1/84	10/8	123	2/10/85	33	30	25	5	0	0	42	15.0	CS	
ry84	K280-1:H	K376-5:I	no e	hi q	no f	10/2-3/84	--	123	2/10/85	45	25	20	5	0	0	44	12.5	CS	ALL ABT
ry84	K280-1:H	K376-5:I	no e	hi q	no f?	10/2-4/84	10/8	123	2/10/85	45	40	28	12	1	0	136	15.5	CS	1 SD SELF?
ry84	K280-1:H	K376-5:I	no e	hi q	f?	10/2-5/84	10/8	123	2/10/85	20	30	19	11	1	30	69	15.5	CS	SELF?
ry84	K280-1:H	K376-5:I	no e	hi q	f?	10/2-6/84	10/7	123	2/10/85	30	24	22	2	1	78	20	12.0	CS	1 BDSD
ry84	K280-1:H	K376-10:I	no e	hi q	no f	10/3-10/84	10/8	123	2/10/85	15	9	8	1	0	0	14	16.0	CS	ALLABT
ry84	K280-1:H	K376-5:I	no e	hi q	no f	10/3-2/84	10/5	123	2/10/85	20	2	1	1	0	9	4	13.0	CS	2 PODS
ry84	K280-1:H	K376-10:I	no e	hi q	f?	10/3-7/84	10/8	123	2/10/85	30	30	4	26	1	0	234	16.0	CS	1 SD SELF?
ry84	K280-1:H	K376-10:I	no e	hi q?	no f	10/3-9/84	--	123	2/10/85	15	14	2	12	0	0	129	13.5	CS	ALL ABT

retusa x pulverulenta

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
rp86	K502-2:H	K881-?:GH	emas	hi q	f	4/18-9/86	5/1	87	7/14/86	15	13	2	11	140	0	7	17.0	CS	1 ABT POD
rp86	K502-2:H	K881-?:GH	emas	hi q	f	4/18-8/86	5/1	102	7/29/86	20	7	5	2	29	0	0	16.5	CS	

retusa x shannoni

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
rs83	K280-1:H	K445-2:H	no e	hi q?	f	10/5-9/83	10/17	106	1/19/84	33	30	6	24	350	48	3	16.5	CS	BUG RESIST
rs84	K280-1:H	K445-1:H	no e	hi q	f	10/12-15a/84	--	131	2/20/85	30	15	5	10	89	35	3	14.5	CS	BUG
rs84	K280-1:H	K445-1:H	no e	hi q	f	10/12-15b/84	10/17	131	2/20/85	34	24	20	4	55	6	1	16.0	CS	
rs84	K280-1:H	K445-1:H	no e	hi q	f	10/12-16/84	10/17	131	2/20/85	28	25	5	20	208	35	4	16.0	CS	
rs84	K280-1:H	K445-1:H	no e	hi q	f	10/12-17/84	10/15	131	2/20/85	20	25	8	17	176	48	3	16.0	CS	

retusa x trichodes

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
rt84	K280-1:H	K738-1:H	no e	hi q	no f	10/1-16/84	--	7	10/8/84	17	0							CS	
rt84	K280-1:H	K738-1:H	no e	hi q	no f	10/1-18/84	--	7	10/8/84	25	0							CS	SLY

rt84	K280-1:H	K738-1:H	no e	hi q	no f	10/4-31/84	--	4	10/8/84	15	0							CS	
rt85	K502-2:H	K90-1:H	no e	med q	no f?	11/14-46/85	--	7	11/21/85	15	2	2	0					CS	SELFS?
rt85	K502-2:H	K738-1:H	no e	hi q	no f	11/4-3/85	--	17	11/21/85	15	0							CS	

SHANNONI (FEMALE) CROSSES

shannoni selfs

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
s82	K405-1:Y2	same	no e	hi q	no f	6/14-6/82	--	4	6/18/82	15	0							CS	
s82	K405-1:Y2	same	no e	hi q	no f	6/15-12/82	--	6	6/21/82	15	0							CS	
s82	K405-1:Y2	same	no e	hi q	no f	6/15-14/82	--	6	6/21/82	15	0							CS	
s82	K405-1:Y2	same	no e	hi q	no f	6/15-17/82	--	6	6/21/82	15	0							CS	
s82	K405-1:Y2	same	no e	hi q	no f	6/15-18/82	--	6	6/21/82	15	0							CS	
s82	K405-1:Y2	same	no e	hi q	no f	6/15-19/82	--	6	6/21/82	15	0							CS	
s82	K405-1:Y2	same	no e	hi q	no f	6/15-20/82	--	6	6/21/82	15	0							CS	
s82	K405-1:Y2	same	no e	hi q	no f	6/15-21/82	--	6	6/21/82	15	0							CS	
s82	K405-1:Y2	same	no e	hi q	no f	6/15-24/82	--	6	6/21/82	15	0							CS	
s82	K405-1:Y2	same	no e	hi q	no f	6/15-25/82	--	6	6/21/82	15	0							CS	
s82	K405-1:Y2	same	no e	hi q	no f	6/15-6/82	--	3	6/18/82	15	0							CS	
s82	K405-1:Y2	same	no e	hi q	no f	6/16-23/82	--	5	6/21/82	15	0							CS	
s82	K405-1:Y2	same	no e	med q	no f	6/18-15/82	--	3	6/21/82	15	0							CS	
s82	K405-1:Y2	same	no e	hi q	no f	6/18-16/82	--	4	6/22/82	15	0							CS	
s82	K405-1:Y2	same	no e	hi q	no f	6/18-17/82	--	4	6/22/82	15	0							CS	
s82	K405-1:Y2	same	no e	hi q	no f	6/18-18/82	--	4	6/22/82	15	0							CS	
s82	K405-1:Y2	same	no e	med q	no f	6/18-19/82	--	3	6/21/82	15	0							CS	
s83	K445-1:H	same	no e	med q	no f	6/10-2/83	--	6	6/16/82	13	0							CS	

shannoni x collinsii

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
sc82	K405-1:Y2	K183-1:I	no e	hi q	no f	7/29-11/82	8/4	46	9/14/82	15	4	4	0					CS	
sc82	K405-1:Y2	K183-1:I	no e	med q	no f	7/29-12/82	--	6	8/4/82	15	0							CS	
sc82	K405-1:Y2	K183-1:I	no e	hi q	no f	7/29-14/82	8/4	46	9/14/82	15	4	4	0					CS	
sc82	K405-1:Y2	K183-1:I	no e	hi q	no f	7/29-15/82	8/4	11	8/9/82	15	3	3	0					CS	
sc82	K405-1:Y2	K183-1:I	no e	med q	no f	7/29-16/82	--	6	8/4/82	15	0							CS	
sc82	K405-1:Y2	K183-1:I	no e	hi q	no f	7/29-17/82	--	6	8/4/82	15	1	1	0					CS	
sc82	K405-1:Y2	K183-1:I	no e	hi q	no f	7/29-6/82	8/4	46	9/14/82	15	3	3	0					CS	
sc82	K405-1:Y2	K183-1:I	no e	hi q	no f	7/29-7/82	8/4	46	9/14/82	15	7	7	0					CS	
sc82	K405-1:Y2	K183-1:I	no e	hi q	no f	7/29-8/82	8/4	46	9/14/82	15	4	4	0					CS	
sc82	K405-1:Y2	K183-1:I	no e	med q	no f	8/6-15/82	--	3	8/9/82	15	0							CS	
sc82	K405-1:Y2	K183-1:I	no e	med q	no f	8/6-16/82	--	3	8/9/82	15	0							CS	
sc83	K445-1:H	K180-1:I	no e	hi q?	f?	7/16-11/83	--	3	7/19/83	20	6	6	0					CS	BAG BROKE 6P
sc83	K445-1:H	K180-1:I	no e	hi q	no f?	7/16-12/83	--	6	7/22/83	20	0							CS	
sc83	K445-1:H	K180-1:I	no e	hi q?	no f?	7/16-13/83	7/22	93	10/17/83	15	3	3	0					CS	LATE PDROP
sc83	K445-1:H	K180-1:I	no e	med q	no f	7/16-14/83	7/22	93	10/17/83	15	7	7	0					CS	LATE PDROP
sc83	K445-1:H	K180-1:I	no e	med q	no f	7/16-18/83	7/22	44	7/22/83	15	3	3	0					CS	LATE PDROP
sc83	K445-1:H	K450-1:H	no e	med q	no f	7/27-5/83	8/2	19	8/15/83	10	3	3	0					CS	
sc83	K445-1:H	K450-1:H	no e	mec q	no f	7/27-6/83	8/2	19	8/15/83	10	3	3	0					CS	
sc86	K475-6:I	K450-1:H	no e	hi q	no f	6/5-3/86	--	44	5/19/86	16	0							CS	
sc86	K475-6:I	K450-1:H	no e	hi q	no f	6/5-2/86	--	44	5/19/86	18	0							CS	
sc86	K475-6:I	K450-1:H	no e	hi q	no f?	6/5-1/86	5/19			18	6	5	1	0?	0?	19?	20.0	CS	NOT YET HRVST
sc86	K475-6:I	K450-1:H	no e	hi q	f?	6/5-4/86	5/19			17	16	14	2	5?	0?	29?	18.0	CS	LOOK 9/30/86

shannoni x diversifolia ssp. diversifolia

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
sd82	K405-1:Y2	K156-1:H	no e	hi q	no f	6/14-1/82	--	4	6/18/82	15	0							CS	
sd82	K405-1:Y2	K156-1:H	no e	hi q	no f	6/14-2/82	--	4	6/18/82	15	0							CS	
sd82	K405-1:Y2	K156-1:H	no e	hi q	no f	6/14-3/82	--	4	6/18/82	15	0							CS	
sd82	K405-1:Y2	K156-1:H	no e	hi q	no f	6/14-4/82	--	7	6/21/82	15	0							CS	
sd82	K405-1:Y2	K156-1:H	no e	hi q	no f	6/16-1/82	--	6	6/22/82	15	0							CS	
sd82	K405-1:Y2	K156-1:H	no e	hi q	no f	6/16-2/82	--	5	6/21/82	15	0							CS	
sd82	K405-1:Y2	K156-1:H	no e	hi q	no f	6/16-4/82	--	5	6/21/82	15	0							CS	
sd82	K405-1:Y2	K156-1:H	no e	hi q	no f	6/16-5/82	--	5	6/21/82	15	0							CS	
sd82	K405-1:Y2	K156-1:H	no e	hi q	no f	6/16-6/82	--	5	6/21/82	15	0							CS	
sd82	K405-1:Y2	K156-1:H	no e	hi q	no f	7/2-11a/82	--	4	7/6/82	15	0							CS	
sd82	K405-1:Y2	K156-1:H	no e	hi q	no f	7/2-12/82	--	4	7/6/82	15	0							CS	
sd82	K405-1:Y2	K156-1:H	no e	hi q	no f	7/2-15/82	--	4	7/6/82	15	0							CS	
sd82	K405-1:Y2	K156-1:H	no e	hi q	no f	7/2-16/82	7/14	24	7/26/82	15	2	2	0					CS	
sd82	K405-1:Y2	K156-1:H	no e	hi q	no f	7/2-17/82	7/14	24	7/26/82	15	4	4	0					CS	PDROP
sd82	K405-1:Y2	K156-1:H	no e	hi q	no f	7/2-18/82	7/14	57	9/14/82	15	4	4	0					CS	PDROP
sd82	K405-1:Y2	K156-2:H	no e	hi q	no f	7/2-19/82	7/14	57	9/14/82	15	5	5	0					CS	PDROP
sd82	K405-1:Y2	K156-2:H	no e	hi q	no f	7/2-20/82	7/14	23	7/26/82	15	1	1	0					CS	PDROP
sd82	K405-1:Y2	K156-2:H	no e	hi q	no f	7/2-21/82	7/14	25	7/26/82	15	3	3	0					CS	PDROP
sd82	K405-1:Y2	K156-2:H	no e	hi q	no f	7/9-5/82	--	5	7/14/82	15	0							CS	
sd83	K445-1:H	K156-1:H	no e	hi q	no f	6/24-4/83	--	3	6/27/83	15	0							CS	
sd83	K445-2:H	K156-1:H	no e	hi q	f	7/15-7/83	7/19	188	1/19/84	15	5	3	2	4	4	20	12.5	CS	LO HEALTH?
sd83	K445-1:H	K156-1:H	no e	med q	no f	7/15-8/83	--	4	7/19/83	13	0							CS	
sd83	K445-1:H	K156-1:H	no e	med q?	no f?	7/15-9/83	--	4	7/19/83	15	2	2	0					CS	WIND BROKE IT?

shannoni x diversifolia ssp. trichandra

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
sz84	K445-1:H	K409-8:I	no e	hi q?	no f	6/28-6/84	--	12	7/10/84	12	2	2	0					CS	BROKE?
sz85	K445-1:H	B85-?:B2	no e	hi q	no f?	10/31-11/85	11/11	117	2/25/86	12	2	0	2	10	2	22	13.5	CS	NICE
sz85	K445-1:H	B85-2:B2	no e	hi q	no f	10/31-12/85	--	4	11/4/85	15	0							CS	
sz85	K445-1:H	B85-?:B2	no e	hi q	f	11/6-2/85	11/12	114	2/28/86	12	10	9	1	0	0	16	13.5	CS	
sz85	K445-1:H	B85-?:B2	no e	hi q	f	11/6-3/85	--	18	11/24/85	15	12	12	0					CS	
sz85	K445-1:H	B85-?:B2	no e	hi q	f	11/6-4/85	11/12	114	2/28/86	15	7	5	2	37	0	0	14.5	CS	ABT?
sz85	K445-1:H	B85-?:B2	no e	hi q	f	11/6-5/85	11/12	114	2/28/86	16	6	3	3	55	0	0	14.5	CS	
sz85	K445-1:H	B85-?:B2	no e	hi q	f	11/6-6/85	11/12	111	2/25/86	15	5	1	4	42	10	16	14.5	CS	T.C.?
sz85	K445-1:H	B85-?:B2	no e	hi q	no f	11/6-7/85	--	6	11/12/85	15	0							CS	
sz85	K445-1:H	B85-?:B2	no e	hi q	no f	11/6-9/85	--	6	11/12/85	15	0							CS	

shannoni x esculenta

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
se82	K405-1:Y2	No K:UH	no e	med q	no f	6/25-1/82	--	5	6/30/82	10	0							CS	
se82	K405-1:Y2	No K:UH	no e	med q	no f	6/25-2/82	--	5	6/30/82	10	0							CS	
se82	K405-3:Y2	No K:UH	no e	hi q	no f	6/25-4/82	6/30	12	7/6/82	13	2	2	0					CS	
se82	K445-1:H	No K:UH	no e	med q	no f	6/25-5/82	--	5	6/30/82	13	0							CS	
se82	K405-1:Y2	No K:UH	no e	hi q	no f	7/7-3/82	--	12	7/19/82	13	0							CS	
se82	K405-1:Y2	No K:UH	no e	hi q	no f	7/7-4/82	--	12	7/19/82	12	0							CS	
se82	K405-1:Y2	No K:UH	no e	med q	no f	7/7-5/82	--	7	7/14/82	13	0							CS	
se83	K445-1:H	K138-7:I	no e	hi q	no f	9/21-4/83	--	26	10/17/83	10	0							CS	
se83	K445-1:H	K138-7:I	no e	hi q	no f	9/21-5/83	--	26	10/17/83	20	0							CS	
se84	K445-2:H	K138-6:I	no e	hi q	no f	7/12-6/84	--	7	7/19/84	10	0							CS	
se84	K445-2:H	K138-6:I	no e	hi q?	no f	7/12-7/84	--	36	7/19/84	5	0							CS	
se84	K445-2:H	K138-6:I	no e	med q	no f	7/16-7/83	7/19	10	9/13/84	10	0							CS	

se84	K445-2:H	K138-6:I	no e	med q	no f?	7/16-8/84	7/19	10	9/13/84	15	0							CS	
se85	K445-1:H	K138-2:I	no e	hi q	no f	11/6-34/85	--	6	11/12/85	15	0							CS	
se85	K445-1:H	K138-2:I	no e	hi q	no f	11/6-36/85	--	6	11/12/85	25	0							CS	

shannoni x lanceolata ssp. lanceolata

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUB	ABT	CM	WHO	NOTES
sn81	K405-1:Y2	K264-1:I	no e	hi q	f	7/28a/81	--	156	12/31/81	15	4	0	4	69	--	--	--	BOO	
sn81	K405-1:Y2	K264-1:I	no e	hi q	f	7/28b/81	--	133	12/8/81	15	3	0	3	53	--	--	--	BOO	
sn81	K405-1:Y2	K264-1:I	no e	hi q	f	7/28c/81	--	133	12/8/81	15	3	0	3	42	--	--	--	BOO	
sn81	K405-1:Y2	K264-1:I	no e	med q	no f?	7/28d/81	--	133	12/8/81	15	3	3	0					BOO	
sn81	K405-1:Y2	K264-1:I	no e	hi q	f	7/29a/81	--	132	12/8/81	15	1	0	1	20	--	--	--	BOO	
sn81	K405-1:Y2	K264-1:I	no e	hi q	f	7/29b/81	--	132	12/8/81	15	1	0	1	14	--	--	--	BOO	
sn81	K405-1:Y2	K264-1:I	no e	hi q	f	7/29c/81	--	132	12/8/81	15	3	0	3	52	--	--	--	BOO	
sn81	K405-1:Y2	K264-1:I	no e	hi q	f	7/30a/81	--	131	12/8/81	15	5	0	5	88	--	--	--	BOO	
sn81	K405-1:Y2	K264-1:I	no e	med q	no f?	7/30b/81	--	41	9/9/81	15	9	9	0					BOO	
sn82	K405-1:Y2	K401-1:I	no e	hi q	no f	7/20-23/82	7/24	6	7/26/82	15	9	9	0					CS	
sn82	K405-1:Y2	K401-1:I	no e	hi q	no f	7/20-24/82	7/26	20	8/9/82	15	2	2	0					CS	
sn82	K405-1:Y2	K401-1:I	no e	hi q	no f	7/20-25/82	7/26	20	8/9/82	15	3	3	0					CS	
sn82	K405-1:Y2	K401-1:I	no e	hi q	no f?	7/20-27/82	7/26	55	9/14/82	15	15	15	0					CS	
sn82	K405-4:Y2	K401-7:I	no e	hi q	no f	7/20-28/82	7/26	21	8/10/82	15	1	1	0					CS	
sn82	K405-4:Y2	K401-7:I	no e	hi q	no f	7/22-14/82	7/26	14	8/9/82	15	3	3	0					CS	
sn82	K405-4:Y2	K401-7:I	no e	hi q	no f	7/22-15/82	7/26	16	8/7/82	15	1	1	0					CS	
sn82	K405-4:Y2	K401-7:I	no e	med q	no f	7/22-16/82	--	4	7/26/82	15	0							CS	
sn82	K405-4:Y2	K401-7:I	no e	med q	no f	7/22-17/82	--	4	7/26/82	15	0							CS	
sn82	K405-4:Y2	K401-7:I	no e	hi q	no f	7/22-18/82	7/26	19	8/9/82	15	1	1	0					CS	
sn83	K445-2:H	K10-2:H	no e	hi q	f	7/13-4/83	7/19	190	1/19/84	15	12	11	1	4	2	10	12.5	CS	SMALL SEEDS
sn83	K445-1:H	K10-2:H	no e	hi q	no f	9/16-10/83	--	3	9/19/83	16	0							CS	
sn83	K445-1:H	K10-2:H	no e	hi q	no f	9/16-8/83	--	7	9/23/83	16	0							CS	
sn83	K445-1:H	K10-2:H	no e	hi q	no f	9/16-9/83	--	7	9/23/83	16	0							CS	
sn84	K445-1:H	K10-2:H	no e	hi q	no f	10/1-19/84	--	24	10/25/84	10	0							CS	
sn84	K445-1:H	K10-2:H	no e	hi q	no f?	10/1-20b/84	10/7	14	10/15/84	15	12	12	0					CS	DROUGHT?
sn84	K445-1:H	K10-2:H	no e	hi q	no f	10/1-20a/84	10/7	24	10/25/84	13	11	11	0					CS	HUH?
sn84	K445-1:H	K10-2:H	no e	hi q?	no f?	10/1-21/84	10/7	14	10/15/84	20	12	12	0					CS	PSYLLIDS?
sn85	K445-1:H	K10-1:H	no e	hi q	no f	10/4-1/85	10/11	20	10/24/85	15	5	5	0					CS	
sn85	K445-1:H	K10-1:H	no e	hi q	f	10/4-5/85	10/11	140	2/28/86	15	11	3	8	122	14	5	14.5	CS	
sn85	K445-1:H	K10-1:H	no e	hi q	f	10/4-4/85	10/11	140	2/28/86	15	10	6	4	56	10	1	13.0	CS	
sn85	K445-1:H	K10-1:H	no e	hi q	f	10/4-3/85	10/11	140	2/28/86	15	9	6	3	39	10	2	12.5	CS	
sn85	K445-1:H	K10-1:H	no e	hi q	f	10/4-2/85	10/11	140	2/28/86	17	11	10	1	0	0	17	12.0	CS	

shannoni x lanceolata ssp. sousae

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUB	ABT	CM	WHO	NOTES
sa82	K405-1:Y2	K393-1:H	no e	hi q	no f?	6/25-13/82	6/30	155	12/2/82	15	5	3	2	0	0	25	12.0	CS	T.C.?
sa82	K405-1:Y2	K393-1:H	no e	hi q	no f	6/25-14/82	--	6	7/1/82	15	0							CS	
sa82	K405-1:Y2	K385-10:I	no e	hi q	no f	7/1-2/82	--	5	7/6/82	15	0							CS	
sa82	K405-1:Y2	K385-10:I	no e	hi q	no f	7/1-3/82	--	5	7/6/82	15	0							CS	
sa82	K405-1:Y2	K385-10:I	no e	hi q	no f	7/1-4/82	--	5	7/6/82	15	0							CS	
sa82	K405-1:Y2	K385-10:I	no e	med q	no f	7/2-10/82	--	4	7/6/82	15	0							CS	
sa82	K405-1:Y2	K385-10:I	no e	hi q	no f	7/2-11/82	--	5	7/26/82	15	0							CS	
sa82	K405-1:Y2	K385-10:I	no e	hi q	no f?	7/2-4/82	--	5	7/7/82	15	1	1	0					CS	
sa82	K405-1:Y2	K385-10:I	no e	hi q	no f	7/2-6/82	7/14	24	7/26/82	15	1	1	0					CS	PDROP
sa82	K405-1:Y2	K385-10:I	no e	hi q	no f	7/2-7/82	--	12	7/14/82	15	0							CS	
sa82	K405-1:Y2	K385-10:I	no e	hi q	no f	7/2-9/82	--	12	7/14/82	15	0							CS	
sa82	K405-1:Y2	K385-10:I	no e	hi q	no f	7/21-10/82	--	5	7/26/82	15	0							CS	
sa82	K405-1:Y2	K385-10:I	no e	hi q	no f	7/21-8/82	7/26	14	8/4/82	15	4	4	0					CS	PDROP

sa82	K405-1:Y2	K385-10:I	no e	hi q	no f	7/21-9/82	--	5	7/26/82	15	0							CS	
sa83	K445-1:H	K393-1:H	no e	med q	no f	7/16-9/83	7/19	17	8/2/83	15	7	7	0					CS	
sa85	K445-1:H	K393-1:H	no e	hi q	f	11/12-44/85	11/21	14	11/26/85	15	6	6	0					CS	PSYLLID?
sa85	K445-1:H	K393-1:H	no e	hi q	no f	11/14-26/85	--	7	11/21/85	15	0							CS	
sa85	K445-1:H	K393-1:H	no e	hi q	f	11/14-27/85	11/21	103	2/25/86	15	10	2	8	38	0	0	16.0	CS	GREEN PODS
sa85	K445-1:H	K393-1:H	no e	hi q	f	11/14-28/85	11/21	25	12/9/85	15	9	9	0					CS	

shannoni x leucocephala

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
sl82	K405-1:Y2	K500-?:Y1	no e	hi q	no f	6/23-1/82	6/30	26	7/19/82	15	9	9	0					CS	
sl82	K405-1:Y2	K500-?:Y1	no e	hi q	no f	6/25-10/82	6/30	31	7/26/82	15	10	10	0					CS	
sl82	K405-1:Y2	K500-?:Y1	no e	hi q	no f	6/25-12/82	6/30	26	7/21/82	15	8	8	0					CS	
sl82	K405-1:Y2	K500-?:Y1	no e	hi q	no f	6/26-12/82	6/30	6	7/2/82	15	10	10	0					CS	
sl82	K405-1:Y2	K500-?:Y1	no e	med q	no f	6/27-2/82	6/30	24	7/21/82	15	10	10	0					CS	
sl82	K405-1:Y2	K500-?:Y1	no e	hi q	no f	6/27-3/82	6/30	17	7/14/82	15	10	10	0					CS	
sl82	K405-1:Y2	K500-?:Y1	no e	hi q	no f	6/27-5/82	6/30	10	7/7/82	15	10	10	0					CS	
sl82	K405-3:Y2	K500-?:Y1	no e	hi q	no f	7/2-24/82	7/14	38	8/9/82	15	9	9	0					CS	
sl82	K405-3:Y2	K500-?:Y1	no e	med q	no f	7/2-25/82	7/14	24	7/26/82	15	3	3	0					CS	
sl83	K445-1:H	K500-9:Y1	no e	med q	no f?	7/8-1/83	--	14	7/22/83	15	0							CS	
sl83	K445-1:H	K500-14:Y1	no e	hi q	f	7/8-2/83	7/22	87	10/17/83	15	5	5	0					CS	
sl83	K445-1:H	K500-14:Y1	no e	med q	no f	7/8-3/83	--	16	7/22/83	15	0							CS	
sl83	K445-1:H	K8-?:A2	no e	hi q	no f	8/11-10/83	--	27	9/7/83	15	0							CS	
sl83	K445-1:H	K8-?:A2	no e	hi q	no f	8/11-11/83	--	4	8/15/83	15	0							CS	

shannoni x macrophylla

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
sa83	K445-1:H	K158-2:H	no e	med q	no f?	7/6-6/83	--	5	7/11	15	1	1	0					CS	BAG BROKE IT?

shannoni x pallida

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
sy84	K445-1:H	K376-5:I	no e	hi q	no f?	10/2-7/84	10/24	139	2/28/86	15	6	5	1	0	3	14	13.0	CS	ALL TINY ABT
sy84	K445-1:H	K376-5:I	no e	hi q	no f	10/2-8/84	10/7	139	2/28/86	15	3	2	1	0	0	32	13.5	CS	ALL TINY ABT
sy85	K445-1:H	K376-?:I2	no e	hi q	f?	10/7-2/85	10/11	134	2/28/86	10	1	0	1	0	0	16	13.5	CS	ALL TINY ABT
sy85	K445-1:H	K376-?:I2	no e	hi q	f	10/7-6/85	10/11	134	2/28/86	15	4	0	4	18	3	25	13.5	CS	
sy85	K445-1:H	K376-?:I2	no e	hi q	no f	10/7-5/85	10/11	17	10/24/86	15	0							CS	
sy85	K445-1:H	K376-?:I2	no e	hi q	f?	10/7-4/85	10/11	134	2/28/86	15	2	1	1	7	0	9	12.0	CS	
sy85	K445-1:H	K376-?:I2	no e	med q	f	10/7-10/85	10/11	134	2/28/86	10	5	0	5	22	0	56	13.0	CS	
sy85	K445-1:H	K376-?:I2	no e	hi q	f?	10/8-2/85	10/11	134	2/28/86	12	2	0	2	18	0	9	13.0	CS	NICE SDS
sy95	K445-1:H	K376-?:I2	no e	hi q	no f	10/8-4/85	10/24	133	2/28/86	18	3	3	0					CS	
sy85	K445-1:H	K376-?:I2	no e	hi q	f	10/8-8/85	10/24	130	2/25/86	15	1	0	1	1	1	14	13.0	CS	
sy85	K445-1:H	K376-?:I2	no e	hi q	f	10/8-3/85	10/11	133	2/28/86	15	14	6	8	37	1	82	13.5	CS	VARY ABT
sy85	K445-1:H	K376-?:I2	no e	hi q	f	10/8-1/85	10/11	133	2/28/86	12	2	1	1	9	0	8	13.0	CS	NICE SDS
sy85	K445-1:H	K376-?:I2	no e	hi q	f?	10/8-9/85	10/11	133	2/28/86	15	4	1	3	19	0	22	12.0	CS	
sy85	K445-1:H	K376-?:I2	no e	hi q	f?	10/8-5/85	10/24	130	2/25/86	17	2	0	2	3	6	22	16.5	CS	

shannoni x pulverulenta

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
sp82	K405-1:Y2	K340-2:Y2	no e	hi q	no f	6/16-13/82	--	5	6/21/82	15	0							CS	
sp82	K405-1:Y2	K340-2:Y2	no e	hi q	no f	6/16-14/82	--	5	6/21/82	15	0							CS	
sp82	K405-1:Y2	K340-2:Y2	no e	hi q	no f	6/16-15/82	--	5	6/21/82	15	0							CS	
sp82	K405-1:Y2	K340-2:Y2	no e	hi q	no f	6/16-16/82	--	5	6/21/82	15	0							CS	
sp82	K405-1:Y2	K340-2:Y2	no e	hi q	no f	6/16-17/82	--	5	6/21/82	15	0							CS	

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
sp82	K405-1:Y2	K340-2:Y2	no e	hi q	no f	6/16-18/82	--	5	6/21/82	15	0							CS	
sp82	K405-1:Y2	K340-2:Y2	no e	hi q	no f	6/16-20/82	--	5	6/21/82	15	0							CS	
sp82	K405-1:Y2	K340-2:Y2	no e	med q	no f	6/16-21/82	--	2	6/18/82	15	0							CS	
sp82	K405-1:Y2	K340-2:Y2	no e	med q	no f	6/16-22/82	--	2	6/18/82	15	0							CS	
sp82	K405-1:Y2	K340-2:Y2	no e	med q	no f	6/16-9/82	--	2	6/18/82	15	0							CS	
sp82	K405-1:Y2	K19-1:Y2	no e	med q	no f	6/18-3/82	--	3	6/21/82	15	0							CS	
sp82	K405-1:Y2	K19-1:Y2	no e	med q	no f	6/18-4/82	--	3	6/21/82	15	0							CS	
sp82	K405-1:Y2	K19-1:Y2	no e	hi q	no f	6/22-4/82	--	3	6/25/82	15	0							CS	
sp82	K405-1:Y2	K19-1:Y2	no e	hi q	no f	6/22-5/82	--	3	6/25/82	15	0							CS	
sp82	K405-1:Y2	K19-1:Y2	no e	hi q	no f	6/22-6/82	--	3	6/25/82	15	0							CS	
sp82	K405-1:Y2	K19-1:Y2	no e	hi q	no f	6/25-6/82	--	5	6/30/82	15	0							CS	
sp82	K405-1:Y2	K340-2:Y2	no e	hi q	no f	7/9-10/82	--	5	7/14/82	15	0							CS	
sp82	K405-1:Y2	K340-2:Y2	no e	hi q	no f	7/9-8/82	--	5	7/14/82	15	0							CS	
sp82	K405-1:Y2	K340-2:Y2	no e	hi q	no f	7/9-9/82	--	5	7/14/82	15	0							CS	
sp83	K405-1:Y2	K19-1:Y2	no e	hi q	no f	6/17-3/83	--	3	6/20/82	15	0							CS	
sp83	K405-4:Y2	K19-1:Y2	no e	hi q	no f	6/17-4/83	--	3	6/20/82	15	0							CS	
sp83	K405-4:Y2	K19-1:Y2	no e	hi q	no f	6/17-5/83	--	7	6/24/82	15	0							CS	
sp83	K445-1:H	K75-2:H	no e	hi q	no f	7/13-2/83	7/19	9	7/22/83	15	1	1	0					CS	

shannoni x retusa

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
sr83	K445-1:H	K280-2?:H	no e	hi q	no f	9/2-7/83	--	5	9/7/83	10	0							CS	
sr84	K445-1:H	K502-2:H	no e	med q	no f	10/10-9/84	--	5	10/15/84	12	0							CS	
sr84	K445-1:H	K280-1:H	no e	hi q	no f	10/12-14/84	10/15	13	10/25/84	20	0							CS	
sr84	K445-1:H	K502-2:H	no e	hi q	no f	10/5-42/84	--	10	10/15/84	20	0							CS	
sr84	K445-1:H	K502-2:H	no e	med q	no f	10/5-43/84	--	10	10/15/84	4	0							CS	
sr84	K445-1:H	K502-2:H	no e	hi q	no f	11/16-6/84	--	4	11/20/84	15	0							CS	
sr84	K445-1:H	K502-2:H	no e	hi q	f	11/16-7/84	--	225	8/9/85	15	5	3	2	6	0	16	15.0	CS	1/8 SDS GREW
sr85	K445-1:H	K502-2:H	no e	hi q	no f	11/14-31/85	--	7	11/21/85	15	0							CS	
sr85	K445-1:H	K502-2:H	no e	hi q	no f?	11/14-34/85	11/21	175	5/8/86	12	1	0	1	0	0	16	12.5	CS	ABT
sr85	K445-1:H	K502-2:H	no e	hi q	no f	11/14-40a/85	--	7	11/21/85	17	0							CS	
sr85	K445-1:H	K502-2:H	no e	hi q	no f	11/14-40b/85	--	7	11/21/85	12	0							CS	
sr85	K445-1:H	K502-2:H	no e	hi q	no f	11/14-41/85	--	7	11/21/85	13	0							CS	
sr85	K445-1:H	K280-1:H	no e	med q	no f	11/4-47/85	--	7	11/11/85	15	0							CS	
sr85	K445-1:H	K280-1:H	no e	hi q	no f	11/4-48/85	--	7	11/11/85	15	0							CS	
sr85	K445-1:H	K280-1:H	no e	med q	no f	11/4-49/85	--	7	11/11/85	15	0							CS	
sr85	K445-1:H	K502-2:H	no e	hi q	no f	11/14-36/85	11/21	6	11/20/85	12	0							CS	

shannoni x trichodes

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
st83	K445-1:H	K90-2:Y2	no e	med q	no f	9/2-5/83	--	5	9/7/83	4	0							CS	LO ST#
st85	K445-1:H	K738-1:H	no e	med q	no f	11/19-1/85	--	6	11/25/85	10	0							CS	
st85	K445-1:H	K738-1:H	no e	hi q	no f	11/19-11a/85	--	6	11/25/85	10	0							CS	SLY
st85	K445-1:H	K738-1:H	no e	hi q	no f	11/19-11b/85	--	6	11/25/85	16	0							CS	
st85	K445-1:H	K738-1:H	no e	hi q	no f	11/19-15/85	--	6	11/25/85	13	0							CS	
st85	K445-1:H	K738-1:H	no e	hi q	no f	11/19-5/85	--	6	11/25/85	10	0							CS	
st85	K445-1:H	K738-1:H	no e	med q	no f	11/19-3/85	--	6	11/25/85	10	0							CS	

TRICHODES (FEMALE) CROSSES

trichodes selfs

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
t84	K738-1:H	same	no e	hi q	no f	10/19-8/84	--	6	10/25/84	14	0							CS	
t84	K738-1:H	same	no e	hi q	no f	10/19-9/84	--	6	10/25/84	15	0							CS	
t84	K738-1:H	same	no e	med q	no f	10/21-3/84	--	4	10/25/84	9	0							CS	LOW ST#
t84	K738-1:H	same	no e	med q	no f	10/19-7/84	--	6	10/25/84	8	0							CS	LOW ST#
t84	K738-1:H	same	no e	med q	no f	10/23-1/84	--	3	10/26/84	5	0							CS	
t84	K738-1:H	same	no e	hi q	no f	10/23-2/84	--	4	10/27/84	12	0							CS	
t84	K738-1:H	same	no e	hi q	no f	10/23-3/84	--	4	10/27/84	14	0							CS	

trichodes x collinsii

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
tc84	K738-1:H	K450-1:H	no e	med q?	no f	10/15-16/84	--	12	10/27/84	3	0							CS	LOW ST#
tc84	K738-1:H	K450-1:H	no e	med q	no f	10/15-19/84	--	10	10/25/84	8	0							CS	LOW ST#
tc85	K738-1:H	K450-1:H	no e	hi q	f	10/7-1/85	10/24	119	2/3/86	20	7	3	4	37	10	1	15.5	CS	GREEN PODS
tc85	K738-1:H	K450-1:H	no e	med q	f	10/7-2/85	10/24	141	2/25/86	10	3	1	2	0	0	17	13.0	CS	

trichodes x diversifolia ssp. diversifolia

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
td83	K738-1:H	k156-2:H	no e	hi q	no f	11/16-5/83	12/7	134	3/29/84	1	6	1	5	0	0	36	12.0	CS	T.C.?
td83	K738-1:H	k156-2:H	no e	hi q	no f	11/16-6/83	12/7	134	3/29/84	13	11	1	10	0	0	63	11.5	CS	T.C.
td83	K738-1:H	k156-2:H	no e	hi q	no f	11/16-4/83	12/7	134	3/29/84	10	2	0	2	0	0	11	13.5	CS	T.C.
td84	K736-1:H	K156-1:H	no e	hi q	no f	11/16-10/84	--	16	12/6/84	10	4	4	0					CS	
td84	K738-1:H	K156-1:H	no e	hi q	no f	11/16-21/84	--	134	3/29/84	10	9	6	3	0	0	28	12.5	CS	ALL ABT
td84	K738-1:H	K156-1:H	no e	hi q	no f	11/16-18/84	--	134	3/29/84	20	18	17	1	0	0	10	12.5	CS	T.C.?
td84	K738-1:H	K156-1:H	no e	hi q	no f	11/16-19/84	--	134	3/29/84	15	13	8	5	0	0	41	10.0	CS	T.C.?

trichodes x diversifolia ssp. trichandra

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
tz84	K738-1:H	B85-1:B2	no e	hi q??	no f	10/12-7/84	--	3	10/15/84	10	0							CS	STYLES POOR
tz85	K738-1:H	B85-?:B2	no e	hi q	f	10/7-1/85	10/24	141	2/25/86	15	8	4	4	0	0	41	13.5	CS	ALL ABT
tz85	K738-1:H	B85-?:B2	no e	hi q	f	11/6-10/85	11/11	89	2/3/86	13	3	1	2	5	3	0	12.0	CS	
tz65	K738-1:H	B85-?:B2	no e	hi q	f	10/7-2/85	10/24	141	2/25/86	15	15	8	7	0	0	60	14.0	CS	ALL ABT
tz85	K738-1:H	B85-?:B2	no e	hi q	f	11/6-11/85	11/11	89	2/3/86	13	3	1	2	4	2	0	8.0	CS	
tz85	K738-1:H	B85-?:B2	no e	med q	no f	11/6-12/85	--	5	11/11/85	10	0							CS	

trichodes x esculenta

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
te84	K738-1:H	K138-1:H	no e	hi q	no f	10/15-3/84	--	10	10/25/84	15	0							CS	LATE HRVST
te84	K738-1:H	K138-1:H	no e	hi q	no f	10/15-4/84	--	10	10/25/84	15	0							CS	LATE HRVST
te84	K738-1:H	K138-1:H	no e	hi q	no f	10/15-5/84	--	10	10/25/84	15	0							CS	LATE HRVST
te84	K738-1:H	K138-1:H	no e	med q?	no f	10/15-2/84	--	10	10/25/84	3	0							CS	LOW ST#

trichodes x lanceolata ssp. lanceolata

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
tn85	K739-1:H	K10-1:H	no e	hi q	f	10/4-3/85	10/24	151	3/4/86	15	9	5	4	0	35	1	13.5	CS	

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
tn85	K738-1:H	K10-1:H	no e	hi q	f	9/29-3/85	10/4	156	3/4/86	15	17	2	15	3	132	10	16.0	CS	
tn85	K738-1:H	K10-1:H	no e	hi q	f	10/4-4/85	10/24	151	3/4/86	17	13	9	4	0	29	4	13.0	CS	
tn85	K738-1:H	K10-2:H	no e	hi q	f	9/30-11b/85	10/4	155	3/4/86	20	16	10	6	3	42	22	15.5	CS	
tn85	K738-1:H	K10-2:H	no e	hi q	f	9/30-12/85	10/4	155	3/4/86	20	17	4	13	2	135	5	16.0	CS	
tn85	K738-1:H	K10-1:H	no e	hi q	f	10/4-2/85	10/24	15	10/19/85	15	5	5	0					CS	
tn85	K738-1:H	K10-2:H	no e	hi q	f	9/30-11a/85	10/4	155	3/4/86	15	12	8	4	0	12	21	14.0	CS	
tn85	K738-1:H	K10-2:H	no e	hi q	f	9/30-8/85	10/4	155	3/4/86	17	11	7	4	0	31	6	15.0	CS	
tn85	K738-1:H	K10-1:H	no e	hi q	f	10/4-1/85	10/24	151	3/4/86	16	13	1	12	8	71	40	16.0	CS	
tn85	K738-1:H	K10-1:H	no e	med q	f	9/29-6/85	10/4	156	3/4/86	15	5	1	4	41	5	0	16.0	CS	
tn85	K738-1:H	K10-1:H	no e	med q	f	9/29-1/85	10/4	156	3/4/86	5	2	2	0	1	17	7	15.5	CS	
tn85	K738-1:H	K10-2:H	no e	med q	f	9/30-10/85	10/4	155	3/4/86	8	7	4	3	2	11	12	15.5	CS	
tn85	K738-1:H	K10-1:H	no e	med q	f	9/29-2/85	10/4	156	3/4/86	5	2	0	2	0	17	3	16.5	CS	

trichodes x lanceolata ssp. sousae

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
tm83	K738-1:H	K393-1:H	no e	hi q	no f	11/16-10/83	12/7	133	3/29/84	15	15	4	11	0	0	99	11.0	CS	FLAT SEEDS
tm83	K738-1:H	K393-1:H	no e	hi q	no f	11/16-8/83	12/7	133	3/29/84	15	13	2	11	0	0	75	12.0	CS	FLAT SEEDS
tm83	K738-1:H	K393-1:H	no e	med q	no f	11/16-9/83	12/7	133	3/29/84	15	7	2	5	0	0	48	13.5	CS	T.C.
tm85	K738-1:H	K393-1:H	no e	hi q	f	10/8-1/85	10/24	118	2/3/86	15	15	0	15	100	23	2	13.5	CS	NICE
tm85	K738-1:H	K393-1:H	no e	hi q	f	10/8-7/85	10/24	4	10/12/85	10	0							CS	
tm85	K738-1:H	K393-1:H	no e	hi q	f	10/8-8/85	10/24	141	2/25/86	10	4	1	3	3	2	28	13.0	CS	
tm85	K738-1:H	K393-1:H	no e	hi q	f	10/8-5/85	10/24	148	3/4/86	15	6	4	2	0	10	9	15.0	CS	
tm85	K738-1:H	K393-1:H	no e	hi q	f	10/8-3/85	10/24	46	11/23/85	15	6	6	0					CS	
tm85	K738-1:H	K393-1:H	no e	hi q	f	10/8-2/85	10/24	46	11/23/85	15	1	1	0					CS	BROKEN?
tm85	K738-1:H	K393-1:H	no e	hi q	no f	10/8-6/85	10/24	16	10/24/85	15	0							CS	
tm85	K738-1:H	K393-1:H	no e	med q	no f	10/8-9/85	10/24	16	10/24/85	3	0							CS	
tm85	K738-1:H	K393-1:H	no e	med q	no f	10/8-10/85	10/24	16	10/24/85	3	0							CS	
tm85	K738-1:H	K393-1:H	no e	med q	no f	10/8-11/85	10/24	16	10/24/85	3	0							CS	

trichodes x leucocephala

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
tl83	K738-1:H	K500-10:Y2	no e	hi q	no f	11/28-7/83	12/7	121	3/29/84	15	15	0	3	0	0	27	10.5	CS	T.C.
tl83	K738-1:H	K500-10:Y2	no e	med q	no f	11/28-5/83	12/7	121	3/29/84	14	7	6	1	0	0	5	10.0	CS	ALL ABT
tl83	K738-1:H	K500-10:Y2	no e	med q	no f	11/28-6/83	12/7	121	3/29/84	14	7	3	4	0	0	20	10.0	CS	ALL ABT
tl83	K738-1:H	K500-10:Y2	no e	hi q	no f?	12/30-6/83	12/7	99	3/29/84	15	15	0	15	0	0	27	11.0	CS	
tl83	K738-1:H	K500-10:Y2	no e	med q	no f	11/28-8/83	12/7	121	3/29/84	9	7	2	5	0	0	19	10.0	CS	FLAT SEEDS

trichodes x macrophylla

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ta85	K738-1:H	K158-1:I	no e	hi q	no f	11/19-4/85	--	6	11/25/85	10	0							CS	GLY

trichodes x pallida

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ty84	K738-1:H	K376-10:I	no e	hi q	no f	10/12-2/84	--	3	10/15/84	15	0							CS	
ty84	K738-1:H	K376-10:I	no e	hi q?	no f?	10/12-1/84	--	3	10/15/84	15	0							CS	

trichodes x retusa

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
tr84	K738-1:H	K280-1:H	no e	hi q	no f	10/13-9/84	--	2	10/15/84	15	0							CS	

trichodes x shannoni

CROSS	FEMALE	MALE	EMAS	XQUAL	XFERT	XDATE	OBS	DAYS	PICKDT	ST#	POD	DRP	PIK	OK	BUG	ABT	CM	WHO	NOTES
ts85	K90-1:H	K445-1:H	no e	hi q	no f?	11/4-7/85	11/11	113	2/25/86	15	2	0	2	0	0	10	9.0	CS	
ts85	K736-1:H	K445-1:H	no e	hi q	no f	11/4-9/85	11/11	21	11/25/85	15	1	1	0					CS	
ts85	K736-1:H	K445-1:H	no e	hi q	no f	11/4-8/85	--	7	11/11/85	15	0							CS	
ts65	K738-1:H	K445-1:H	no e	hi q	f	11/4-11/85	11/11	91	2/3/86	15	6	3	3	10	13	0	14.0	CS	
ts85	K738-1:H	K445-1:H	no e	hi q	no f	11/4-12/85	--	7	11/11/85	14	0							CS	
ts85	K738-1:H	K445-1:H	no e	hi q	f	11/4-13/85	11/11	113	2/25/86	15	6	3	3	0	0	15	11.5	CS	TWIGS DIED?
ts85	K738-1:H	K445-1:H	no e	hi q	no f	11/4-15/85	--	7	11/11/85	15	0							CS	
ts85	K739-1:H	K445-1:H	no e	hi q	no f	11/4-14/85	--	7	11/11/85	15	0							CS	
ts85	K738-1:H	K445-1:H	no e	med q?	no f?	11/4-10/85	--	7	11/11/85	6	0							CS	
ts85	K738-1:H	K445-1:H	no e	med q?	no f?	11/4-9/85	--	7	11/11/85	6	0							CS	

Appendix 2b. Summary of Interspecific Crosses and Selfs, Sorted Alphabetically by Species Used as Female.

This appendix summarizes the individual pollinations listed in Appendix 2a. The abbreviations used for species, used under the heading **CROSS**, were explained in Table 11.

Explanations of other headings are as follows: **N** is the total number of flower heads pollinated. **F, Sa, Sp** and **So** are the numbers of pollinations of flower heads which could be categorized in one of four incompatibility classes; "F" produced viable-appearing seeds, "Sa" only produced abortive seeds, "Sp" had all of its developing pods abort prior to harvest, and "So" flower heads aborted without setting pods. **Fl** is the total number of florets (or stigmas) pollinated. **Pset, Poff** and **Ppik** are cumulative counts of the pods set, dropped and harvested. **Cm** is the mean length of the harvested pods. **Days** is the mean number of days from pollination to harvest. **Ok, Bug** and **Abt** are the mean numbers of viable, insect or fungal-infested and aborted seed. These were then calculated into percentiles and reported under **Ok %, Bug %** and **Abt %. Ppk/10F** is the calculated mean number of pods harvested for every 10 florets pollinated. **Gsd/F** is the expected (calculated) number of viable seeds per floret pollinated. **Poff** is the percentage of pods which prematurely aborted before harvest. **Fert** is a cumulative compatibility rating for each cross or self; "F" means at least one viable-appearing seed was harvested, "<F"

means less than one viable-appearing seed was produced on the average (calculated) after pollination of ten florets, "Sa" means only aborted seed was harvested, "Sp" means all pods which developed aborted before harvest, and "So" means no pods set following any pollinations. **Field** denoted whether the seeds harvested were germinated; "yes" means the resulting tree(s) are still alive in the field, "yes (d)" means all seedlings died after planting, "yes*" means the hybrids produced were of a higher ploidy than expected (based on the ploidy levels of the species hybridized), and "yes?" means final verification of the hybrid or self is lacking.

SUMMARY OF SELFS AND CROSSES

L. collinsii as female.

CROSS	N	F	Sa	Sp	So	Fl	Pset	Poff	Ppik	cm	Days	Ok	Bug	Abt	Ok	Bug	Abt	Ppk/10F	Gsd/F	Poff	Fert	Field
															%	%	%	%	%	%		
COL	35	0	1	0	34	467	1	0	1	14.5	232	0	0	14	0	0	100	0.02	0.00	0	Sa	yes?
COL DV4	7	0	5	0	2	93	49	10	39	11.9	166	0	0	594	0	0	100	4.19	0.00	20	Sa	
COL DV2	7	0	0	0	7	89	0														So	
COL ESC	8	0	1	0	7	75	19	0	19	12.5	106	0	0	214	0	0	100	2.53	0.00	0	Sa	
COL LAN	8	2	5	0	1	131	65	18	47	12.5	165	42	0	533	7	0	93	3.59	0.32	28	F	yes
COL LNS	16	0	6	3	7	258	88	49	39	13.1	212	0	0	421	0	0	100	1.51	0.00	56	Sa	yes
COL LEU	5	0	4	0	1	80	21	0	21	10.8	231	0	0	155	0	0	100	2.63	0.00	0	Sa	
COL MAC	4	2	0	0	2	55	6	0	6	12.3	245	55	8	6	80	11	9	1.09	1.15	0	F	
COL PAL	11	0	0	0	11	172	0														So	
COL PUL	1	0	0	0	1	5	0														So	
COL RET	15	0	0	0	15	190	0														So	
COL SHA	12	0	10	1	1	160	95	45	50	13.2	201	0	0	668	0	0	100	3.13	0.00	47	Sa	
COL TRI	4	0	2	0	2	56	5	0	5	14.5	146	0	0	51	0	0	100	0.89	0.00	0	Sa	
Averages										12.8	189					1		2.17	0.16	17		

L. diversifolia ssp. diversifolia as female.

CROSS	N	F	Sa	Sp	So	Fl	Pset	Poff	Ppik	cm	Days	Ok	Bug	Abt	Ok	Bug	Abt	Ppk/10F	Gsd/F	Poff	Fert	Field
															%	%	%	%	%	%		
DV4 COL	10	0	0	9	1	172	121	121	0											100	Sp	
DV4	31	7	0	11	13	471	186	138	48	11.7	99	781	24	15	95	3	2	1.02	1.71	74	F	yes
DV4 DV2	24	0	0	0	24	355	0														So	
DV4 ESC	2	0	0	0	2	25	0														So	
DV4 LAN	8	2	0	2	4	108	38	24	14	10.5	93	122	6	37	74	4	22	1.30	1.19	63	F	yes
DV4 LNS	7	0	0	0	7	105	0														So	
DV4 LEU	3	3	0	0	0	56	35	23	12	9.8	129	132	3	5	94	2	4	2.14	2.41	66	F	yes
DV4 MAC	4	0	0	2	2	60	3	3	0											100	Sp	
DV4 PAL	27	10	0	2	15	405	88	30	58	—	121	791	0	134	86	0	14	1.43	1.95	34	F	yes
DV4 PUL	10	0	0	0	10	140	0														So	
DV4 RET	5	0	0	0	5	80	0														So	
DV4 SHA	3	2	0	0	1	50	30	17	13	11.5	92	30	0	150	17	0	83	2.60	0.60	57	F	yes
DV4 TRI	2	0	0	0	2	30	0														So	
Averages										8.7	107					2		1.70	1.57	71		

SUMMARY OF SELFS AND CROSSES

L. *diversifolia* ssp. *trichandra* as female.

CROSS	N	F	Sa	Sp	So	Fl	Pset	Poff	Ppik	cm	Days	Ok	Bug	Abt	Ok	Bug	Abt	Ppk/10F	Gsd/F	Poff	Fert	Field
															%	%	%	%	%	%		
DV2 COL	18	9	0	3	6	330	195	109	86	10.7	140	829	87	30	88	9	3	2.61	2.78	56	F	yes
DV2 DV4	70	15	0	7	48	1056	217	139	78	—	264	602	0	526	53	0	47	0.74	0.57	64	F	yes
DV2	19	0	0	2	17	305	4	4	0											100	Sp	
DV2 ESC	10	0	0	0	10	140	0														So	
DV2 LAN	8	4	0	2	2	131	64	14	50	12.0	281	552	4	64	89	1	10	3.82	8.43	22	F	yes
DV2 LNS	9	3	0	0	6	125	27	7	20	11.3	336	202	41	5	81	17	2	1.60	1.94	26	F	yes
DV2 LEU	8	2	0	0	6	157	50	43	7	8.0	137	12	2	32	26	4	70	0.45	0.09	86	<F	yes
DV2 MAC	3	0	0	0	3	45	0														So	
DV2 PAL	14	0	0	0	14	205	0														So	
DV2 PUL	4	3	0	0	1	72	45	25	20	—	259	107	0	146	42	0	58	2.78	1.49	56	F	yes
DV2 RET	11	0	0	1	10	152	1	1	0											100	Sp	
DV2 SHA	11	6	0	3	2	176	108	41	67	7.8	214	460	52	36	84	9	7	3.81	2.91	38	F	yes
DV2 TRI	9	0	0	2	7	129	0														So	
Averages										7.1	233					6		2.26	2.60	61		

L. *esculenta* as female.

CROSS	N	F	Sa	Sp	So	Fl	Pset	Poff	Ppik	cm	Days	Ok	Bug	Abt	Ok	Bug	Abt	Ppk/10F	Gsd/F	Poff	Fert	Field
															%	%	%	%	%	%		
ESC COL	7	0	0	0	7	113	0														So	
ESC DV4	14	0	3	0	11	220	17	10	7	19.8	133	0	0	107	0	0	100	0.32	0.00	59	Sa	
ESC DV2	5	0	0	0	5	103	0														So	
ESC	9	0	0	0	9	145	0														So	yes
ESC LAN	10	0	0	0	10	170	0														So	
ESC LNS	12	0	0	0	12	203	0														So	
ESC LEU	4	0	4	0	0	65	46	34	12	15.3	120	0	0	114	0	0	100	1.85	0.00	74	Sa	yes
ESC MAC																					—	
ESC PAL	3	0	1	0	2	45	4	0	4	—	—	0	0	40	0	0	100	0.89	0.00	0	Sa	
ESC PUL																					—	
ESC RET	5	0	1	0	4	90	6	0	6	8.0	122	0	0	40	0	0	100	0.67	0.00	0	Sa	
ESC SHA	1	1	0	0	0	20	1	0	1	19.5	138	2	8	4	14	57	29	0.50	0.50	0	F	yes
ESC TRI	3	0	0	0	3	42	0														So	
Averages										12.5	103					11		0.85	0.10	27		

SUMMARY OF SELFS AND CROSSES

L. lanceolata ssp. *lanceolata* as female.

CROSS	N	F	Sa	Sp	So	Fl	Pset	Poff	Ppik	cm	Days	Ok	Bug	Abt	Ok	Bug	Abt	Ppk/10F	Gsd/F	Poff	Fert	Field
															%	%	%	%	%	%		
LAN COL	12	6	0	1	5	180	62	27	35	15.4	90	436	186	25	67	29	4	1.94	3.46	44	F	yes (d)
LAN DV4	12	1	1	0	10	171	21	15	6	11.5	83	2	2	96	2	2	96	0.35	0.02	71	<F	
LAN DV2	10	3	0	0	7	143	20	6	14	11.7	66	84	46	7	61	34	5	0.98	0.91	30	F	yes
LAN ESC	9	0	0	0	9	120	0														So	
LAN	12	0	1	0	11	176	1	0	1	6.5	—	0	0	5	0	0	100	0.06	0.00	0	Sa	yes?
LAN LNS	16	13	0	0	3	285	222	156	66	14.5	67	647	321	9	66	33	1	2.32	3.40	70	F	yes
LAN LEU	6	3	1	0	2	103	77	7	70	12.6	68	8	10	816	1	1	98	6.80	0.17	9	F	
LAN MAC																					—	
LAN PAL	10	0	0	0	10	164	0														So	
LAN FUL																					—	
LAN RET	5	0	0	0	5	70	0														So	
LAN SHA	6	2	0	0	4	83	32	3	29	13.5	62	333	40	8	87	11	2	3.49	4.49	9	F	yes
LAN TRI	11	1	0	0	10	140	2	0	2	13.0	66	2	18	7	7	67	26	0.14	0.14	0	F	
Averages										12.3	63					22		2.01	1.57	30		

L. lanceolata ssp. *sousae* as female.

CROSS	N	F	Sa	Sp	So	Fl	Pset	Poff	Ppik	cm	Days	Ok	Bug	Abt	Ok	Bug	Abt	Ppk/10F	Gsd/F	Poff	Fert	Field
															%	%	%	%	%	%		
LNS COL	8	7	0	0	1	174	126	57	69	17.1	113	299	522	11	36	63	1	3.97	4.72	45	F	yes
LNS DV4	8	0	1	0	7	198	13	0	13	16.0	146	0	0	119	0	0	100	0.66	0.00	0	Sa	
LNS DV2	13	0	0	2	11	207	6	6	0											100	Sp	
LNS ESC	7	(2)	0	0	5	124	16	0	16	15.8	122	0	70	48	0	59	41	1.29	0.56	0	F?	
LNS LAN	7	6	0	0	1	250	231	62	169	17.8	132	761	1866	143	28	67	5	6.76	10.51	27	F	yes
LNS	9	0	0	0	9	165	0														So	
LNS LEU	8	0	3	0	5	140	18	5	13	14.2	123	0	0	91	0	0	100	0.93	0.00	28	Sa	
LNS MAC	3	0	0	0	3	36	0														So	
LNS PAL	8	0	0	0	8	165	0														So	
LNS FUL	2	0	0	0	1	55	0														So	
LNS RET	9	0	0	0	9	160	0														So	
LNS SHA	10	8	0	1	1	284	210	66	144	15.1	109	371	1574	27	19	80	1	5.07	6.85	31	F	yes
LNS TRI	5	0	0	0	5	72	0														So	
Averages										16.0	124					45		3.11	3.77	33		

SUMMARY OF SELFS AND CROSSES

L. *leucocephala* as female.

CROSS	N	F	Sa	Sp	So	Fl	Pset	Poff	Ppik	cm	Days	Ok	Bug	Abt	Ok	Bug	Abt	Ppk/10F	Gsd/F	Poff	Fert	Field
															%	%	%	%	%	%		
LEU COL	11	5	0	5	1	165	83	64	19	15.5	88	35	178	139	10	51	39	1.15	1.29	77	F	yes (d)
LEU DV4	17	12	0	1	4	226	116	25	91	21.5	79	1471	626	42	69	29	2	4.03	9.28	22	F	yes
LEU DV2	9	1	5	0	3	142	33	7	26	16.0	80	0	8	223	0	3	97	1.83	0.06	21	<F	
LEU ESC	5	3	0	1	1	80	15	9	6	22.2	134	61	39	4	59	38	3	0.75	1.25	60	F	yes
LEU LAN	17	14	3	0	0	260	144	24	120	17.6	71	745	66	358	63	6	31	4.62	3.12	17	F	yes
LEU LNS	5	0	0	0	5	75	0														So	
LEU	8	7	0	0	1	101	60	6	54	20.4	83	214	1119	7	16	84	5	5.35	13.20	10	F	yes
LEU MAC	1	0	0	0	1	10	0														So	
LEU PAL	4	4	0	0	0	72	60	27	33	21.3	100	523	220	15	69	29	2	4.58	10.32	45	F	yes
LEU PUL	11	2	0	0	9	155	5	0	5	14.8	85	42	1	1	96	2	2	0.32	0.28	0	F	yes
LEU RET	5	3	0	0	2	75	6	0	6	23.8	96	90	9	5	86	9	5	0.80	1.32	0	F	yes
LEU SHA	17	17	0	0	0	252	143	13	130	23.8	79	2132	52	33	96	2	2	5.16	8.67	9	F	yes
LEU TRI	3	2	0	0	1	40	8	4	4	17.8	86	21	0	0	100	0	0	1.00	0.53	50	F	yes
Averages										19.5	89					23		2.69	4.48	28		

L. *pallida* as female.

CROSS	N	F	Sa	Sp	So	Fl	Pset	Poff	Ppik	cm	Days	Ok	Bug	Abt	Ok	Bug	Abt	Ppk/10F	Gsd/F	Poff	Fert	Field
															%	%	%	%	%	%		
PAL COL	14	2	0	0	12	233	16	12	4	9.3	156	5	3	8				0.17	0.03	75	<F	
PAL DV4	48	18	0	0	30	721	118	69	49	—	114	832	0	47	95	0	5	0.68	1.15	58	F	yes
PAL DV2	69	0	0	0	69	1008	0														So	
PAL ESC	13	0	0	1	12	266	1	1	0											100	Sp	
PAL LAN	14	0	0	4	10	300	10	10	0											100	Sp	
PAL LNS	16	0	0	2	14	277	14	14	0											100	Sp	
PAL LEU	14	2	0	3	9	254	17	13	4	10.0	124	0	21	2	0	91	9	0.16	0.08	76	F	yes
PAL MAC																					—	
PAL	7	0	0	0	7	126	0														So	
PAL PUL																					—	
PAL RET	11	0	0	0	11	200	0														So	
PAL SHA	19	3	1	3	12	323	24	15	9	12.4	85	29	11	56	30	12	58	0.28	0.12	63	F	yes (d)
PAL TRI	11	0	0	0	11	172	0														So	
Averages										7.9	120					34		0.32	0.35	82		

SUMMARY OF SELFS AND CROSSES

L. pulverulenta as female.

CROSS	N	F	Sa	Sp	So	Fl	Pset	Poff	Ppik	cm	Days	Ok	Bug	Abt	Ok	Bug	Abt	Ppk/10F	Gsd/F	Poff	Fert	Field
															%	%	%	%	%	%		
PUL COL	16	15	0	1	0	241	168	36	132	13.3	87	1377	428	67	73	23	4	5.48	7.49	21	F	yes
PUL DV4	11	7	0	0	4	165	50	17	33	12.7	91	250	167	9	59	39	2	2.00	2.53	34	F	yes
PUL DV2	3	0	0	0	3	45	0														So	
PUL ESC	1	0	0	0	1	15	0														So	
PUL LAN	11	11	0	0	0	165	152	29	123	13.3	83	920	1215	106	41	54	5	7.45	12.94	19	F	yes
PUL LNS	21	18	0	2	1	303	161	83	78	10.5	91	652	137	144	70	15	15	2.57	2.60	52	F	yes
PUL LEU	15	12	2	1	0	215	120	45	75	9.9	90	435	199	52	63	29	8	3.49	2.95	38	F	yes
PUL MAC	2	0	0	0	2	30	0														So	
PUL PAL																					—	
PUL	15	0	0	2	13	225	8	8	0											100	Sp	yes?
PUL RET	9	0	0	5?	0	130	61	61	0											100	Sp?	
PUL SHA	11	7	0	3	1	165	79	38	41	12.7	91	193	441	50	28	65	7	2.48	3.84	48	F	yes (d)
PUL TRI	1	1	0	0	0	15	1	0	1	10.0	144	8	0	11	42	0	58	0.67	0.53	0	F	
Averages										11.7	97					32		3.45	4.70	46		

L. retusa as female.

CROSS	N	F	Sa	Sp	So	Fl	Pset	Poff	Ppik	cm	Days	Ok	Bug	Abt	Ok	Bug	Abt	Ppk/10F	Gsd/F	Poff	Fert	Field
															%	%	%	%	%	%		
RET COL	3	3	0	0	0	55	25	4	21	14.8	110	232	9	6	94	4	2	3.82	4.38	16	F	yes
RET DV4	11	2	0	1	8	180	13	10	3	15.8	115	13	6	15	38	18	44	0.17	0.11	77	F	yes
RET DV2	9	1?	0	2	6	135	3	2	1	16.0	90	16	0	0	100	0	0	0.07	0.12	67	F?	
RET ESC	7	3	0	1	3	127	52	12	41	18.2	120	318	34	215	56	6	38	3.23	2.77	23	F	yes
RET LAN	10	2?	0	3	5	164	24	20	4	14.0	102	25?	4?	1	86	14	0	0.24	0.18	83	F	yes
RET LNS	15	0	0	2	13	280	2	2	0											100	Sp	
RET LEU	8	6	0	1	1	166	115	37	78	16.9	116	253	72	510	30	9	61	4.70	1.96	32	F	yes
RET MAC																					—	
RET PAL	10	5?	5	0	0	268	217	135	82	14.8	123	4?	117?	775				3.06	0.45	62	F	yes
RET PUL	2	2	0	0	0	35	20	7	13	16.8	95	169	0	7	96	0	4	3.71	4.83	35	F	yes
RET	14	3	0	0	11	289	8	3	5	11.0	111	40	5	1	87	11	2	0.17	0.16	38	F	yes?
RET SHA	5	5	0	0	0	145	119	44	75	15.8	126	878	172	14	83	16	1	5.17	7.24	37	F	yes
RET TRI	5	0	0	1	4	87	2	2	0											100	Sp	
Averages										15.4	111					9		2.43	2.22	56		

SUMMARY OF CROSSES

L. *shannoni* as female.

CROSS	N	F	Sa	Sp	So	Fl	Pset	Poff	Ppik	cm	Days	Ok	Bug	Abt	Ok	Bug	Abt	Ppk/10F	Gsd/F	Poff	Fert	Field
															%	%	%	%	%	%		
SHA COL	22	1?	1?	13	7	339	73	70	3	19.0	?	5?	0?	48	9	0	91	0.09	0.01	96	<F	
SHA DV4	23	1	0	7	15	343	26	24	2	12.5	188	4	4	20	14	14	72	0.06	0.02	92	<F	
SHA DV2	10	4	1	2	3	142	44	32	12	14.1	114	144	12	54	69	6	25	0.85	1.10	73	F	yes (d)
SHA ESC	15	0	0	1	14	194	2	2	0											100	Sp	
SHA LAN	32	11	1	14	6	483	160	123	37	12.9	141	559	36	35	89	6	5	0.77	1.23	77	F	yes
SHA LNS	19	1	1	6	11	285	43	33	10	14.0	129	38	0	25	60	0	40	0.35	0.13	77	F	
SHA LEU	14	0	0	10	4	210	84	84	0											100	Sp	
SHA MAC	1	0	0	1	0	15	1	1	0											100	Sp	
SHA PAL	14	10	2	1	1	199	49	19	30	13.3	134	134	14	309	29	3	69	1.51	0.74	39	F	yes (d)
SHA FUL	23	0	0	1	22	345	1	1	0											100	Sp	
SHA RET	16	1	1	0	14	222	6	3	3	13.8	200	6	0	32	16	0	84	0.14	0.03	50	F	yes
SHA	18	0	0	0	18	268	0														So	yes?
SHA TRI	7	0	0	0	7	73	0														So	
Averages										14.2	129					4		0.54	0.47	82		

L. *trichodes* as female.

CROSS	N	F	Sa	Sp	So	Fl	Pset	Poff	Ppik	cm	Days	Ok	Bug	Abt	Ok	Bug	Abt	Ppk/10F	Gsd/F	Poff	Fert	Field
															%	%	%	%	%			
TRI COL	4	1	1	0	2	41	10	4	6	14.3	130	37	10	18	57	15	28	1.46	1.15	40	F	
TRI DV4	7	0	6	1	0	79	63	37	26	12.0	134	0	0	189	0	0	100	3.29	0.00	59	Sa	
TRI DV2	6	4	0	0	2	76	29	14	15	11.9	115	9	5	101	8	4	88	1.97	0.18	48	F	
TRI ESC	4	0	0	0	4	48	0														So	
TRI LAN	13	12	0	0	1	183	129	58	71	15.2	154	60	537	131	8	74	18	3.88	3.26	45	F	yes
TRI LNS	13	3	3	2	5	149	67	20	47	13.0	134	103	35	261	26	9	65	3.15	0.93	30	F	yes
TRI LEU	5	0	5	0	0	67	51	11	28	10.3	117	0	0	98	0	0	100	4.18	0.00	22	Sa	
TRI MAC	1	0	0	0	1	10	0														So	
TRI PAL	2	0	0	0	2	30	0														So	
TRI FUL																					—	
TRI RET	1	0	0	0	1	15	0														So	
TRI SHA	10	1	2	1	6	131	15	7	8	11.5	106	10	13	25	21	27	52	0.61	0.18	47	F	
TRI	7	0	0	0	7	77	0														So	
Averages										12.6	127					18		2.65	0.81	42		

Appendix 3. Psyllid Resistance of *Leucaena* Species and Hybrids.

This appendix contains an article by Sorensson and Brewbaker (1987) which was published in "Leucaena Research Reports" Vol 7(2):29-31. This article describes the range of psyllid resistance based on damage and populations of psyllids of twelve *Leucaena* species and 51 verified interspecific hybrids. *L. diversifolia* ssp. *diversifolia* K156 x *L. lanceolata* ssp. *sousae* K385 was later ascertained to be invalid; all other hybrids have been verified.

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PSYLLID RESISTANCE OF LEUCAENA HYBRIDS AND SPECIES

Resistance to the leucaena psyllid has been observed in many locations. A thorough evaluation of resistance is the subject of an ongoing project of NFTA, through support of USAID. Summarized here are preliminary observations from U. Hawaii nurseries (899 accesssions of 12 *Leucaena* spp. and several unidentified taxa.

The leucaena psyllid was first observed in Hawaii in April 1984 and was epibiotic throughout the islands within a few months (Sorensson and Brewbaker, 1984). At that time, resistance was evident among species such as *L. collinsii*, *L. esculenta*, *L. pallida* and *L. retusa*. While some provenances of generally susceptible species appeared moderately tolerant, even these were completely defoliated and had some dieback (e.g., K156 *L. diversifolia* 4n). Severe defoliation was especially notable in the dry season of 1985 (April-Sept.), and many trees suffered dieback, rarely severe enough to kill the tree. During the wet winter season, biological control, particularly by *Curinus coeruleus* Mulsant ladybird beetles, increased greatly. Most susceptible lines of leucocephala resprouted, although some died.

The following observations were taken largely in the summer of 1986 (Table 1). Psyllid populations were high but predation was adequate to allow near-normal tree growth of moderately or highly resistant trees. Most scores were made from flowering trees over one year old. An empirical 1-9 score was applied integrating observations on psyllid populations, reproduction, and damage on young vegetative shoots, where:

- 1-3 = highly resistant
- 4-6 = intermediate, some evidence of damage
- 7-9 = susceptible and often severely damaged

Table 1. Psyllid ratings for *Leucaena* species.

Species	Rating	Provenances	Comments
L. collinsii	1-2	12	Excellent resistance
L. diversifolia 2n	3-7	32	Generally resistant
L. " 4n	4-9	39	Some highly damaged
L. esculenta	1-4	51	Some damaged while young
L. greggii	3-7	31	Susceptible or tolerant
L. lanceolata	5-8	35	" "
L. " sousae*	4-6	7	" "
L. leucocephala	5-9	531	" "
L. macrophylla	4-7	13	" "
L. pallida	1-2	18	Excellent resistance
L. pulverulenta	6-9	16	Heavily damaged
L. retusa	2-5	15	Tolerant or resistant
L. shannoni	4-6	21	Susceptible or tolerant
L. trichodes	4-7	24	" "

* The arboreal subspecies.

All accessions of *L. collinsii* and *L. pallida* at the U. Hawaii were highly resistant. Seedlings of some accessions of *L. esculenta* were heavily damaged but later developed strong resistance. *L. retusa* appeared to have high resistance, although its hybrid with *L. diversifolia* 4n had poorer resistance than expected (Table 2). Our *L. macrophylla* provenances are young trees, but many had good resistance.

Our observations compare favorably with earlier reports of the psyllid resistance of the species. The high tolerance of *L. diversifolia* (both 2n and 4n) was verified in Taiwan (F.J. Pan, unpublished) and the Philippines, and that of *L. collinsii* was verified by Hollingsworth et al. (1985). Othman and Prine (1984) recorded psyllid damage on 373 accessions grown in Florida, using a 0-10 scale in Sept. 1983. Mean damage ratings of the species ranged from 0.3 for 3 plots of *L. pulverulenta* to 4.4 for 512 plots of *L. leucocephala*. As psyllids were recent arrivals in Florida it is possible that infestation pressures were still low. Even so, it is difficult to account for the discrepancies between our two sets of data; we identified *L. esculenta* as resistant and *L. pulverulenta* as susceptible and they reported the reverse (3.2 and 0.3). Both species have occasionally been misidentified; potentially they had some *L. leucocephala* as "*L. esculenta*" and *L. diversifolia* 2n as "*L. pulverulenta*".

The best *L. leucocephala* lines in Othman and Prine's (1984) study included K2 (0.5), K26 (0.0), K40 (0.0), K43, 46 and 47 (0.5), K53 (0.0), K83 (0.5) and K98 (0.5) in addition to PI384519 (0.5) and PI443539 (0.0). The lines that Othman and Prine found highly resistant were susceptible in Hawaii. In Hawaii our most resistant lines have been K527, K537, K538, K584, K591, K636, K656 and K658 (all giants from N.E. Mexico except for K584 from Veracruz).

Psyllid ratings on interspecific hybrids are listed in Table 2. Resistance was generally intermediate to that of the parent provenances (although *L. pulverulenta* x *L. diversifolia* 4n exhibited heterosis for resistance). General combining ability was highest for the resistant species *L. collinsii*, *L. esculenta* and *L. pallida* (2.8, 3.0 and 3.3). In some instances different crosses of the same species hybrids differed in resistance, as expected from the ranges of resistance displayed within the species (Table 1).

Of the hybrids in Table 2, several show promise due to their psyllid resistance and vigor. The tetraploid hybrids are all excellent, although most *L. leucocephala* x *L. diversifolia* have damage. Advanced progenies of this hybrid have segregated for resistance (F.J. Pan, unpublished). Moreover, we have produced new hybrids with resistant *L. leucocephala* K636 x *L. diversifolia* 4n and these should be superior to present hybrids. In particular, the hybrid of *L. leucocephala* x *L. pallida* looks promising. It is a large, spreading tree with heavy leaf production.

Some diploid and triploid hybrids also look promising although seed production may be a problem. Two seedless triploids, *L. leucocephala* x *L. esculenta* and *L. pulverulenta* x *L. diversifolia* are particularly fast-growing and have resistance. *L. diversifolia* 2n x *L. leucocephala* has also been outstanding. It produces some seed and has been used in acid-tolerance breeding by Dr. E.M. Hutton. The diploids are often quite variable in growth. L. diversifolia 2n x L. collinsii is highly resistant but lanky, and L. collinsii x L. lanceolata is also resistant but somewhat shrubby. L. collinsii, L. diversifolia 2n, L. lanceolata ssp. sousae and L. macrophylla have produced the best hybrids (all of these species are interfertile).

Table 2. Psyllid ratings of 53 Leucaena species hybrids on a 1-9 scale. Chromosome numbers (2n) are given in the table heading. Mean species ratings are in parentheses.

Female \ Male	COL 52	DIV 52	DIV 104	ESC 52	GRE 56?	LAN 52	LNS 52	LEU 104	MAC 52	PAL 104	PUL 56	RET 56	SHA 52	TRI 52	G.C.A.
L. collinsii	(1)					2	3								2.5
L. diversif. 2n	2	(5)	5			6	6	6					8		5.5
L. diversif. 4n			(6)			8	5	6		3			5		5.4
L. esculenta				(2)				3					3		3.0
L. greggii					(5)										-
L. lanceolata	3	6				(7)	5						5		4.8
L. lanc. sousae	3					5	(5)						4		4.0
L. leucocephala	3		6	3		7		(7)		4	7	5	6	6	5.2
L. macrophylla		3							(4)						3.0
L. pallida			3							(2)			5		4.0
L. pulverulenta	3		2			9	8	9			(8)		6		6.2
L. retusa	3		7	3				7		3	6	(4)	4		4.7
L. shannoni		6				6						4	(5)		5.3
L. trichodes						6	6							(6)	6.0
G.C.A.*	2.8	6.0	4.6	3.0	-	6.1	5.5	6.2	-	3.3	6.5	4.5	5.1	6.0	

* General Combining Ability = Mean of all hybrids of this parent as male or female.

The mechanisms and genetics of resistance are not yet understood. Resistance is not well-correlated to twig pubescence, flower size or color, leaflet size, mimosine or chromosome number. However, in the case of L. esculenta (and L. pallida which is a species derived from L. esculenta and L. diversifolia) there is a sticky leaf exudate which is probably related to resistance. It may be mechanical in that it coats the young leaves. Following heavy rainfalls, leaves which do not have the coating may be attacked by psyllids. However, L. collinsii does not have the exudate and therefore has a different mechanism of resistance. The resistance of L. retusa is not understood, but the tree is slow-growing and generally has little succulent tissue.

L. leucocephala is the major leucaena of commerce and immediate interest is focusing on its resistance and genes easily transferred into it. Wood production may not be affected significantly by psyllids although damage on leucaenas cut for fodder should continue to be a major problem.

References:

Hollingsworth, R.G., R.I. Thomas and W. Liebregts. 1985. New psyllid pest on leucaena in Western Samoa. LRR 6:100-102.
Othman, A.B. and G.M. Prine. 1984. Leucaena accessions resistant to jumping plant lice. LRR 5:86-87.
Sorensson, C.T. and J.L. Brewbaker. 1984. Newly introduced psyllid in Hawaii injurious to leucaena. LRR 5:91-93.

Appendix 4. Leaf Traits of Interspecific Hybrids.

Appendix 4a. Data.

Appendix 4a lists the data of 50 interspecific Leucaena hybrids and their parents for numbers of leaflets per pinna (Table 47), numbers of pinnae per leaf (Table 48), leaflet length (Table 49) and leaflet width (Table 50). Parental species which do not differ significantly for leaf traits are asterisked (*).

Appendix 4b. Graphs of Leaf Data of Parents and Hybrids.

Appendix 4b contains ten plates (16-26) of graphs of natural log data of 19 diploid species hybrids, 7 triploid species hybrids and 4 tetraploid species hybrids. All graphs show the hybrid plotted between the parents; the parent with the large leaflets and fewer leaflets per pinna is always placed at the far left. Those species combinations not presented in the direction of the cross (female x male) are denoted with a dot.

All plates follow the same format. Each plate is composed of seven subfigures, labeled a-g:

a. Leaflets per pinna.
b. Pinnae per leaf.
c. Leaflets per leaf.
d. Leaflet length in cm.
e. Leaflet width in cm.
f. Leaflet area in cm^2.
g. Leaf area in cm^2.

Data for graphs c, f and g were derived as described in Chapter 3.

Table 47. -- Actual and predicted number of leaflets/pinna of 50 interspecific Leucaena hybrids, data of parental species, and percentage that the actual data exceeds (+) or underestimates (-) the expected data.

X	Parents of Hybrid P1 Female	P2 Male	Plate # /Code	Means and Standard Dev. P1	F1	P2	Exp.	%
2x	COL K185	LAN K264	16 CN	94.6±1.65	37.4±1.90	10.4±0.84	31.4	+ 16
2x	COL K450	LNS K393	19 CM	94.6±1.65	18.0±1.05	13.6±1.26	35.9	-199
2x	DV2 K409	COL K185	16 ZC*	95.6±2.46	113.1±5.42	94.6±1.65	95.1	+ 16
2x	DV2 B85	LAN K10	15 ZN	95.6±2.46	36.6±2.50	10.4±0.84	31.5	+ 14
2x	DV2 B85	LNS K393	18 ZM	95.6±2.46	39.6±2.31	13.6±1.26	36.1	- 9
2x	DV2 K409	PUL K19	18 ZP	95.6±2.46	115.0±5.98	132.2±5.03	112.4	+ 2
2x	DV2 K409	SHA K405	-- ZS	95.6±2.46	43.2±1.40	20.0±1.89	43.7	- 1
2x	ESC K138	SHA K445	15 ES	163.4±3.53	65.2±4.03	20.0±1.89	57.2	+ 12
2x	LAN K10	DV2 B85	17 NZ	10.4±0.84	36.2±2.39	95.6±2.46	31.5	+ 13
2x	LAN K10	LNS K393	-- NM	10.4±0.84	9.4±0.97	13.6±1.26	11.9	- 27
2x	LAN K10	SHA K445	17 NS	10.4±0.84	17.8±0.63	20.0±1.89	14.4	+ 19
2x	LNS K393	COL K450	17 MC	13.6±1.26	27.3±0.99	94.6±1.65	35.9	- 32
2x	LNS K393	LAN K10	-- MN	13.6±1.26	10.4±0.84	10.4±0.84	11.9	- 14
2x	LNS K393	SHA K445	16 MS	13.6±1.26	15.7±1.50	20.0±1.89	16.5	- 5
2x	MAC K158	DV2 K--	20 AZ	10.0±0.94	32.6±0.97	100.0±2.46	31.6	+ 3
2x	MAC K158	LNS?K--	-- AM?	10.0±0.94	10.8±1.48	13.6±1.26	11.7	- 8
2x	PUL K19	COL K450	15 PC	132.2±5.03	116.4±1.26	94.6±1.65	111.8	+ 4
2x	PUL K19	LAN K10	-- PN	132.2±5.03	33.4±0.97	10.4±0.84	37.1	- 11
2x	PUL K19	LNS K393	-- PM	132.2±5.03	34.0±0.94	13.6±1.26	42.4	- 25
2x	RET K280	ESC K138	18 RE	14.6±0.97	50.2±1.14	163.4±3.53	48.8	+ 3
2x	RET K280	LAN K10	-- RN	14.6±0.97	13.0±1.11	10.4±0.84	12.3	+ 5
2x	RET K502	PUL K881	19 RP	13.0±1.41	46.8±4.24	125.8±9.31	40.4	+ 14
2x	RET K280	SHA K445	-- RS	14.6±0.97	15.0±1.05	20.0±1.89	17.1	- 14
2x	SHA K405	LAN K264	17 SN	20.0±1.89	17.2±1.03	10.4±0.84	14.4	+ 16
2x	SHA K445	RET K280	18 SR	20.0±1.89	19.6±1.83	14.6±0.97	17.1	+ 13
2x	TRI K738	LNS K393	15 TM	6.9±0.87	9.4±0.97	13.6±1.26	9.7	- 3
2x	TRI K738	LAN K10	16 TN	6.9±0.87	8.0±0.94	10.4±0.84	8.5	- 6
3x	DV2 K409	DV4 K156	-- ZD	95.6±2.46	111.6±3.50	139.4±2.32	122.9	- 10
3x	DV2 K11	LEU K8	22 ZL	95.6±2.46	50.3±2.86	33.2±1.69	47.2	+ 6
3x	DV4 K156	LAN K10	-- DN	139.4±2.32	58.8±1.93	10.4±0.84	58.7	+ 0
3x	DV4 K156	SHA K445	-- DS	139.4±2.32	70.4±2.63	20.0±1.89	73.0	- 4
3x	ESC K898	LEU --	-- EL	167.2±9.56	59.6±1.26	36.2±1.14	60.3	- 1
3x	LEU K8	COL K183	-- LC	33.2±1.69	36.8±1.40	94.6±1.65	47.1	- 28
3x	LEU K8	ESC K138	22 LE	33.2±1.69	58.4±2.07	163.4±3.53	56.5	+ 3
3x	LEU K8	LAN K264	23 LN	33.2±1.69	23.4±2.12	10.4±0.84	22.5	+ 4
3x	LEU K614	PUL K75	22 LP	33.2±1.69	54.4±1.58	132.2±5.03	52.6	+ 3
3x	LEU K8	RET K280	-- LR	33.2±1.69	28.8±1.93	14.6±0.97	25.2	+ 13
3x	LEU K8	SHA K405	23 LS	33.2±1.69	26.0±1.99	20.0±1.89	28.0	- 8
3x	LEU K8	TRI K738	23 LT	33.2±1.69	20.8±1.40	6.9±0.87	19.7	+ 5
3x	PUL K19	DV4 K156	-- PD*	132.2±5.03	130.6±1.74	139.4±2.32	137.0	- 5
3x	PUL K19	LEU K--	-- PL	132.2±5.03	52.2±1.14	33.2±1.69	52.6	- 1
3x	PAL K376	SHA K445	24 YS	114.2±4.26	37.0±3.75	20.0±1.89	63.9	- 73
3x	RET K280	LEU K500	-- RL	14.6±0.97	26.8±1.69	33.2±1.69	25.2	+ 6
4x	DV4 K156	LEU K8	25 DL	139.4±2.32	70.8±3.91	33.2±1.69	68.0	+ 4
4x	DV4 K165	PAL K376	25 DY	139.4±2.32	127.0±8.18	114.2±4.26	126.2	+ 1
4x	LEU K8	DV4 K156	25 LD	33.2±1.69	73.0±3.91	139.4±2.32	68.0	+ 7
4x	LEU K8	PAL K376	-- LY	33.2±1.69	73.4±1.90	114.2±4.26	61.6	+ 16
4x	PAL K376	DV4 K165	25 YD	114.2±4.26	132.6±1.90	139.4±2.32	126.2	+ 5
4x	RET K280	DV4 K156	-- RD	14.6±0.97	51.8±1.48	139.4±2.32	45.1	+ 13
4x	RET K280	PAL K376	-- RY	14.6±0.97	38.8±1.03	114.2±4.26	40.8	- 5

* No significant difference between data of parental species.

Table 48. -- Actual and predicted numbers of pinnae/leaf of 50 interspecific Leucaena hybrids, data of parental species, and the percentage that the actual data exceeds (+) or underestimates (-) the expected data.

X	Parents of Hybrid P1 Female	P2 Male	Plate # /Code	Means and Standard Dev. P1	F1	P2	Exp.	%
2x	COL K185	LAN K264	16 CN	25.2±3.0	18.2±1.8	7.4±0.9	13.7	+ 25
2x	COL K450	LNS K393	19 CM	25.2±3.0	6.0±0.9	8.2±1.7	14.4	- 140
2x	DV2 K409	COL K185	16 ZC	41.4±7.0	32.2±5.4	25.2±3.0	32.3	- 0
2x	DV2 B85	LAN K10	15 ZN	41.4±7.0	17.8±0.6	8.0±0.9	18.2	- 2
2x	DV2 B85	LNS K393	18 ZM	41.4±7.0	20.0±1.4	8.2±1.8	18.4	+ 8
2x	DV2 K409	PUL K19	18 ZP*	41.4±7.0	38.0±5.2	30.8±3.5	35.7	+ 6
2x	DV2 K409	SHA K405	-- ZS	41.4±7.0	17.8±1.2	9.8±2.0	20.1	- 13
2x	ESC K138	SHA K445	15 ES	90.2±9.7	22.2±3.0	9.8±2.0	29.7	- 34
2x	LAN K10	LNS K393	-- NM*	8.0±0.9	8.6±0.5	8.2±1.8	8.1	+ 6
2x	LAN K10	SHA K445	17 NS*	8.0±0.9	9.4±1.1	9.8±2.0	8.9	+ 6
2x	LAN K10	DV2 B85	17 NZ	8.0±0.9	19.4±1.7	41.4±7.0	18.2	+ 7
2x	LNS K393	COL K450	17 MC	8.2±1.8	6.6±1.1	25.2±3.0	14.4	- 118
2x	LNS K393	LAN K10	-- MN*	8.2±1.8	8.2±0.3	8.0±0.9	8.1	+ 1
2x	LNS K393	SHA K445	16 MS*	8.2±1.8	8.8±1.5	9.8±2.0	9.0	- 2
2x	MAC K158	DV2 K--	20 AZ	6.0±1.6	14.4±2.1	41.4±7.0	15.8	- 10
2x	MAC K158	LNS?K--	-- AM?	6.0±1.6	6.0±0.0	8.2±1.8	7.0	- 17
2x	PUL K19	COL K450	15 PC*	30.8±3.5	35.8±4.8	25.2±3.0	27.9	+ 22
2x	PUL K19	LAN K10	-- PN	30.8±3.5	15.8±2.0	8.0±0.9	15.7	+ 1
2x	PUL K19	LNS K393	-- PM	30.8±3.5	14.6±1.7	8.2±1.8	15.9	- 9
2x	RET K280	ESC K138	18 RE	10.0±0.0	36.0±4.2	90.2±9.7	30.0	+ 20
2x	RET K280	LAN K10	-- RN	10.0±0.0	11.2±1.0	8.0±0.9	8.9	+ 26
2x	RET K502	PUL K881	19 RP	9.0±1.0	17.6±1.6	36.2±2.7	18.0	- 2
2x	RET K280	SHA K445	-- RS*	10.0±0.0	9.4±1.0	9.8±2.0	9.9	- 5
2x	SHA K405	LAN K264	17 SN*	9.8±1.9	10.4±1.9	7.4±1.0	8.5	+ 22
2x	SHA K445	RET K280	18 SR*	9.8±1.9	11.6±2.4	10.0±0.0	9.9	+ 17
2x	TRI K738	LAN K10	16 TN	4.2±0.6	7.2±1.1	8.0±0.9	5.8	+ 24
2x	TRI K738	LNS K393	15 TM	4.2±0.6	7.4±1.1	8.2±1.8	5.9	+ 25
3x	DV2 K409	DV4 K156	-- ZD	41.4±7.0	25.0±2.2	61.8±4.2	54.1	- 116
3x	DV2 K11	LEU K8	22 ZL	41.4±7.0	21.6±1.6	17.0±1.5	22.9	- 6
3x	DV4 K156	LAN K10	-- DN	61.8±4.2	27.4±2.8	8.0±0.9	31.3	- 14
3x	DV4 K156	SHA K445	-- DS	61.8±4.2	27.4±2.5	9.8±2.0	33.5	- 22
3x	ESC K898	LEU K--	-- EL	72.5±9.8	29.4±3.0	14.0±2.2	24.2	+ 21
3x	LEU K8	COL K183	-- LC	17.0±1.5	4.5±0.7	25.2±3.0	19.4	- 331
3x	LEU K8	ESC K138	22 LE	17.0±1.5	28.8±1.7	90.2±9.7	29.7	- 3
3x	LEU K8	LAN K264	23 LN	17.0±1.5	13.0±1.2	8.0±0.8	13.2	- 2
3x	LEU K614	PUL K75	22 LP	17.0±1.5	23.4±2.1	30.8±3.5	20.7	+ 13
3x	LEU K8	RET K280	-- LR	17.0±1.5	15.8±0.7	10.0±0.0	14.2	+ 11
3x	LEU K8	SHA K405	23 LS	17.0±1.5	13.0±1.5	9.8±2.0	14.1	- 8
3x	LEU K8	TRI K738	23 LT	17.0±1.5	12.0±0.8	4.2±0.6	10.7	+ 12
3x	PAL K376	SHA K445	24 YS	35.8±2.6	4.0±3.8	9.8±2.0	23.2	- 480
3x	PUL K19	DV4 K156	-- PD	30.8±3.5	52.0±2.2	61.8±4.2	49.0	+ 6
3x	PUL K19	LEU K--	-- PL	30.8±3.5	19.4±1.9	17.0±1.5	20.7	- 7
3x	RET K280	LEU K500	-- RL	10.0±0.0	14.8±0.5	17.0±1.5	14.2	+ 4
4x	DV4 K156	LEU K8	25 DL	61.8±4.2	29.0±1.7	17.0±1.5	32.4	- 12
4x	DV4 K165	PAL K376	25 DY	61.8±4.2	47.2±6.5	35.8±2.6	47.0	+ 0
4x	LEU K8	DV4 K156	25 LD	17.0±1.5	29.4±3.4	61.8±4.2	32.4	- 10
4x	LEU K8	PAL K376	-- LY	17.0±1.5	30.0±2.5	35.8±2.5	24.7	+ 21
4x	PAL K376	DV4 K165	25 YD	35.8±2.6	53.2±5.0	61.8±4.2	47.0	+ 13
4x	RET K280	DV4 K156	-- RD	10.0±0.0	22.6±3.8	61.8±4.2	24.9	- 9
4x	RET K280	PAL K376	-- RY	10.0±0.0	23.6±2.3	35.8±2.6	18.9	+ 52

* No significant difference between data of parental species.

Table 49. -- Actual and predicted leaflet length (cm) of 50 interspecific <u>Leucaena</u> hybrids, data of parental species, and percentage that the actual data exceeds (+) or underestimates (-) the expected data.

X	Parents of Hybrid P1 Female	P2 Male	Plate # /Code	Means and Standard Dev. P1	F1	P2	Exp.	%
2x	COL K185	LAN K264	16 CN	0.835±0.045	1.657±0.083	3.641±0.279	1.744	- 5
2x	COL K450	LNS K393	19 CM	0.835±0.046	2.102±0.124	3.565±0.289	1.725	+ 18
2x	DV2 K409	COL K185	16 ZC	0.337±0.051	0.705±0.030	0.835±0.045	0.530	+ 25
2x	DV2 B85	LAN K10	15 ZN	0.337±0.051	0.921±0.048	3.815±0.306	1.134	- 23
2x	DV2 B85	LNS K393	18 ZM	0.337±0.051	1.661±0.099	3.565±0.289	1.096	+ 34
2x	DV2 K409	PUL K19	18 ZP	0.337±0.051	0.393±0.035	0.454±0.017	0.391	- 1
2x	DV2 K409	SHA K405	-- ZS	0.337±0.051	1.088±0.035	1.857±0.083	0.791	+ 38
2x	ESC K138	SHA K445	15 ES	0.634±0.016	1.357±0.097	1.857±0.083	1.085	+ 25
2x	LAN K10	LNS K393	-- NM*	3.815±0.306	2.559±0.204	3.565±0.289	3.688	- 44
2x	LAN K10	SHA K445	17 NS	3.815±0.306	1.860±0.107	1.857±0.083	2.662	- 43
2x	LAN K10	DV2 B85	17 NZ	3.815±0.306	0.869±0.025	0.337±0.051	1.134	- 23
2x	LNS K393	COL K450	17 MC	3.565±0.289	1.452±0.087	0.835±0.046	1.725	- 19
2x	LNS K393	LAN K10	-- MN*	3.565±0.289	2.962±1.193	3.815±0.306	3.688	- 25
2x	LNS K393	SHA K445	16 MS	3.565±0.289	2.598±0.137	1.857±0.083	2.573	+ 1
2x	MAC K158	DV2 K--	20 AZ	5.151±0.443	1.568±0.089	0.337±0.051	1.318	+ 19
2x	MAC K158	LNS?K--	-- AM?	5.151±0.443	3.998±0.140	3.565±0.289	4.285	- 7
2x	PUL K19	COL K450	15 PC	0.454±0.017	0.561±0.012	0.835±0.046	0.616	- 10
2x	PUL K19	LAN K10	-- PN	0.454±0.017	1.295±0.096	3.815±0.306	1.316	- 2
2x	PUL K19	LNS K393	-- PM	0.454±0.017	1.157±0.050	3.565±0.289	1.272	- 10
2x	RET K280	ESC K138	18 RE	2.151±0.111	0.984±0.039	0.634±0.016	1.168	+ 19
2x	RET K280	LAN K10	-- RN	2.151±0.111	2.152±0.150	3.815±0.306	2.865	- 33
2x	RET K502	PUL K881	19 RP	2.435±0.152	1.043±0.057	0.474±0.024	1.074	- 3
2x	RET K280	SHA K445	-- RS	2.151±0.111	1.683±0.049	1.857±0.083	1.999	- 19
2x	SHA K405	LAN K264	17 SN	1.857±0.083	2.306±0.129	3.641±0.279	2.600	- 13
2x	SHA K445	RET K280	18 SR	1.857±0.083	2.029±0.061	2.277±0.102	2.056	- 1
2x	TRI K738	LAN K10	16 TN*	4.409±0.327	3.518±0.300	3.815±0.306	4.101	- 17
2x	TRI K738	LNS K393	15 TM	4.409±0.327	5.157±0.462	3.565±0.289	3.965	+ 23
3x	DV2 K409	DV4 K156	-- ZD	0.337±0.051	0.417±0.017	0.547±0.020	0.465	- 12
3x	DV2 K11	LEU K8	22 ZL	0.337±0.051	1.177±0.060	1.622±0.083	0.961	+ 22
3x	DV4 K156	LAN K10	-- DN	0.547±0.020	0.779±0.036	3.815±0.306	1.045	- 34
3x	DV4 K156	SHA K445	-- DS	0.547±0.020	0.700±0.036	1.857±0.083	0.822	- 17
3x	ESC K898	LEU K--	-- EL	0.303±0.013	1.114±0.063	1.242±0.058	0.776	+ 30
3x	LEU K8	COL K183	-- LC	1.622±0.083	1.259±0.047	0.835±0.045	1.300	- 3
3x	LEU K8	ESC K138	22 LE	1.622±0.083	1.080±0.046	0.634±0.016	1.186	- 10
3x	LEU K8	LAN K264	23 LN	1.622±0.083	1.608±0.136	3.815±0.307	2.157	- 34
3x	LEU K614	PUL K75	22 LP	1.622±0.083	1.120±0.074	0.454±0.017	1.061	+ 5
3x	LEU K8	RET K280	-- LR	1.622±0.083	1.861±0.059	2.151±0.111	1.782	+ 4
3x	LEU K8	SHA K405	23 LS	1.622±0.083	1.258±0.050	1.857±0.083	1.697	- 35
3x	LEU K8	TRI K738	23 LT	1.622±0.083	2.312±0.084	4.409±0.327	2.264	+ 2
3x	PAL K376	SHA K445	24 YS	0.696±0.041	0.405±0.014	1.857±0.083	0.965	- 38
3x	PUL K19	DV4 K156	-- PD	0.454±0.017	0.475±0.019	0.547±0.020	0.514	- 8
3x	PUL K19	LEU K--	-- PL	0.454±0.017	0.888±0.058	1.622±0.083	1.061	- 19
3x	RET K280	LEU K500	-- RL	2.151±0.111	1.808±0.103	1.622±0.083	1.782	+ 1
4x	DV4 K156	LEU K8	25 DL	0.547±0.020	1.006±0.038	1.622±0.083	0.942	+ 6
4x	DV4 K165	PAL K376	25 DY	0.547±0.020	0.606±0.028	0.696±0.041	0.617	- 2
4x	LEU K8	DV4 K156	25 LD	1.622±0.083	0.887±0.050	0.547±0.020	0.942	- 6
4x	LEU K8	PAL K376	-- LY	1.622±0.083	1.277±0.048	0.696±0.041	1.063	+ 15
4x	PAL K376	DV4 K165	25 YD	0.696±0.041	0.701±0.041	0.547±0.020	0.617	+ 14
4x	RET K280	DV4 K156	-- RD	2.151±0.111	0.750±0.063	0.547±0.020	1.085	- 45
4x	RET K280	PAL K376	-- RY	2.151±0.111	1.328±0.056	0.696±0.041	1.224	+ 8

* No significant difference between data of parental species.

Table 50. -- Actual and predicted leaflet width (cm) of 50 interspecific Leucaena hybrids, data of parental species, and percentage that the actual data exceeds (+) or underestimates (-) the expected data.

X	Parents of Hybrid P1 Female	P2 Male	Plate # /Code	Means and Standard Dev. P1	F1	P2	Exp.	%
2x	COL K185	LAN K264	16 CN	0.221±0.014	0.514±0.021	1.714±0.116	0.615	- 20
2x	COL K450	LNS K393	19 CM	0.221±0.014	0.596±0.074	1.759±0.193	0.623	- 5
2x	DV2 K409	COL K185	16 ZC	0.080±0.021	0.142±0.013	0.221±0.014	0.133	- 6
2x	DV2 B85	LAN K10	15 ZN	0.080±0.021	0.329±0.014	1.514±0.109	0.348	- 6
2x	DV2 B85	LNS K393	18 ZM	0.080±0.021	0.473±0.033	1.759±0.193	0.375	+ 21
2x	DV2 K409	PUL K19	18 ZP*	0.080±0.021	0.065±0.009	0.094±0.004	0.087	- 34
2x	DV2 K409	SHA K405	-- ZS	0.080±0.021	0.327±0.020	0.878±0.052	0.265	+ 19
2x	ESC K138	SHA K445	15 ES	0.097±0.004	0.353±0.031	0.878±0.052	0.292	+ 17
2x	LAN K10	LNS K393	-- NM	1.514±0.109	1.543±0.158	1.759±0.193	1.632	- 6
2x	LAN K10	SHA K445	17 NS	1.514±0.109	0.836±0.051	0.878±0.052	1.153	- 38
2x	LAN K10	DV2 B85	17 NZ	1.514±0.109	0.317±0.017	0.080±0.021	0.348	- 10
2x	LNS K393	COL K450	17 MC	1.759±0.193	0.544±0.050	0.221±0.014	0.623	- 15
2x	LNS K393	LAN K10	-- MN*	1.759±0.193	1.740±0.115	1.514±0.109	1.632	+ 6
2x	LNS K393	SHA K445	16 MS	1.759±0.193	1.533±0.126	0.878±0.052	1.243	+ 19
2x	MAC K158	DV2 K--	20 AZ	1.734±0.099	0.508±0.029	0.080±0.021	0.372	+ 27
2x	MAC K158	LNS?K--	-- AM?*	1.734±0.099	1.548±0.068	1.759±0.193	1.746	- 13
2x	PUL K19	COL K450	15 PC	0.094±0.004	0.121±0.005	0.221±0.014	0.144	- 19
2x	PUL K19	LAN K10	-- PN	0.094±0.004	0.395±0.026	1.514±0.109	0.377	+ 5
2x	PUL K19	LNS K393	-- PM	0.094±0.004	0.371±0.017	1.759±0.193	0.407	- 10
2x	RET K280	ESC K138	18 RE	1.012±0.048	0.212±0.012	0.097±0.004	0.313	- 48
2x	RET K280	LAN K10	-- RN	1.012±0.048	1.385±0.138	1.759±0.193	1.334	+ 4
2x	RET K502	PUL K881	19 RP	1.123±0.067	0.330±0.022	0.082±0.071	0.303	+ 8
2x	RET K280	SHA K445	-- RS	0.977±0.044	1.046±0.044	0.878±0.052	0.926	+ 11
2x	SHA K405	LAN K264	17 SN	0.878±0.052	1.224±0.061	1.714±0.116	1.227	- 0
2x	SHA K445	RET K280	18 SR	0.878±0.052	1.086±0.076	0.977±0.044	0.926	+ 15
2x	TRI K738	LAN K10	16 TN	2.571±0.222	2.444±0.110	1.514±0.109	1.973	+ 19
2x	TRI K738	LNS K393	15 TM	2.571±0.222	3.535±0.223	1.759±0.193	2.127	+ 40
3x	DV2 K409	DV4 K156	-- ZD*	0.080±0.021	0.083±0.006	0.095±0.007	0.090	- 8
3x	DV2 K11	LEU K8	22 ZL	0.080±0.021	0.278±0.259	0.497±0.031	0.270	+ 3
3x	DV4 K156	LAN K10	-- DN	0.095±0.007	0.212±0.013	1.514±0.109	0.239	- 13
3x	DV4 K156	SHA K445	-- DS	0.095±0.007	0.192±0.011	0.878±0.052	0.199	- 4
3x	ESC K898	LEU K--	-- EL	0.068±0.008	0.239±0.012	0.315±0.015	0.189	+ 21
3x	LEU K8	COL K183	-- LC	0.497±0.031	0.371±0.016	0.221±0.014	0.379	- 2
3x	LEU K8	ESC K138	22 LE	0.497±0.031	0.285±0.012	0.097±0.004	0.288	- 1
3x	LEU K8	LAN K264	23 LN	0.497±0.031	0.577±0.046	1.514±0.109	0.720	- 25
3x	LEU K614	PUL K75	22 LP	0.497±0.031	0.311±0.014	0.094±0.004	0.285	+ 8
3x	LEU K8	RET K280	-- LR	0.497±0.031	0.547±0.033	1.012±0.048	0.630	- 15
3x	LEU K8	SHA K405	23 LS	0.497±0.031	0.401±0.038	0.878±0.052	0.601	- 50
3x	LEU K8	TRI K738	23 LT	0.497±0.031	0.766±0.060	2.571±0.211	0.860	- 12
3x	PAL K376	SHA K445	24 YS	0.132±0.012	0.135±0.008	0.878±0.052	0.248	- 84
3x	PUL K19	DV4 K156	-- PD*	0.094±0.004	0.084±0.005	0.095±0.007	0.094	- 12
3x	PUL K19	LEU K--	-- PL	0.094±0.004	0.206±0.010	0.497±0.031	0.285	- 38
3x	RET K280	LEU K500	-- RL	1.012±0.048	0.577±0.032	0.497±0.031	0.630	- 9
4x	DV4 K156	LEU K8	25 DL	0.095±0.007	0.224±0.025	0.497±0.031	0.217	+ 3
4x	DV4 K165	PAL K376	25 DY	0.095±0.007	0.110±0.009	0.132±0.012	0.112	- 2
4x	LEU K8	DV4 K156	25 LD	0.497±0.031	0.165±0.009	0.095±0.007	0.217	- 32
4x	LEU K8	PAL K376	-- LY	0.497±0.031	0.298±0.011	0.132±0.012	0.256	+ 14
4x	PAL K376	DV4 K165	25 YD	0.132±0.012	0.099±0.014	0.095±0.007	0.112	- 13
4x	RET K280	DV4 K156	-- RD	1.012±0.048	0.203±0.015	0.095±0.007	0.311	- 53
4x	RET K280	PAL K376	-- RY	1.012±0.048	0.415±0.020	0.132±0.012	0.365	+ 12

* No significant difference between data of parental species.

Plate XVa-g. Leaf trait plots of four diploid interspecific hybrids:

- -- L. *pulverulenta* K340 x L. *collinsii* K450 (2x=54) "PC"
- -- L. *esculenta* K138 x L. *shannoni* K445 (2x=52) "ES"
- -- L. *diversifolia* ssp. *trichandra* (K480 x K409) x L. *lanceolata* ssp. *lanceolata* K10 (2x=52) "ZN"
- -- L. *trichodes* K738 x L. *lanceolata* ssp. *sousae* K393 (2x=52) "TM"

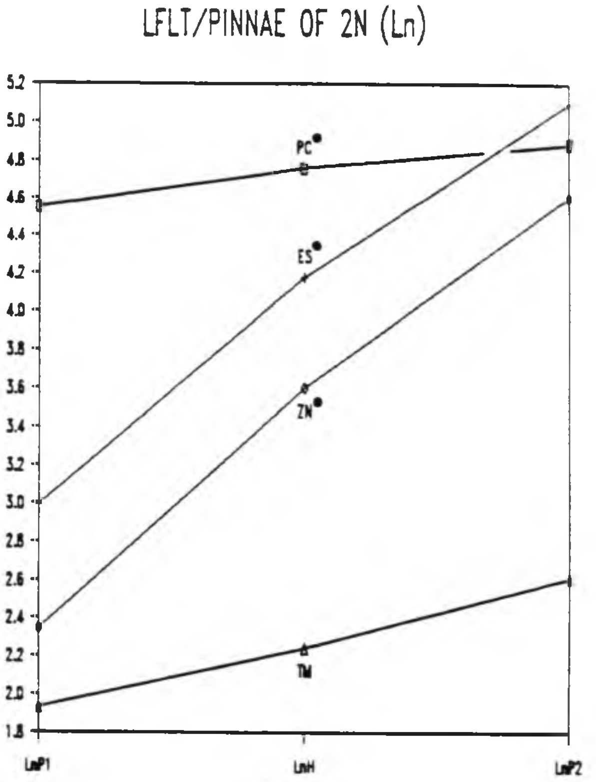

Plate XVa.

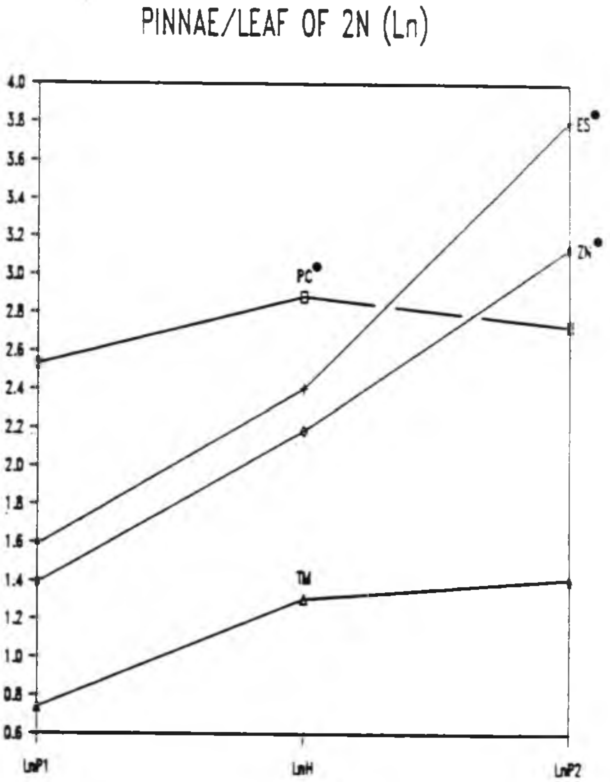

Plate XVb.

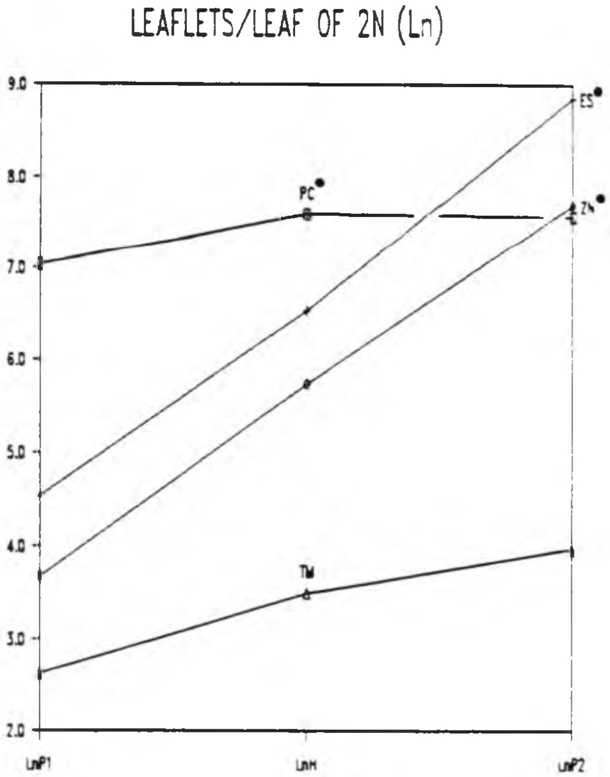

Plate XVc.

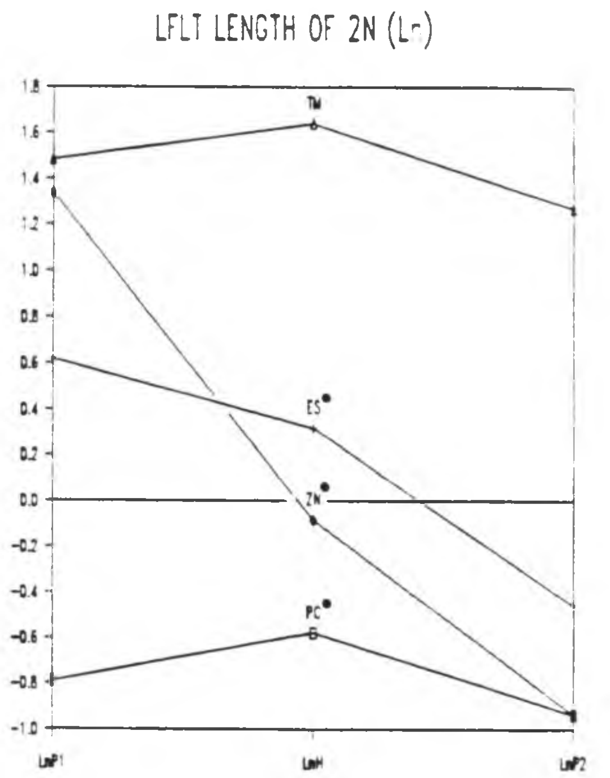

Plate XVd.

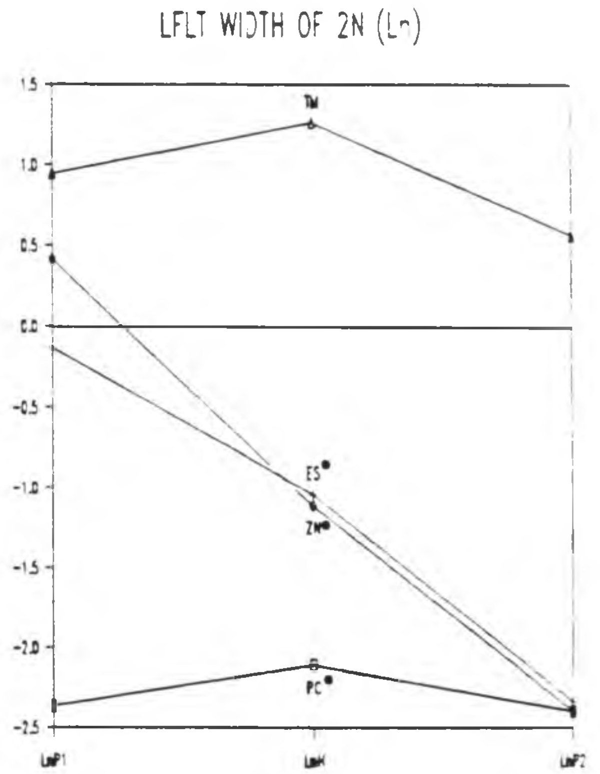

Plate XVe.

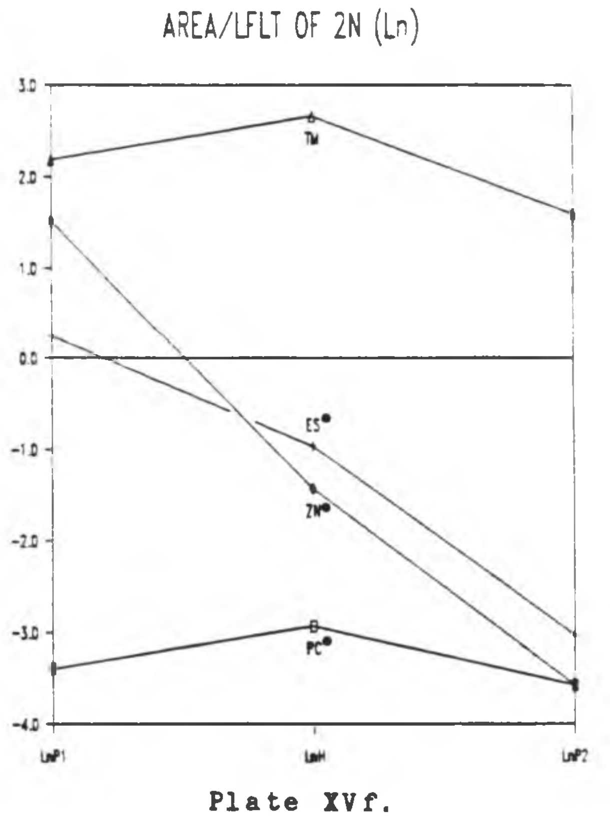

Plate XVf.

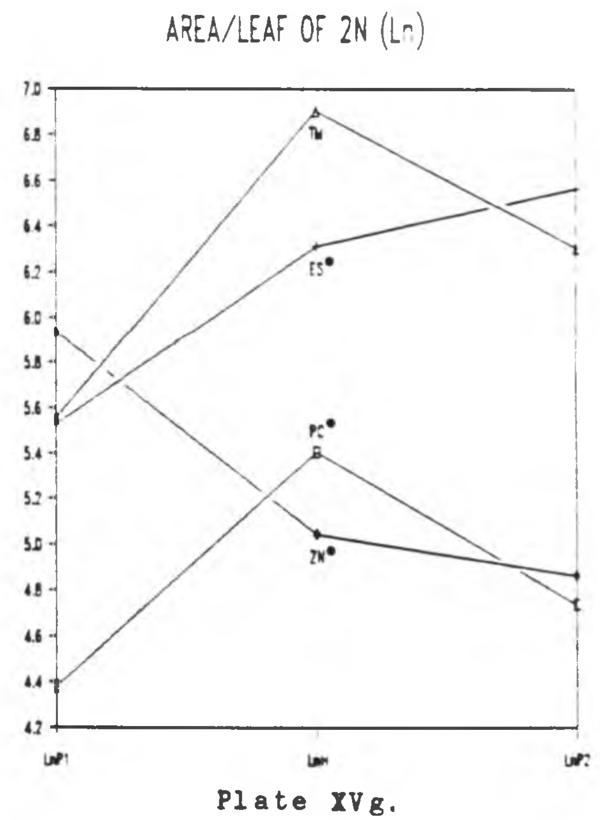

Plate XVg.

Plate XVIa-g. Leaf trait plots of four diploid interspecific hybrids:

-- *L. diversifolia* ssp. *trichandra* K423 x *L. collinsii* K183 (2x=54) "ZC"

-- *L. collinsii* K180 x *L. lanceolata* ssp. *lanceolata* K264 (2x=54) "CN"

-- *L. lanceolata* ssp. *sousae* K393 x *L. shannoni* K445 (2x=52) "MS"

-- *L. trichodes* K738 x *L. lanceolata* ssp. *lanceolata* K10 (2x=52) "TN"

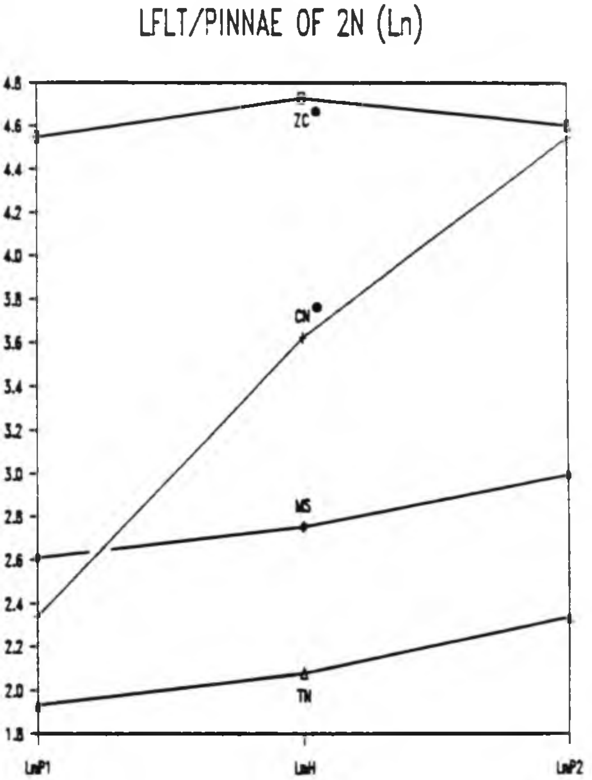

Plate XVIa.

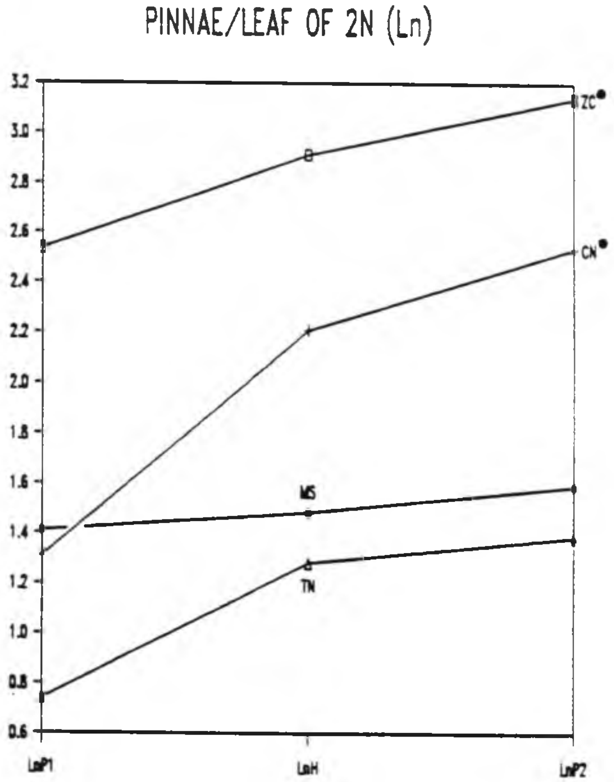

Plate XVIb.

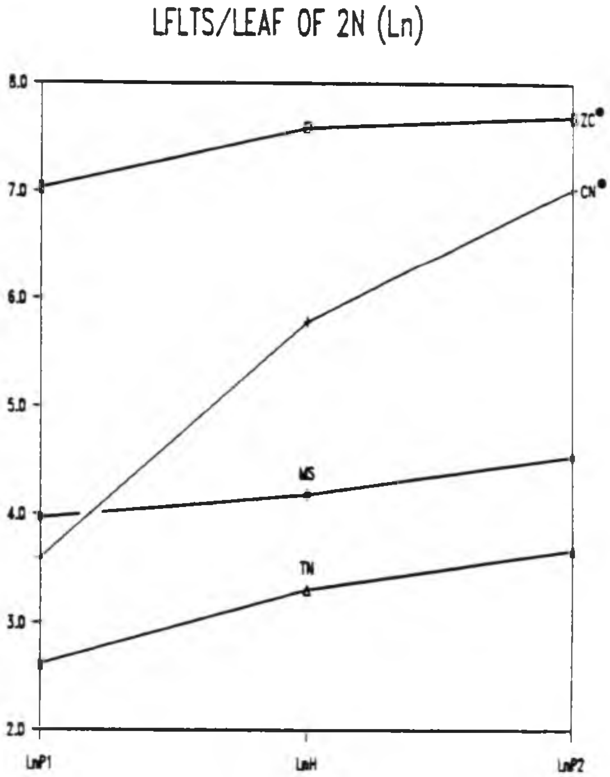

Plate XVIc.

LFLT LENGTH OF 2N (Ln)

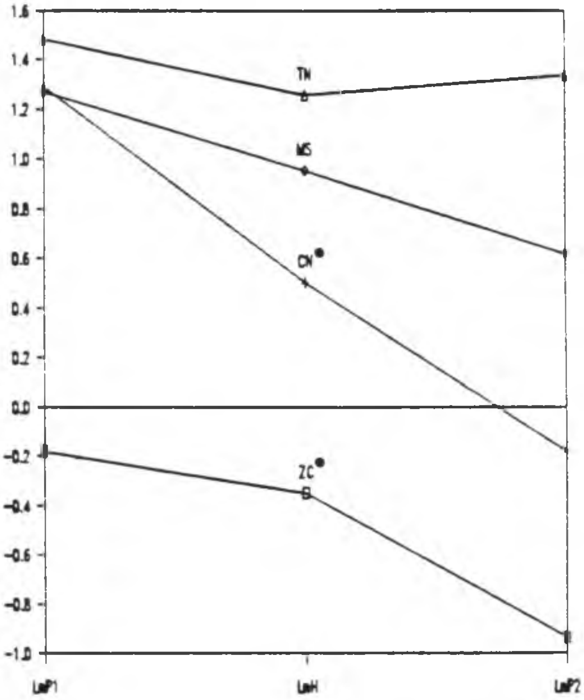

Plate XVId.

LFLT WIDTH OF 2N (Ln)

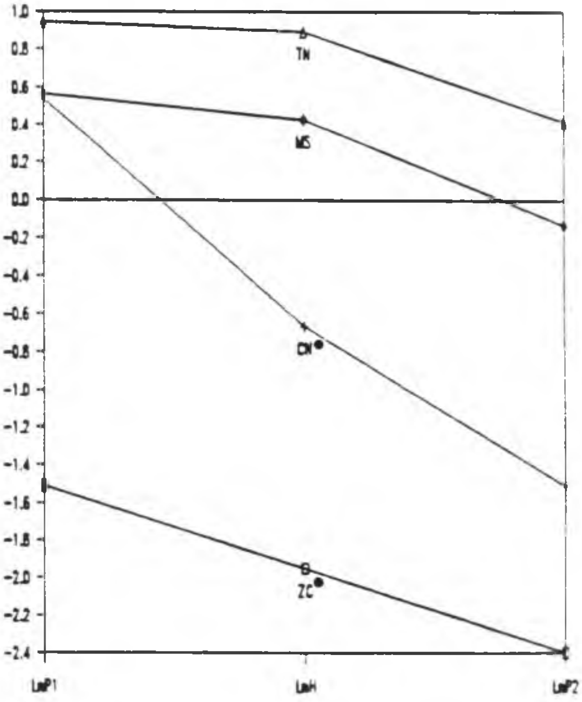

Plate XVIe.

AREA/LFLT OF 2N (Ln)

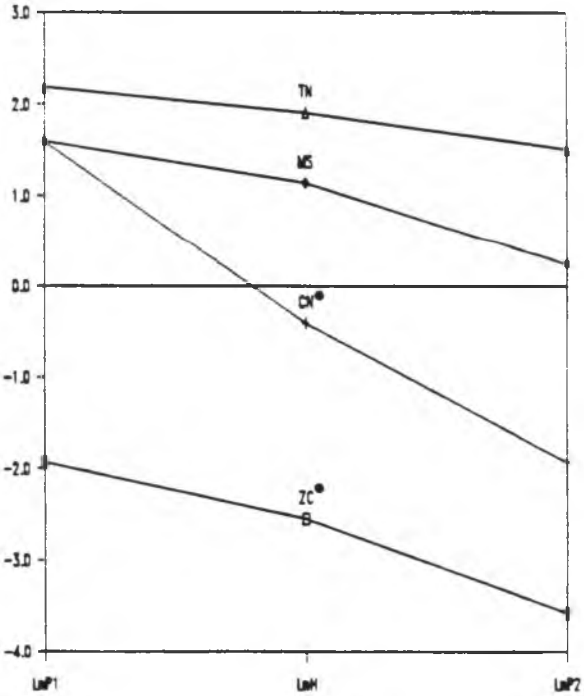

Plate XVIf.

AREA/LEAF OF 2N (Ln)

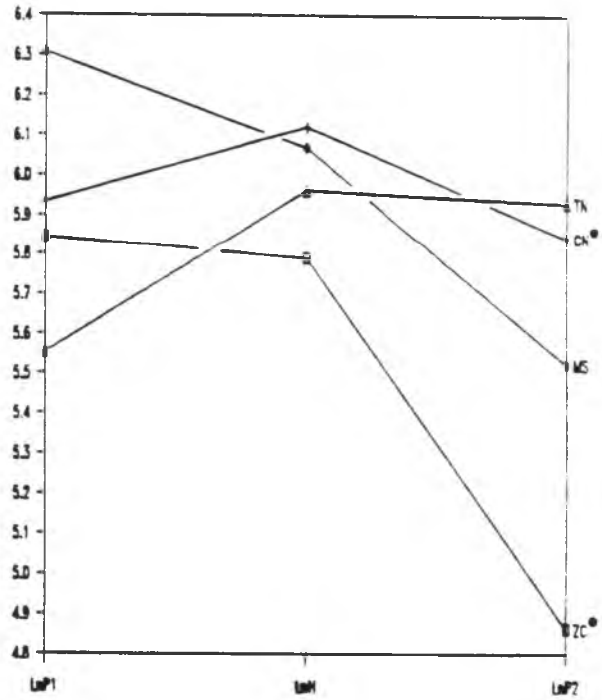

Plate XVIg.

Plate XVIIa-g. Leaf trait plots of four diploid interspecific hybrids:

-- L. lanceolata ssp. lanceolata K10 x L. diversifolia ssp. trichandra (K480 x K409) (2x=52) "NZ"

-- L. lanceolata ssp. sousae K393 x L. collinsii K450 (2x=54) "MC"

-- L. lanceolata ssp. lanceolata K10 x L. shannoni K445 (2x=52) "NS"

-- L. lanceolata ssp. lanceolata K10 x L. shannoni K445 (2x=52) "NS"

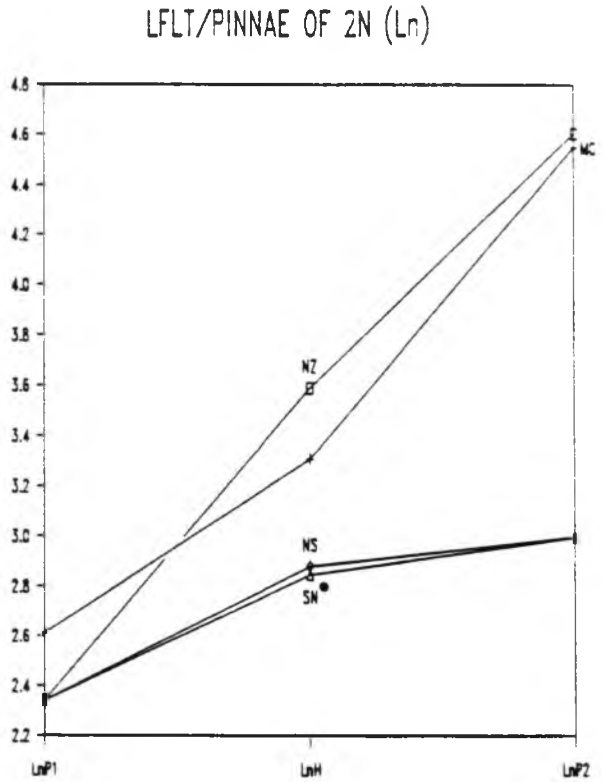

Plate XVIIa.

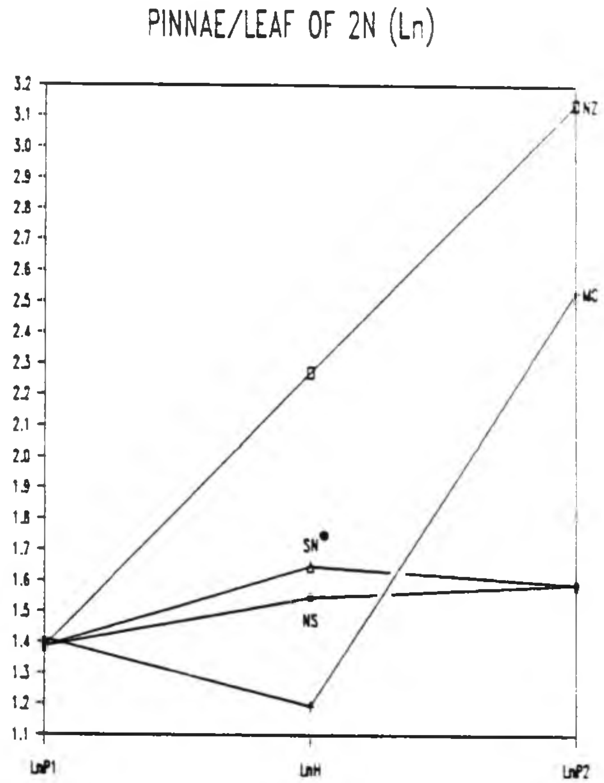

Plate XVIIb.

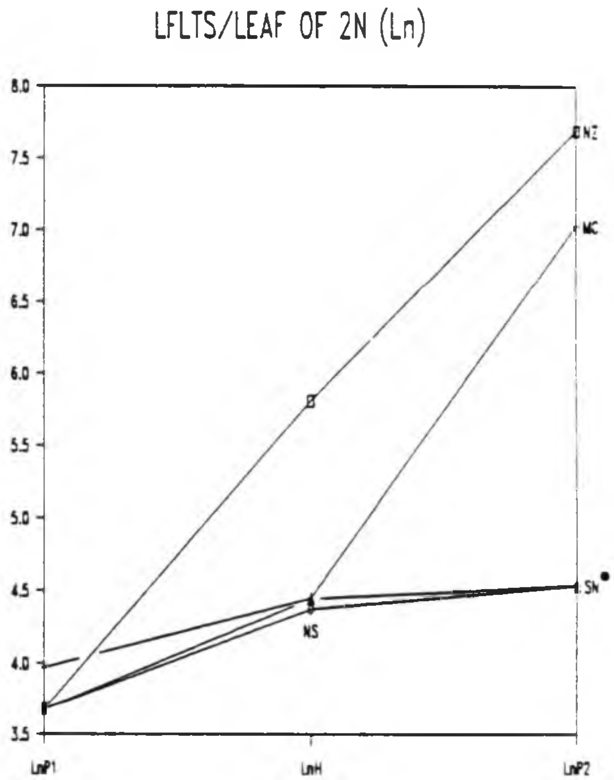

Plate XVIIc.

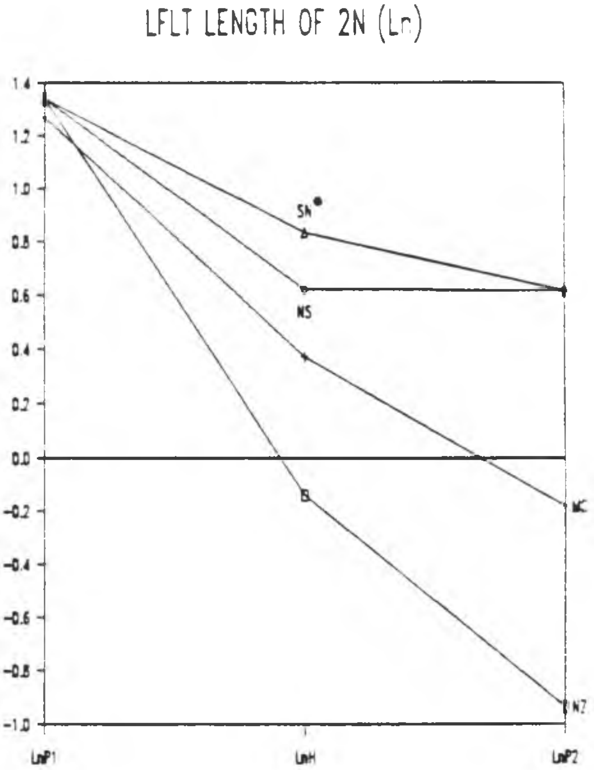

Plate XVIId.

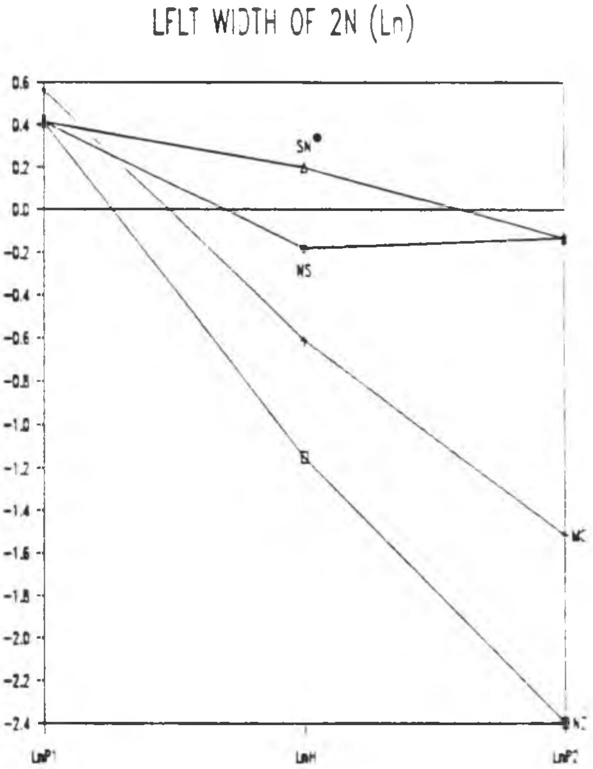

Plate XVIIe.

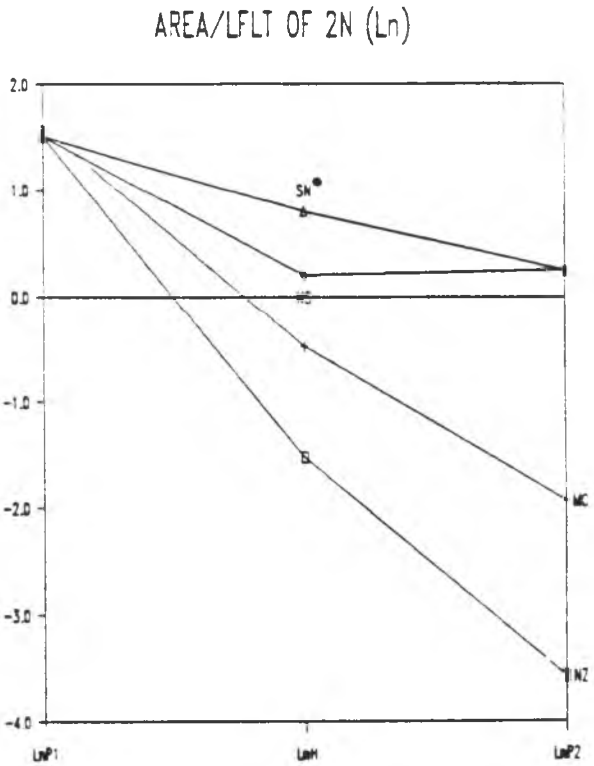

Plate XVIIf.

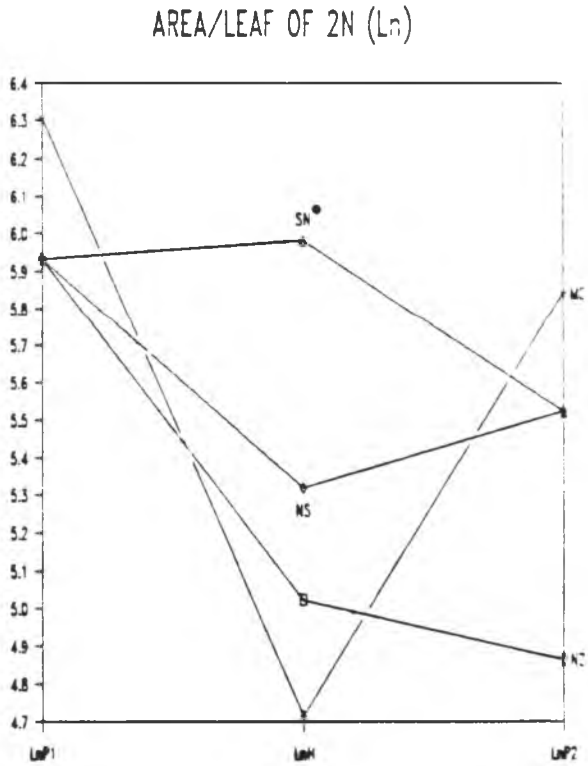

Plate XVIIg.

Plate XVIIIa-g. Leaf trait plots of four diploid interspecific hybrids:

-- L. diversifolia ssp. trichandra K409 x L. pulverulenta K340 (2x=54) "ZP"

-- L. retusa K280 x L. esculenta K138 (2x=54) "RE"

-- L. diversifolia ssp. trichandra (K480 x K409) x L. lanceolata ssp. sousae K393 (2x=52) "ZM"

-- L. shannoni K445 x L. retusa K280 (2x=54) "SR"

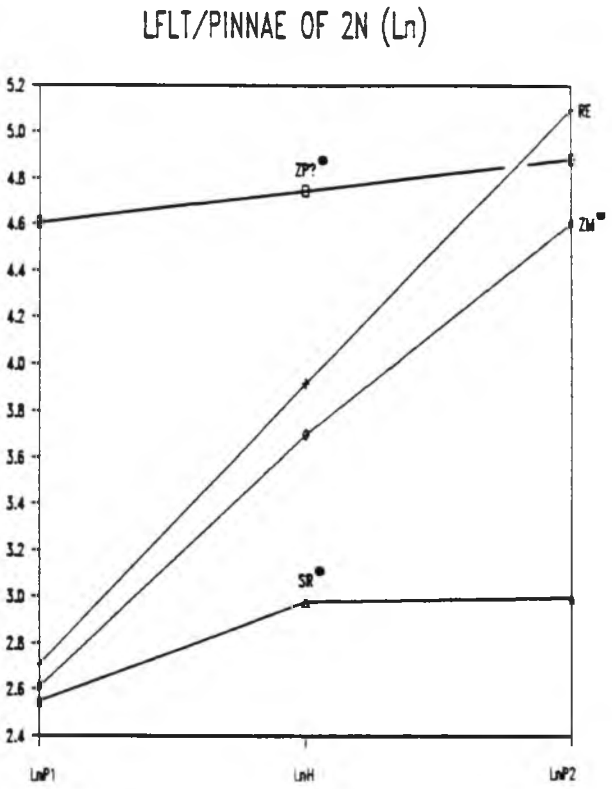

Plate XVIIIa.

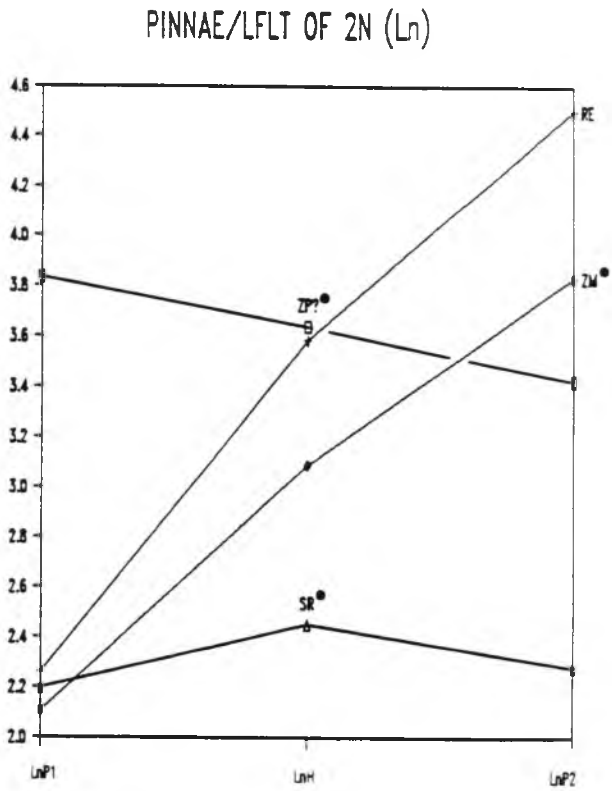

Plate XVIIIb.

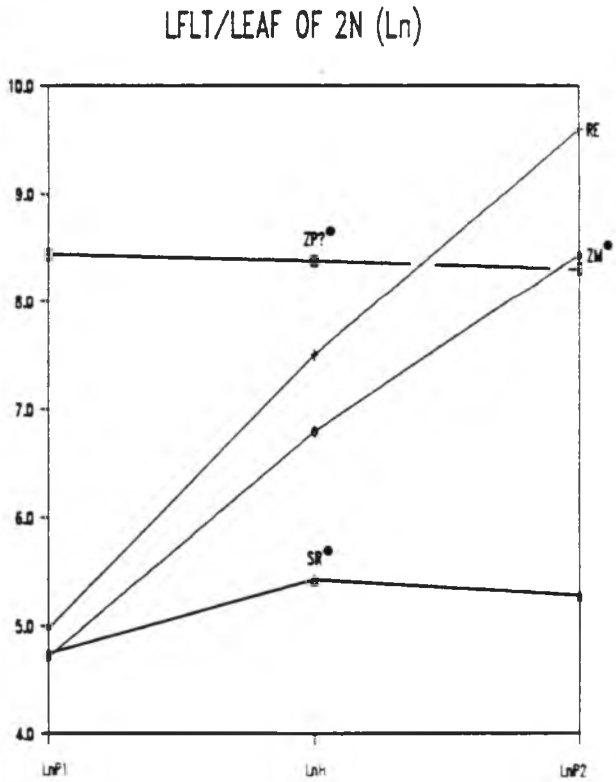

Plate XVIIIc.

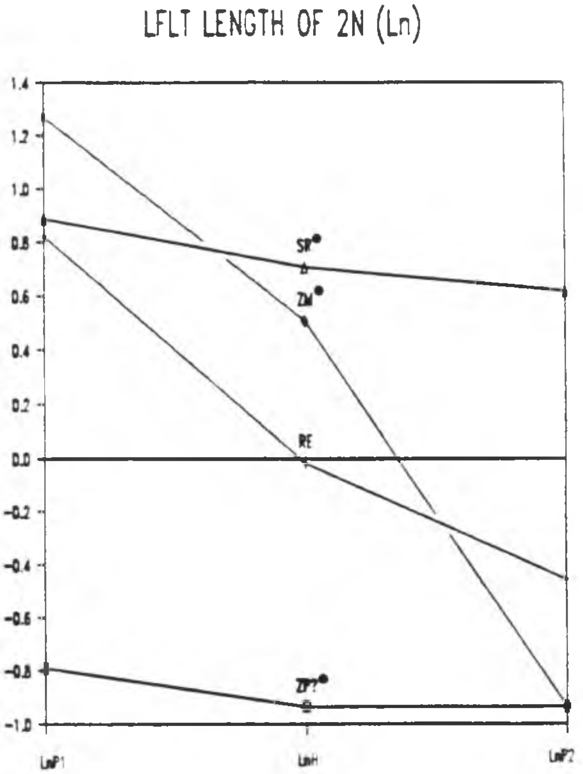

Plate XVIIId.

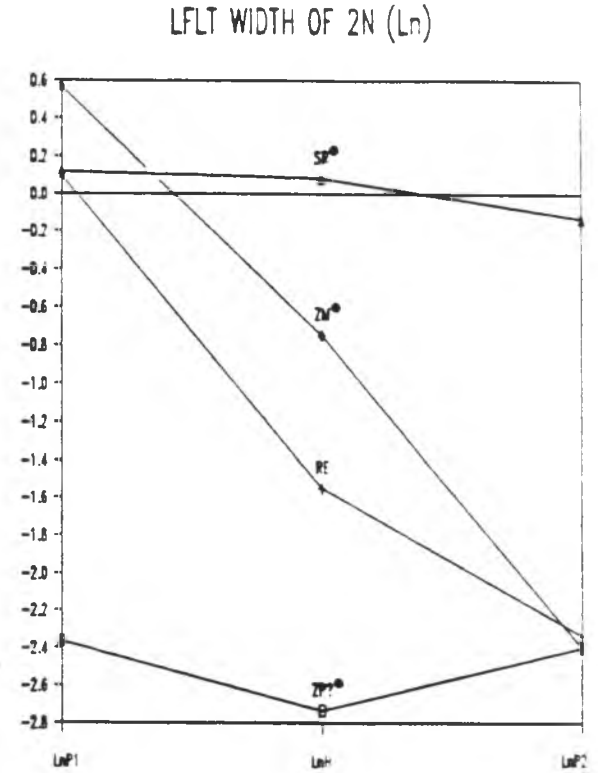

Plate XVIIIe.

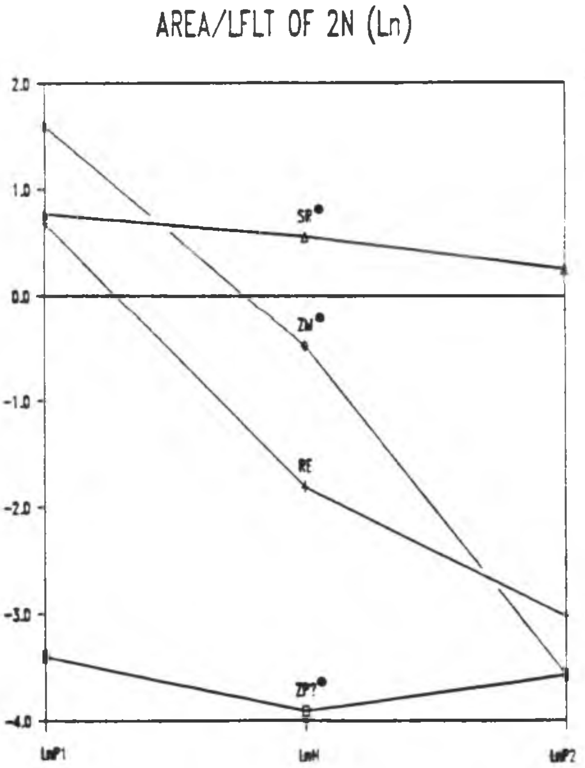

Plate XVIIIf.

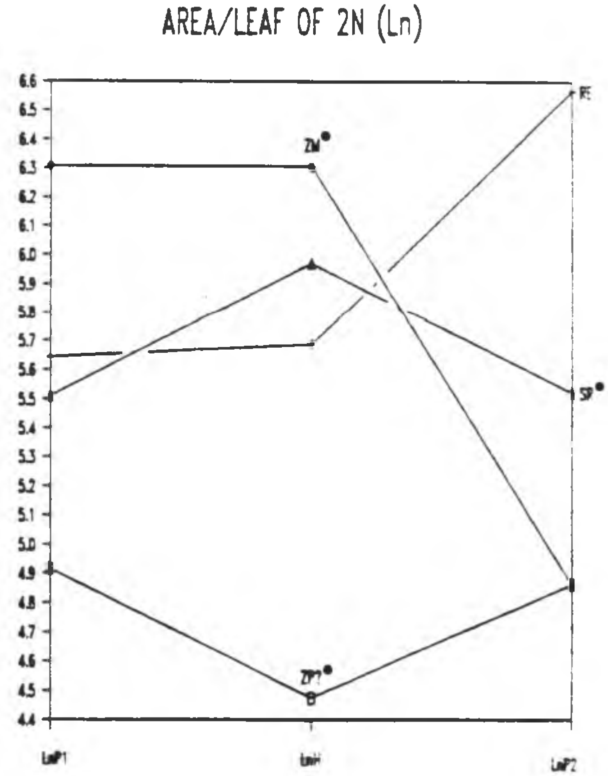

Plate XVIIIg.

Plate XIXa-g. Leaf trait plots of the same trees of two diploid interspecific hybrids at 21 and 50 days after transplanting:

- -- *L. retusa* K502 x *L. pulverulenta* K881 (2x=56) at 21 days after transplanting "RP1"
- -- *L. retusa* K502 x *L. pulverulenta* K881 (2x=56) at 50 days after transplanting "RP2"
- -- *L. collinsii* K450 x *L. lanceolata* ssp. *sousae* K393 (2x=54) at 21 days after transplanting "CM1"
- -- *L. collinsii* K450 x *L. lanceolata* ssp. *sousae* K393 (2x=54) at 50 days after transplanting "CM2"

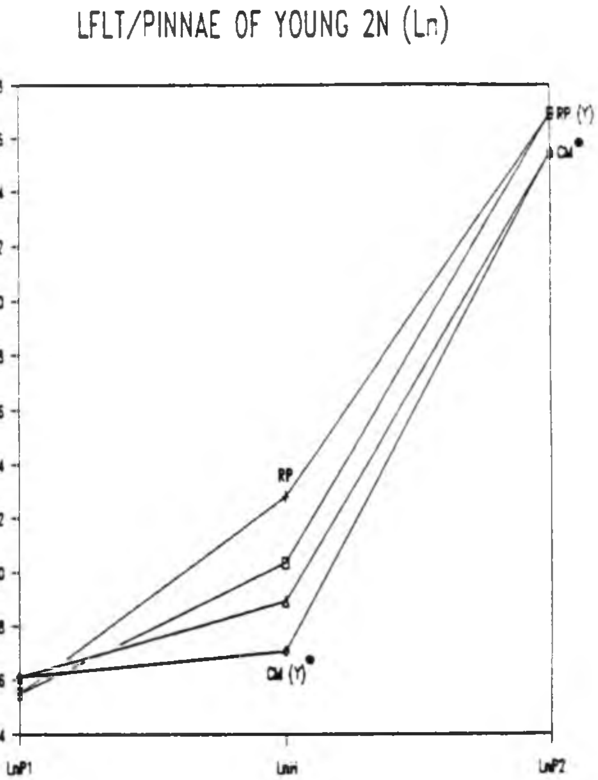

Plate XIXa.

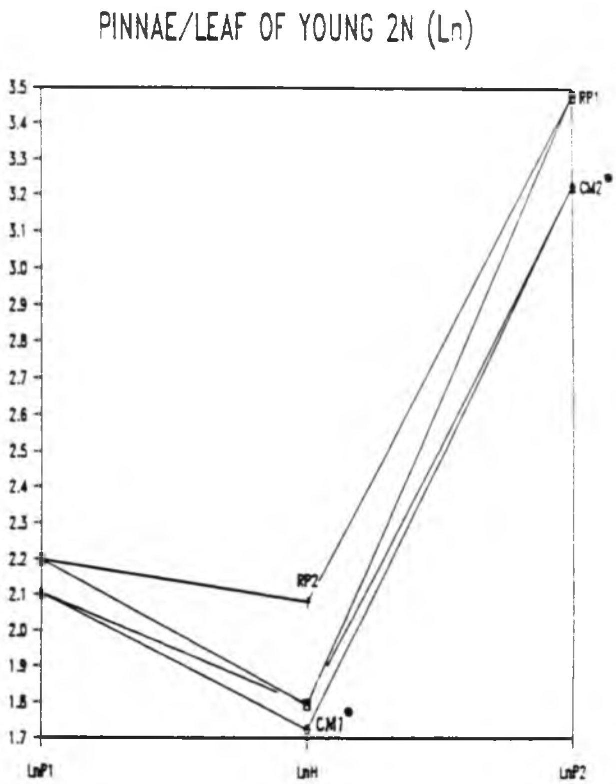

Plate XIXb.

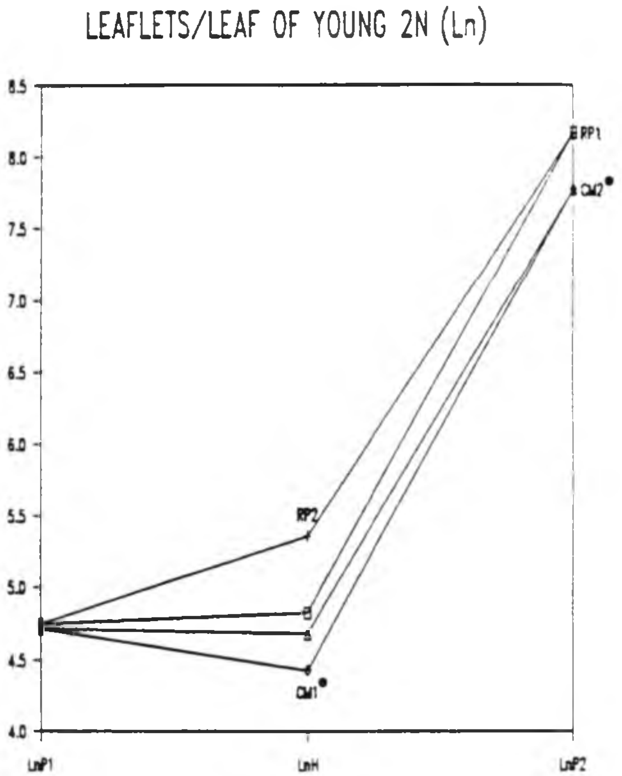

Plate XIXc.

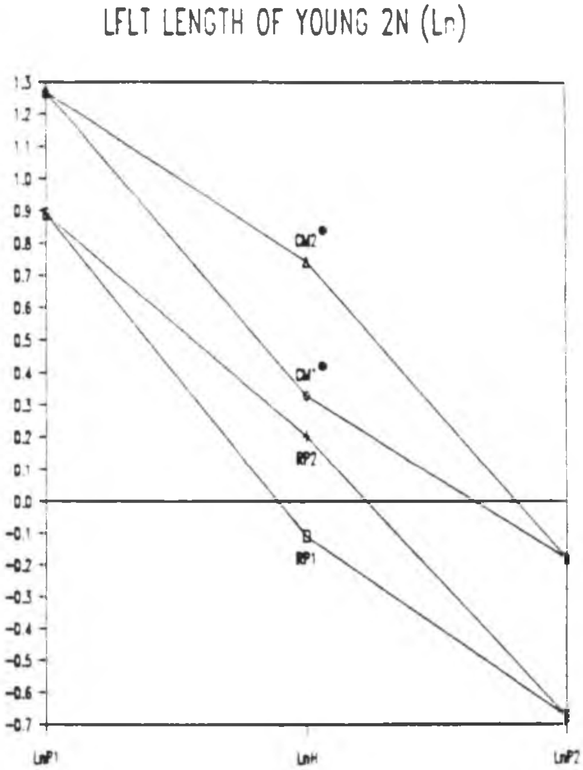

Plate XIXd.

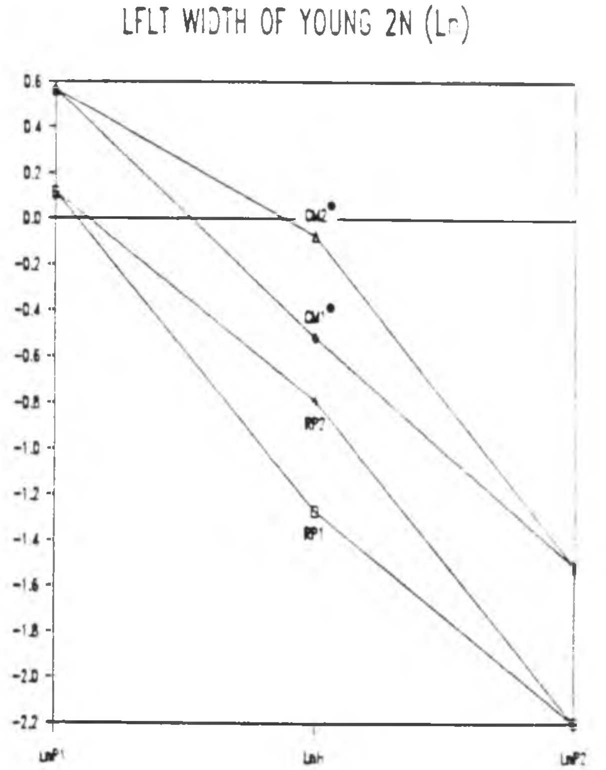

Plate XIXe.

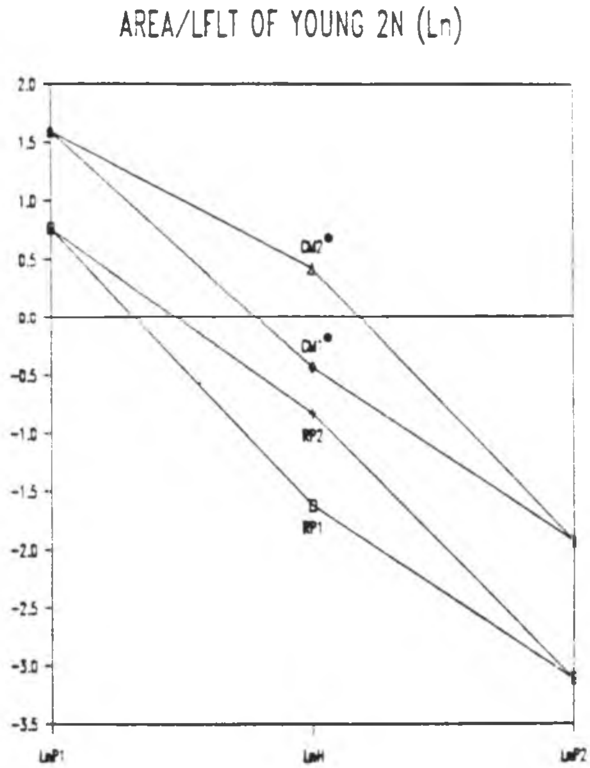

Plate XIXf.

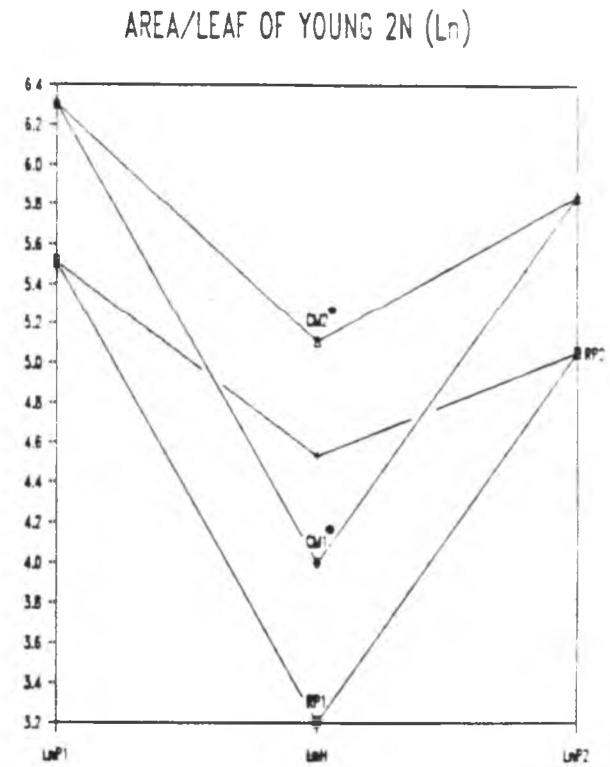

Plate XIXg.

Plate XXa-g. Leaf trait plots of a diploid interspecific hybrid, and two open-pollinated progenies of diploid species used as females.

-- *L. trichodes* K738 x *L. lanceolata* ssp. *sousae* K393 (2x=52) "TM"

-- A small leaflet progeny of *L. macrophylla* K158 plotted as *L. macrophylla* K158 x *L. collinsii* K450 (2x=54) (AC?) and plotted as *L. macrophylla* K158 x *L. diversifolia* ssp. *trichandra* (K480 x K409) (2x=52) (AZ?). The hybrid is probably *L. macrophylla* K158 x *L. diversifolia* ssp. *trichandra* K--.

-- A large-leaflet progeny of *L. macrophylla* K158 plotted as *L. macrophylla* K158 x *L. lanceolata* ssp. *sousae* K393 (2x=52) (AM?). The progeny appears to be an unusual sib; not an interspecific hybrid.

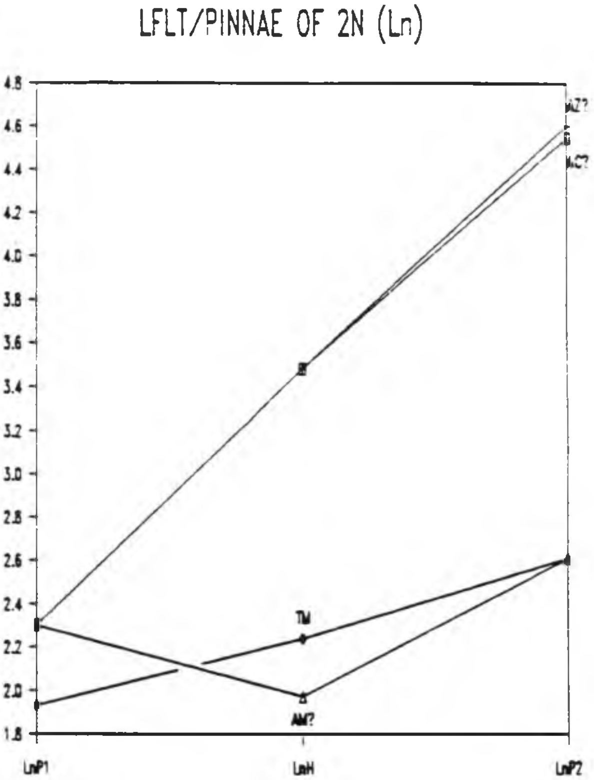

Plate XXa.

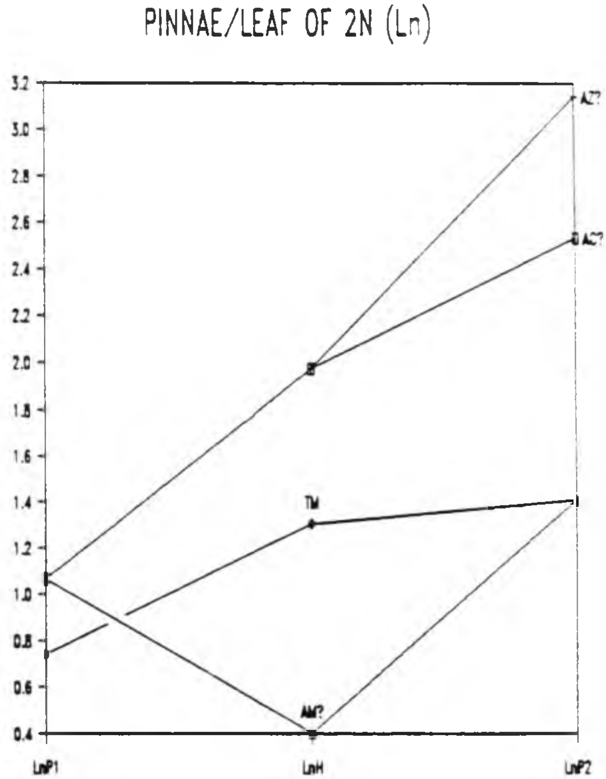

Plate XXb.

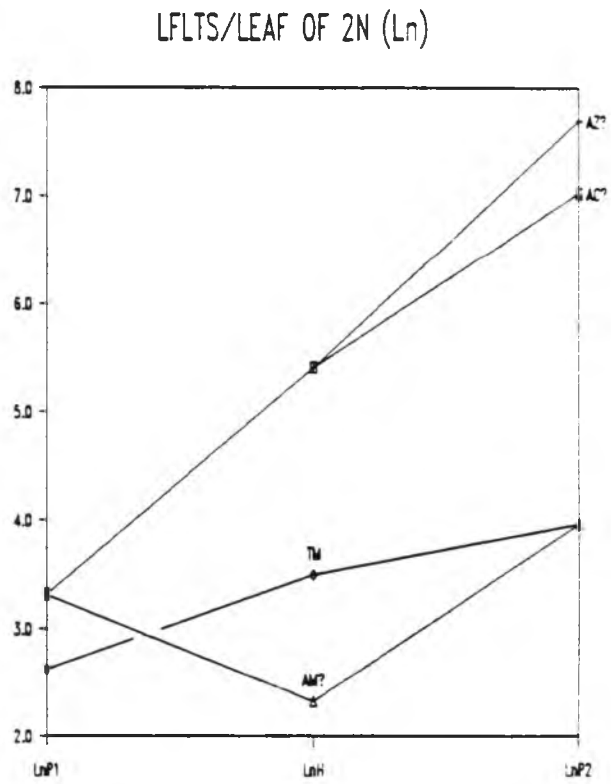

Plate XXc.

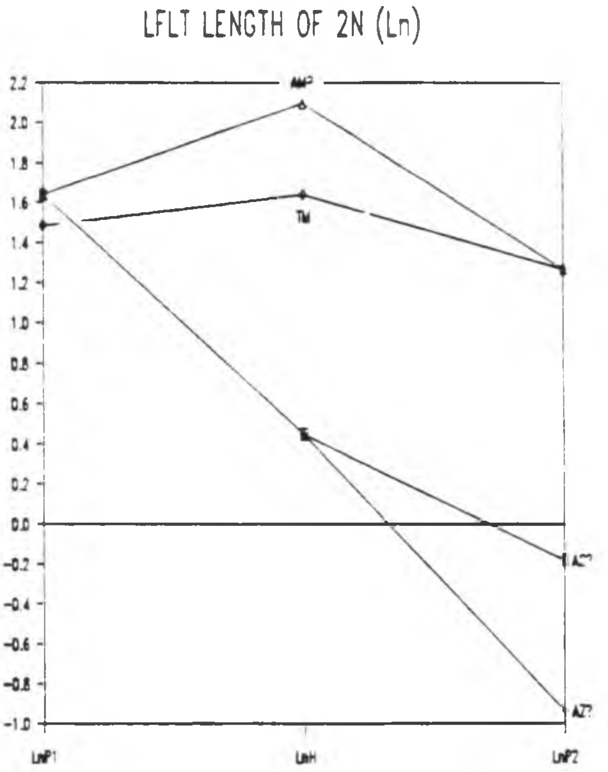

Plate XXd.

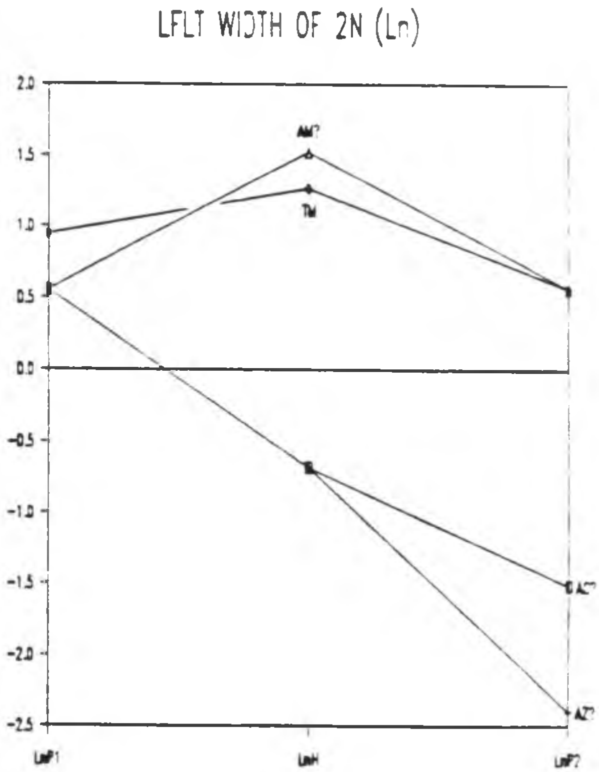

Plate XXe.

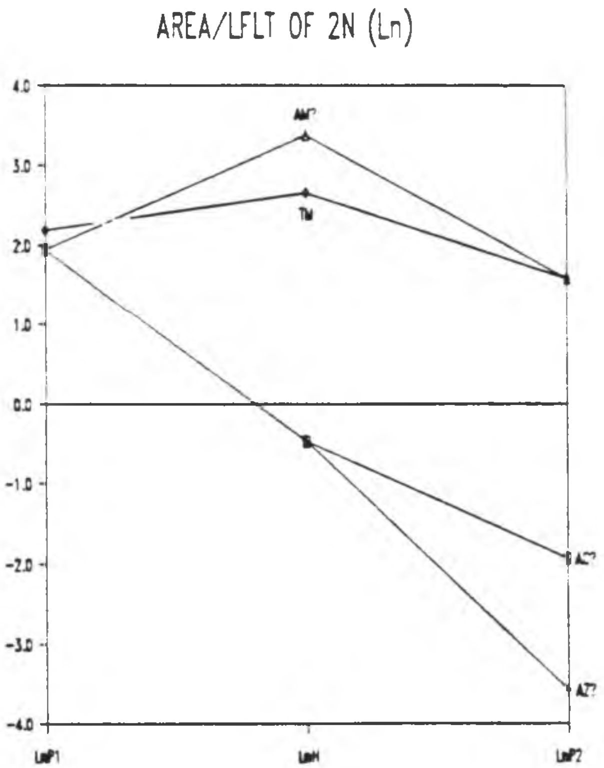

Plate XXf.

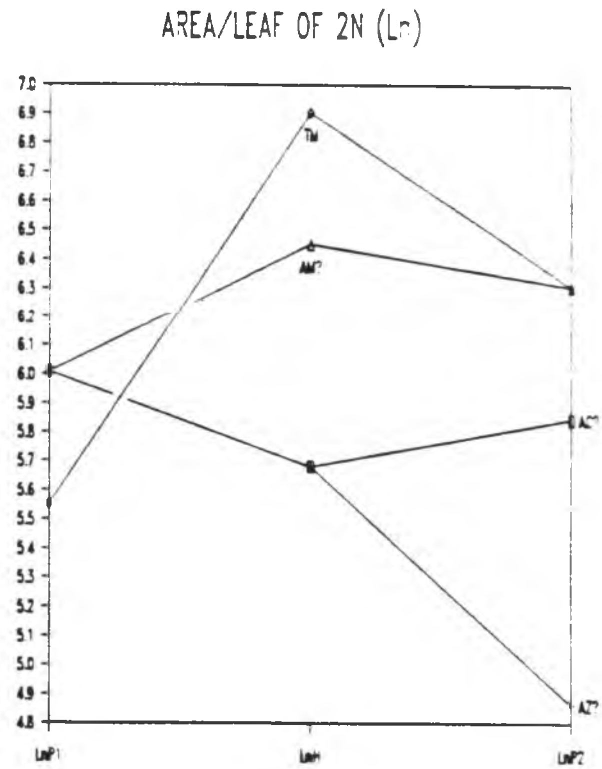

Plate XXg.

Plate XXIa-g. Leaf trait plots of six triploid interspecific hybrids plotted without accounting for dosage effects (hybrids are placed at the midpoint of the x-axis):

-- L. leucocephala K8 x L. esculenta K138 (3x=78) "LE"

-- L. leucocephala K614 x L. pulverulenta K75 (3x=80) "LP"

-- L. diversifolia ssp. trichandra K11 x L. leucocephala K8 (3x=78) "ZL"

-- L. leucocephala K8 x L. shannoni K405 (3x=78) "LS"

-- L. leucocephala K8 x L. lanceolata ssp. lanceolata K10 (3x=78) "LN"

-- L. leucocephala K8 x L. trichodes K738 (3x=78) "LT"

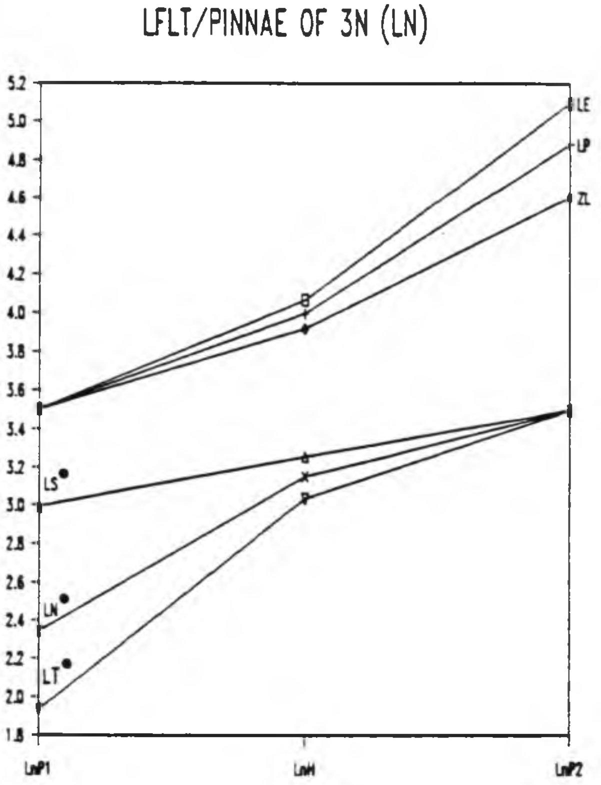

Plate XXIa.

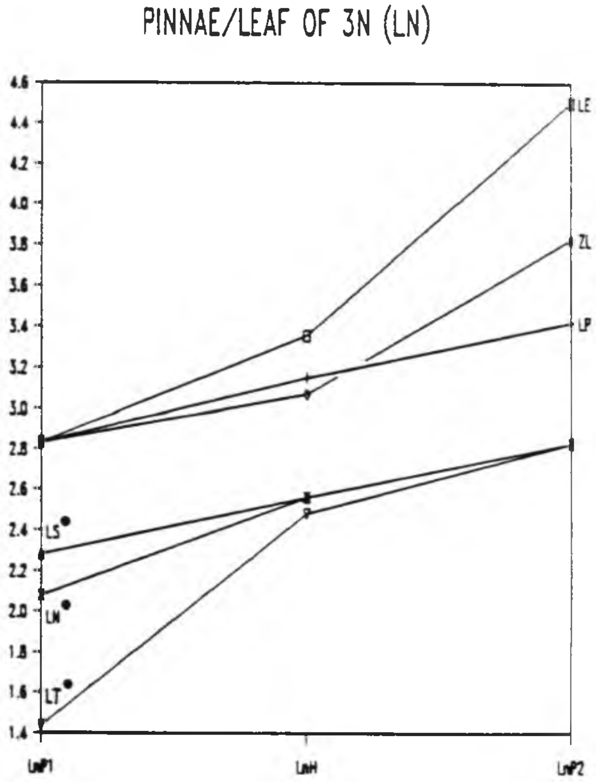

Plate XXIb.

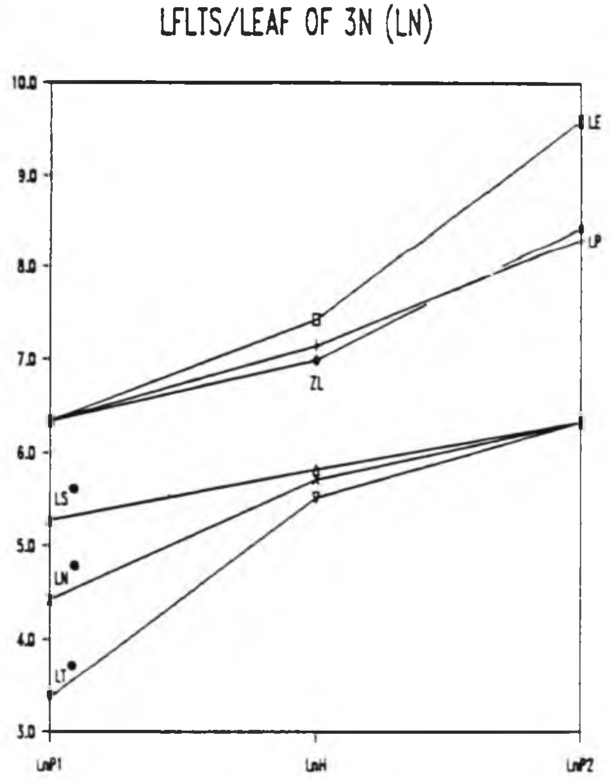

Plate XXIc.

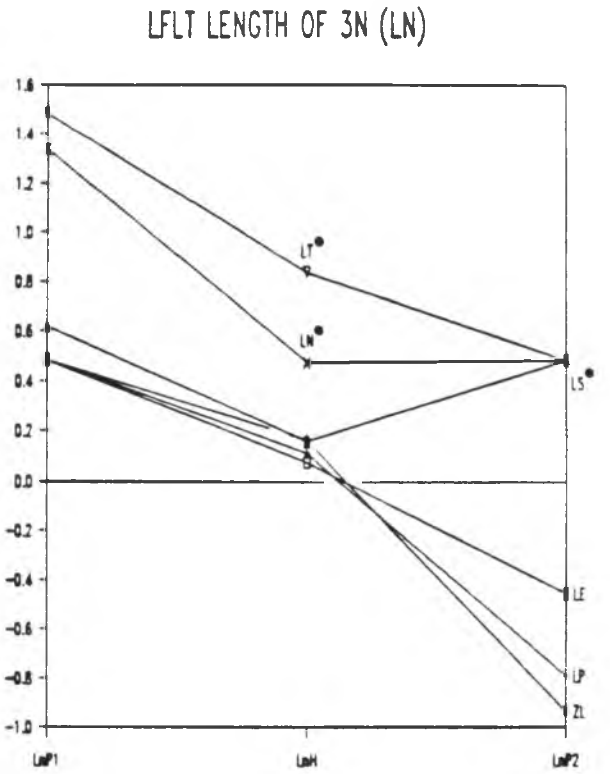

Plate XXId.

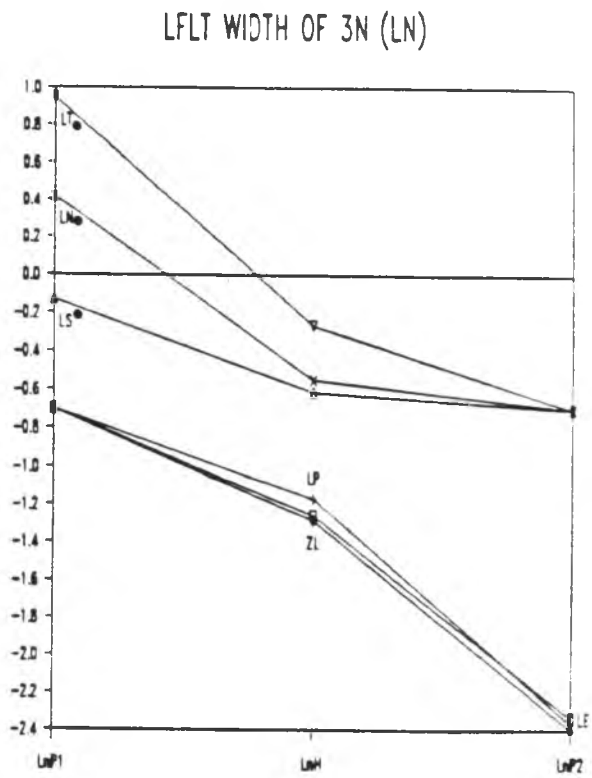

Plate XXIe.

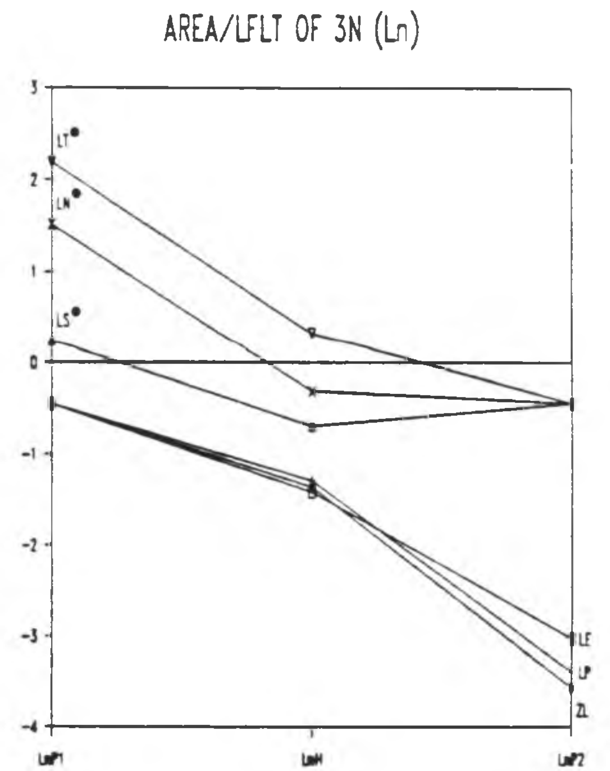

Plate XXIf.

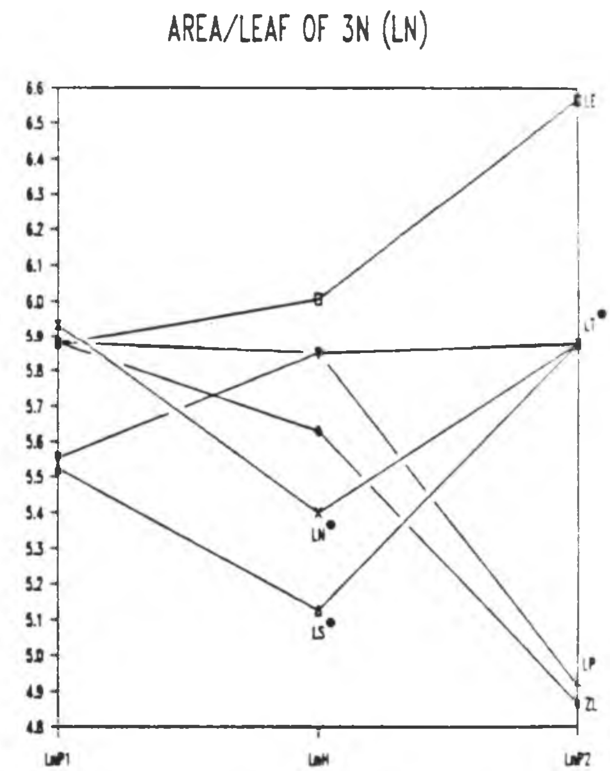

Plate XXIg.

Plate XXIIa-g. Leaf trait plots of three triploid interspecific hybrids plotted to account for dosage effects (hybrids are placed one-third toward the tetraploid parent on the x-axis):

- -- *L. leucocephala* K8 x *L. esculenta* K138 (3x=78) "LE"
- -- *L. leucocephala* K614 x *L. pulverulenta* K75 (3x=80) "LP"
- -- *L. diversifolia* ssp. *trichandra* K11 x *L. leucocephala* K8 (3x=78) "ZL"

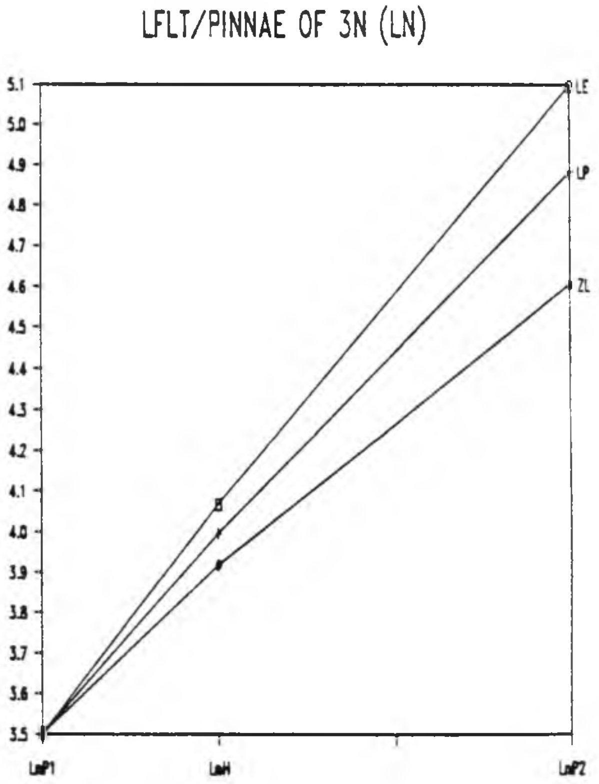

Plate XXIIa.

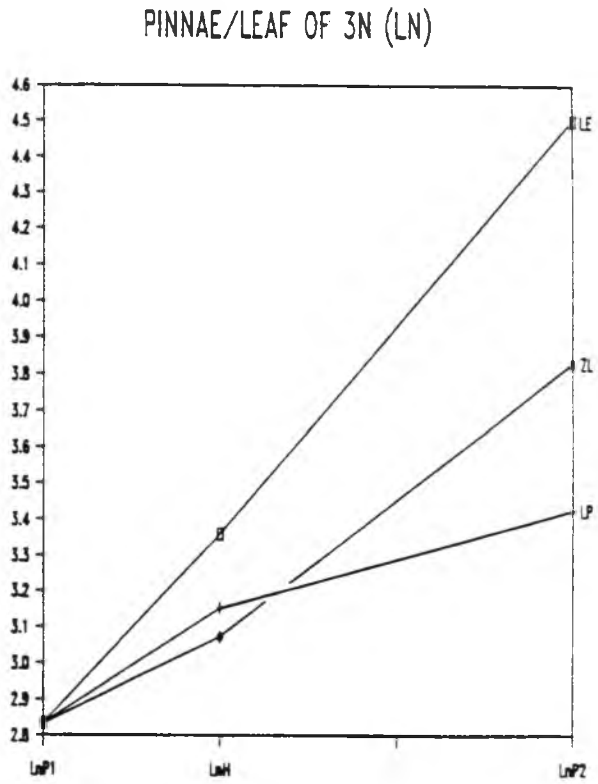

Plate XXIIb.

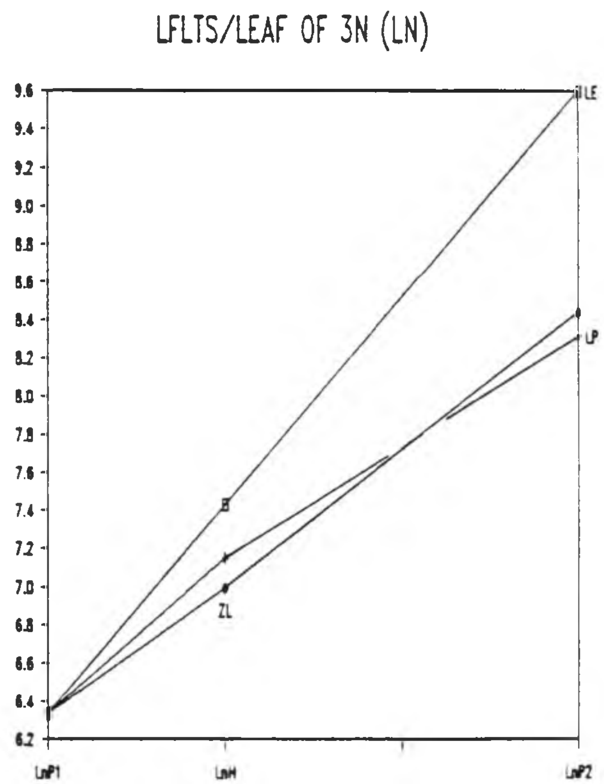

Plate XXIIc.

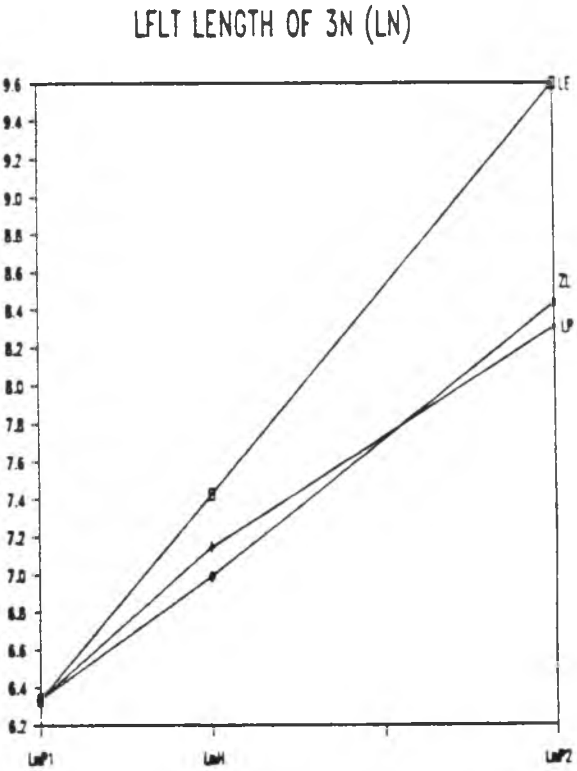

Plate XXIId.

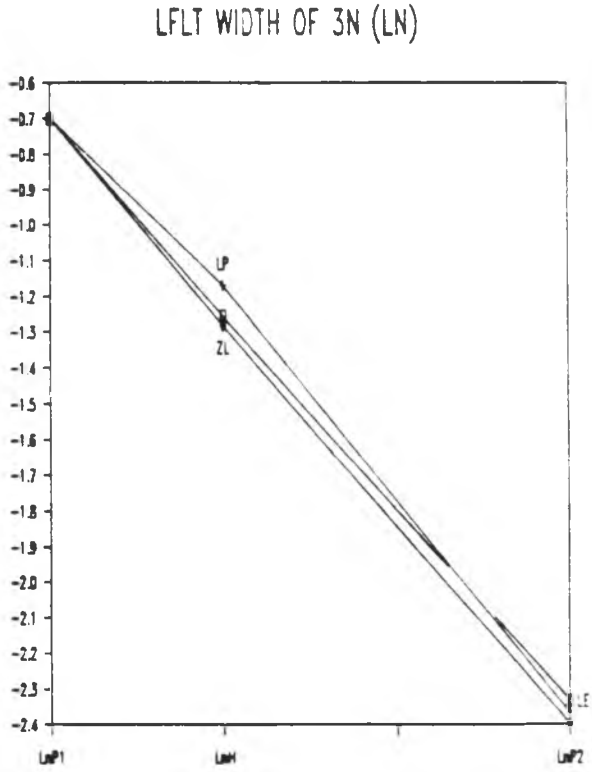

Plate XXIIe.

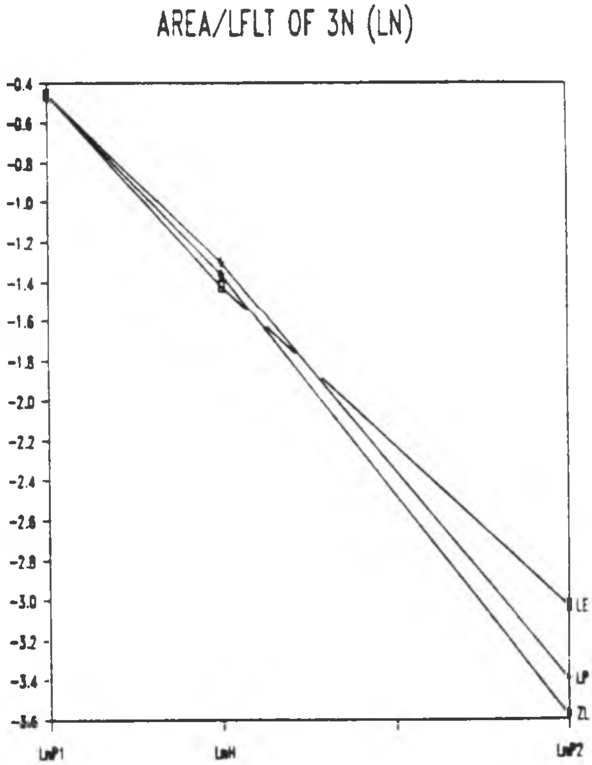

Plate XXIIf.

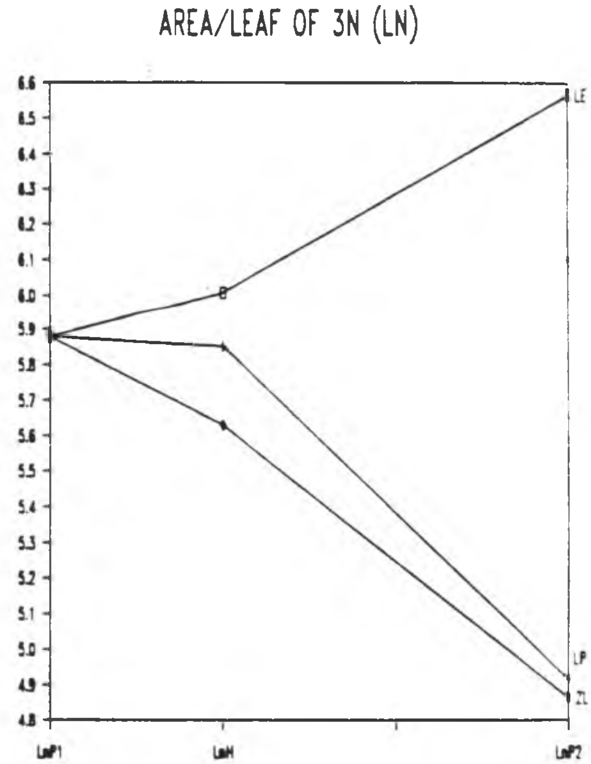

Plate XXIIg.

Plate XXIIIa-g. Leaf trait plots of three triploid interspecific hybrids plotted to account for dosage effects (hybrids are placed one-third toward the tetraploid parent on the x-axis):

-- *L. leucocephala* K8 x *L. shannoni* K405 (3x=78) "LS"

-- *L. leucocephala* K8 x *L. lanceolata* ssp. *lanceolata* K10 (3x=78) "LN"

-- *L. leucocephala* K8 x *L. trichodes* K738 (3x=78) "LT"

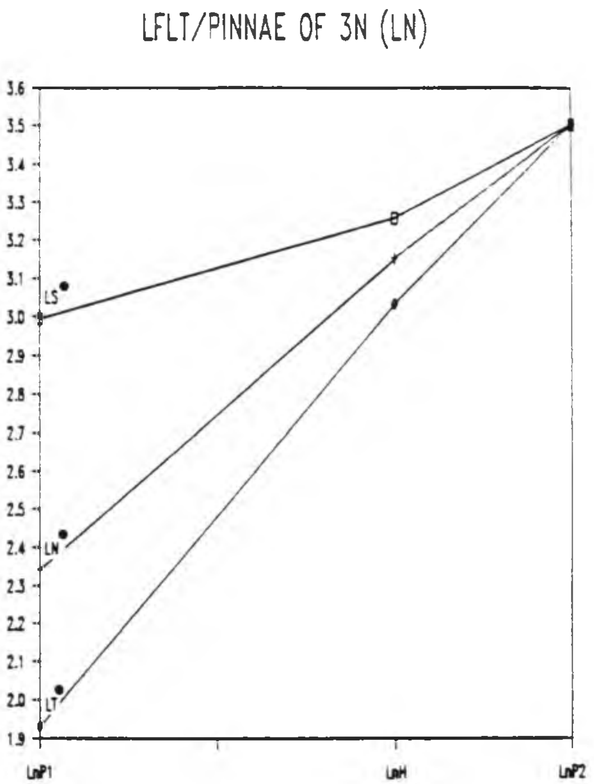

Plate XXIIIa.

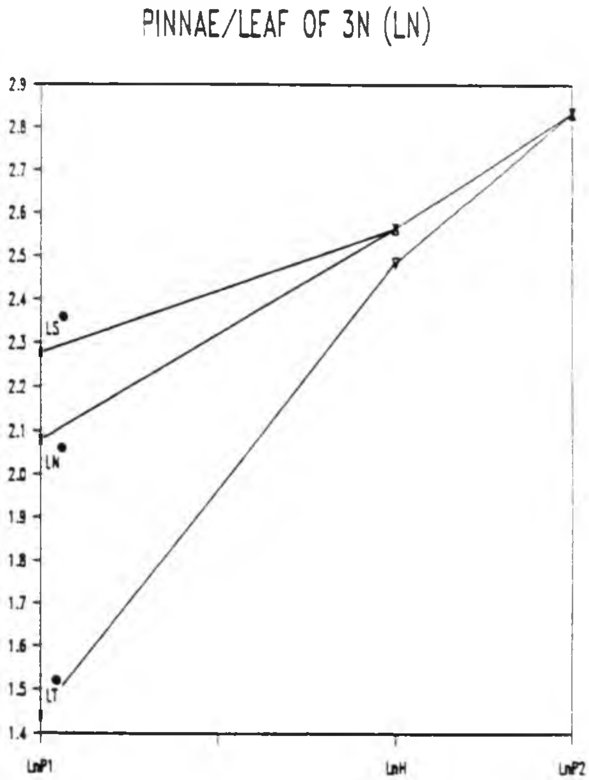

Plate XXIIIb.

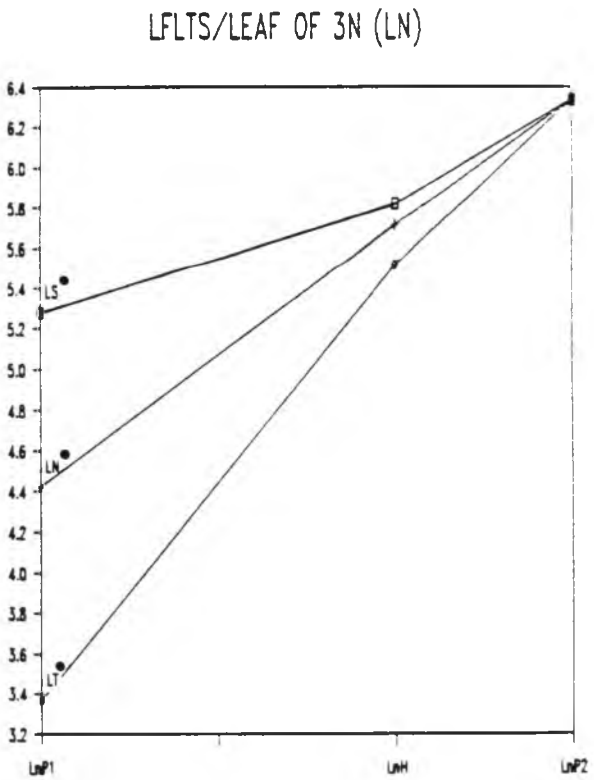

Plate XXIIIc.

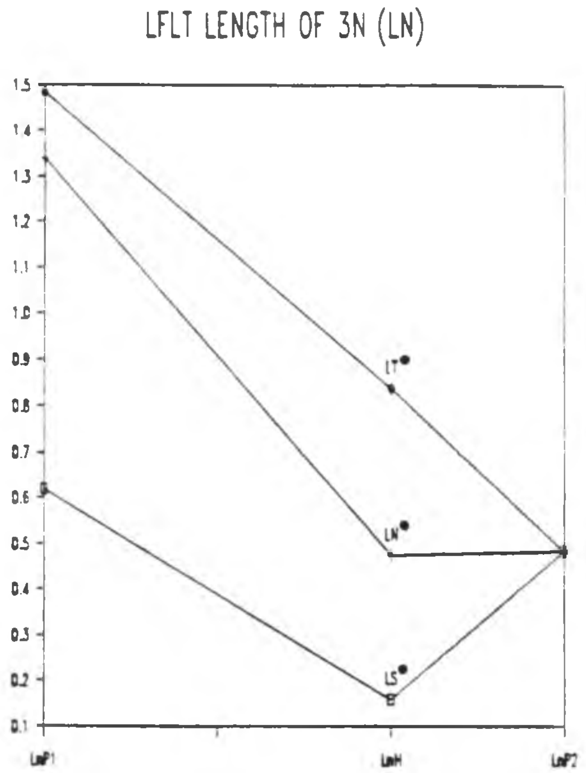

Plate XXIIId.

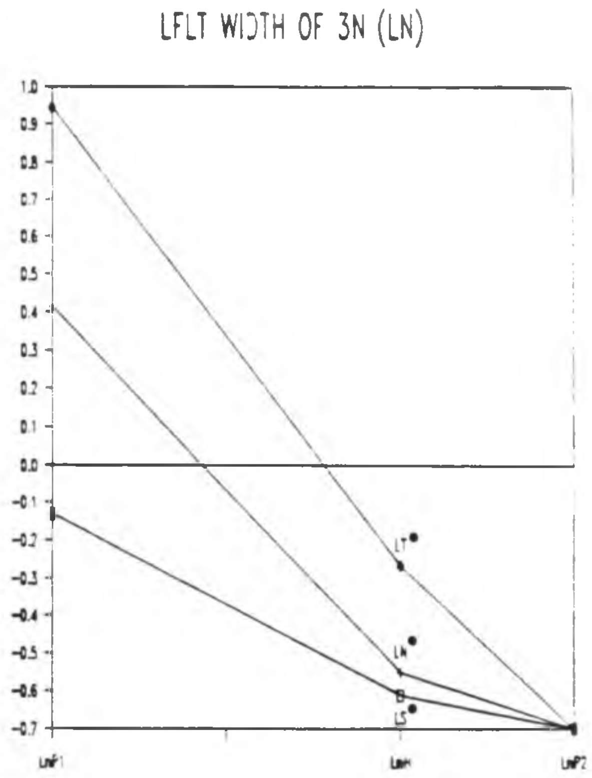

Plate XXIIIe.

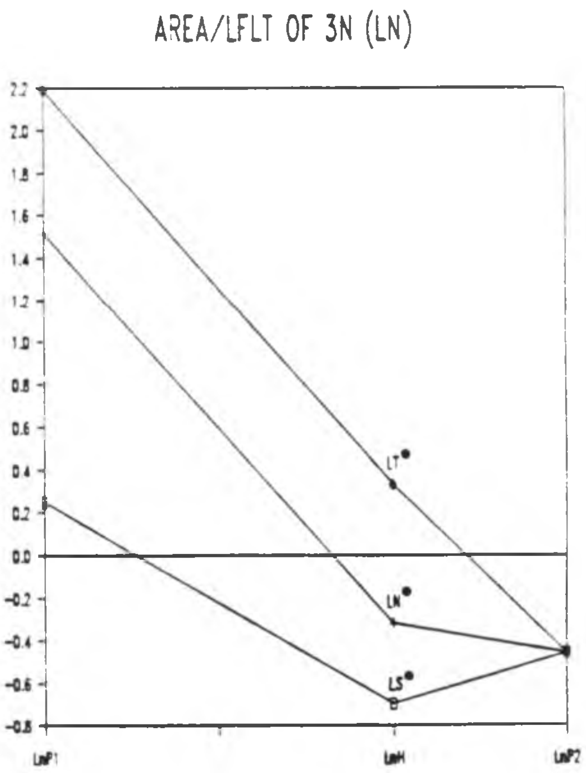

Plate XXIIIf.

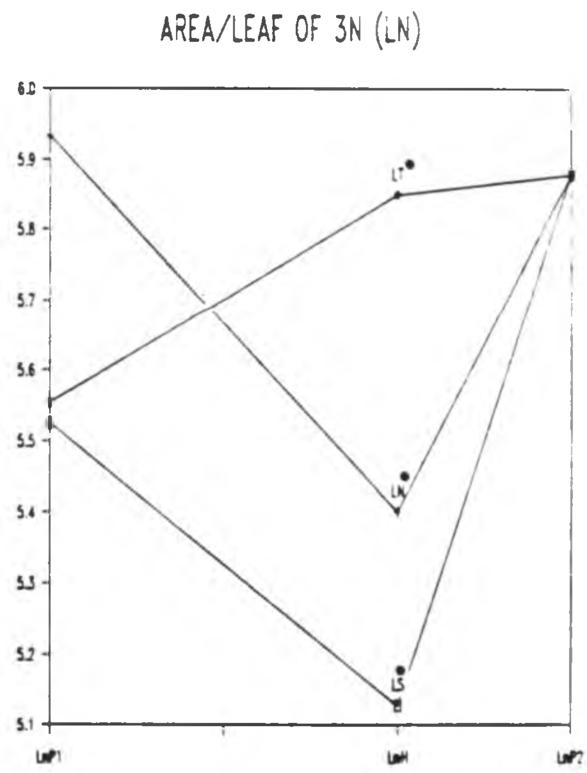

Plate XXIIIg.

Plate XXIV. Leaf trait plots of a triploid interspecific hybrid plotted to account for dosage effects (the hybrid is placed one-third towards the tetraploid parent on the x-axis):

-- L. *pallida* K376 x L. *shannoni* K445 (3x=78) "YS"

LFLT/PINNAE OF YOUNG 3N (Ln)

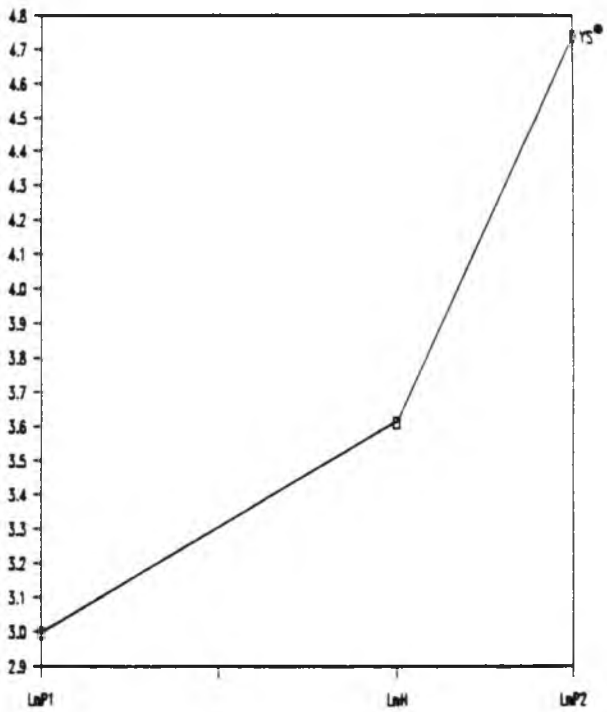

Plate XIVa.

PINNAE/LEAF OF YOUNG 3N (Ln)

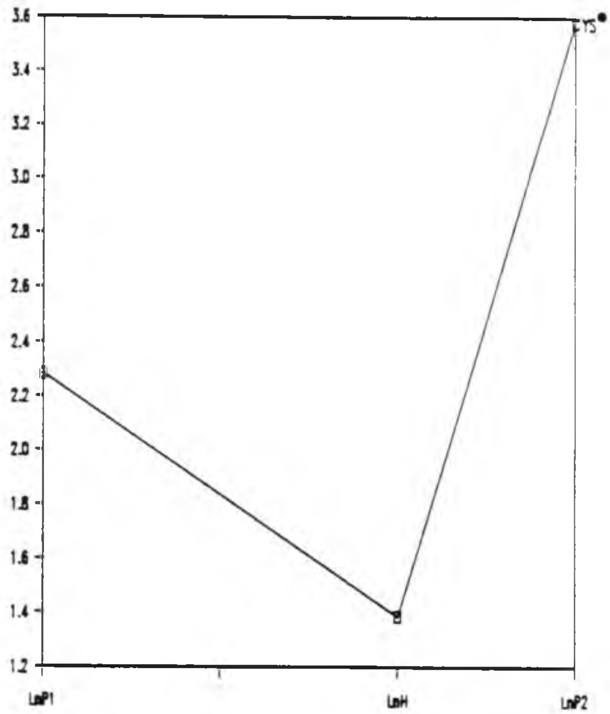

Plate XIVb.

LFLTS/LEAF OF YOUNG 3N (Ln)

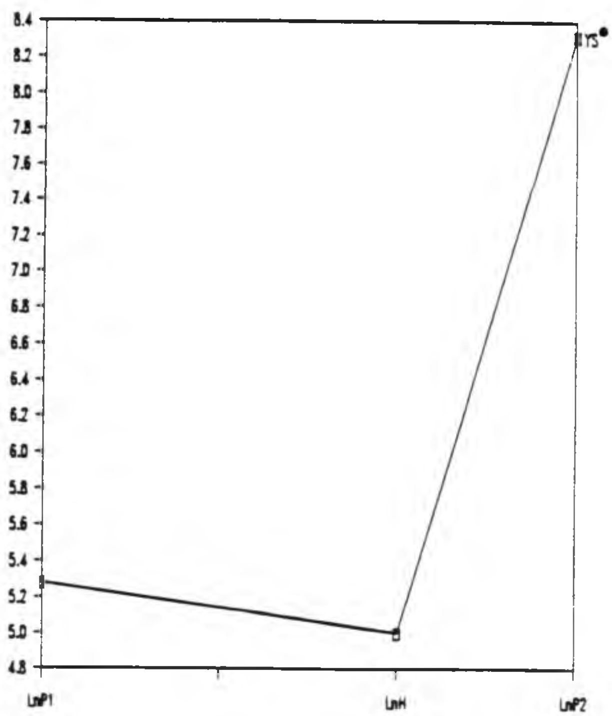

Plate XIVc.

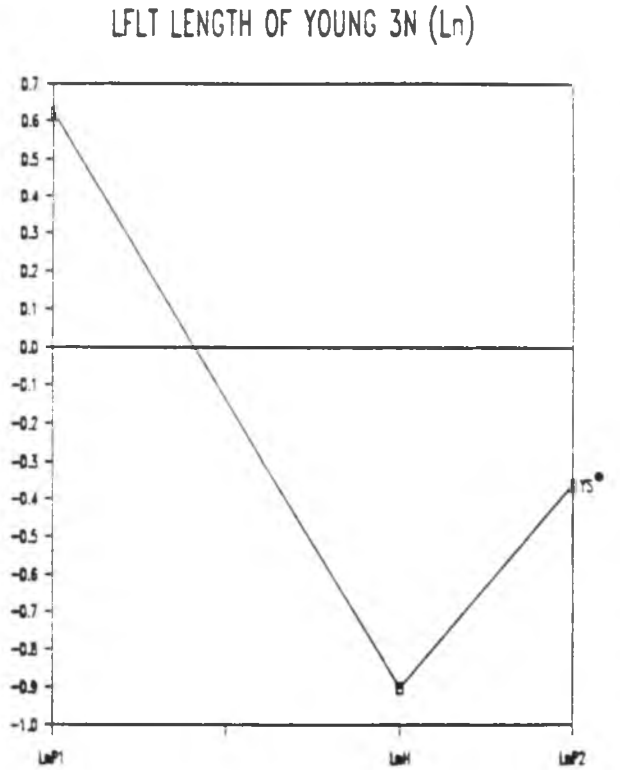

Plate XIVd.

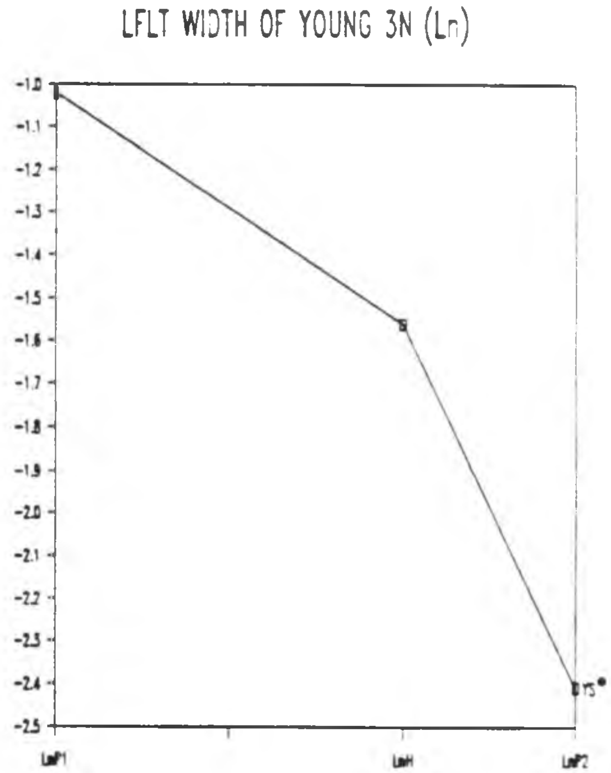

Plate XIVe.

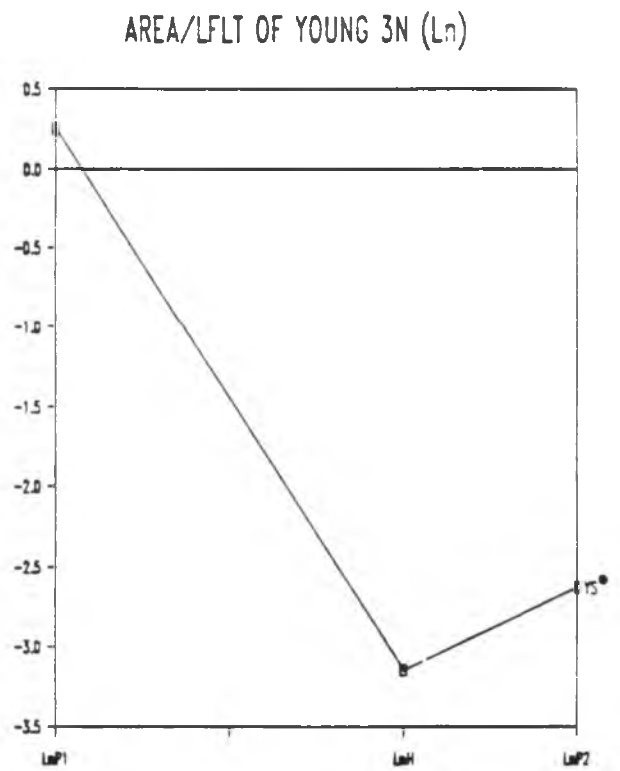

Plate XIVf.

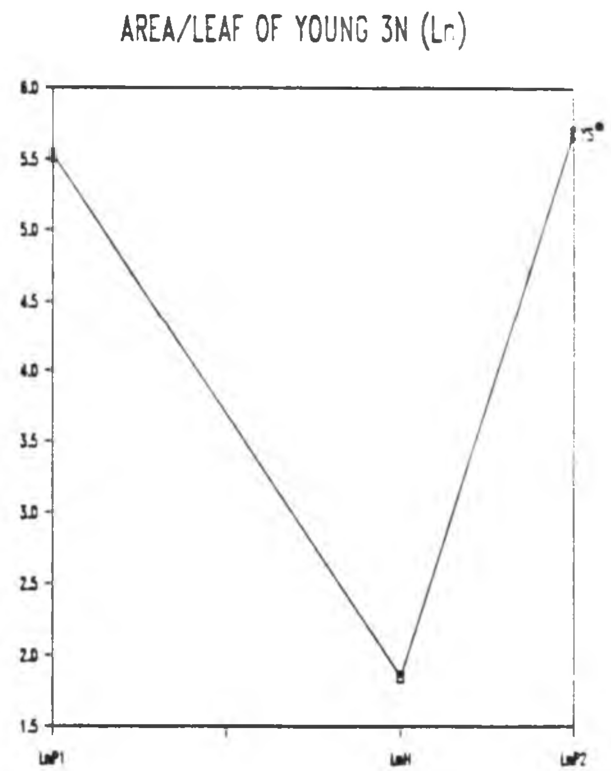

Plate XIVg.

Plate XXVa-g. Leaf trait plots of four tetraploid interspecific hybrids.

-- *L. pallida* K376 x *L. diversifolia* ssp. *diversifolia* K165 (4x=104) "YD"

-- *L. diversifolia* ssp. *diversifolia* K156 x *L. pallida* K376 (4x=104) "DY"

-- *L. leucocephala* K8 x *L. diversifolia* ssp. *diversifolia* K500 (4x=104) "LD"

-- *L. diversifolia* ssp. *diversifolia* K156 x *L. leucocephala* K8 (4x=104) "DL"

LFLT/PINNAE OF 4N (Ln)

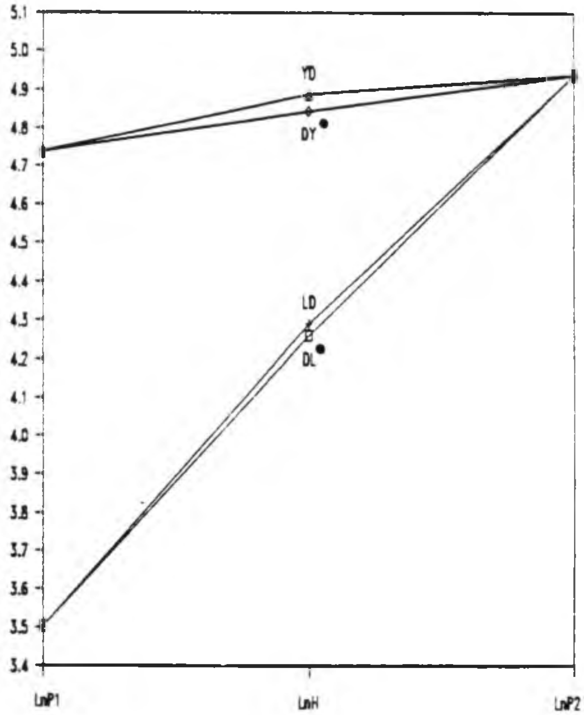

Plate XVa.

PINNAE/LEAF OF 4N (Ln)

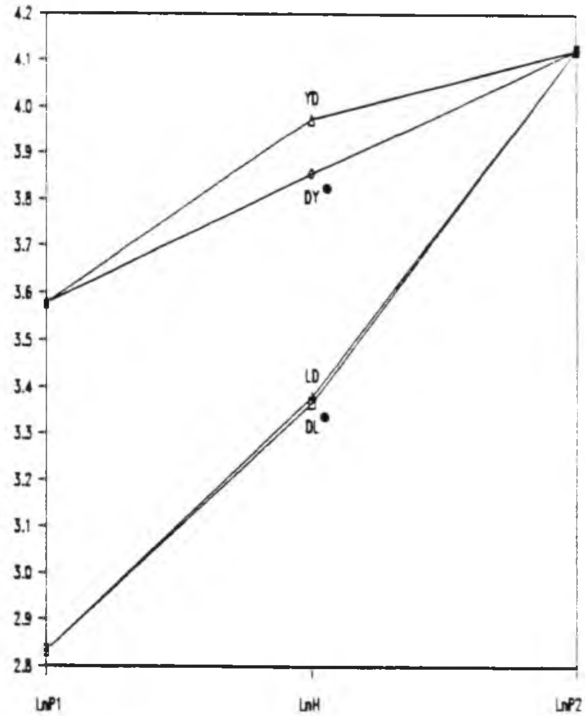

Plate XVb.

LFLTS/LEAF OF 4N (Ln)

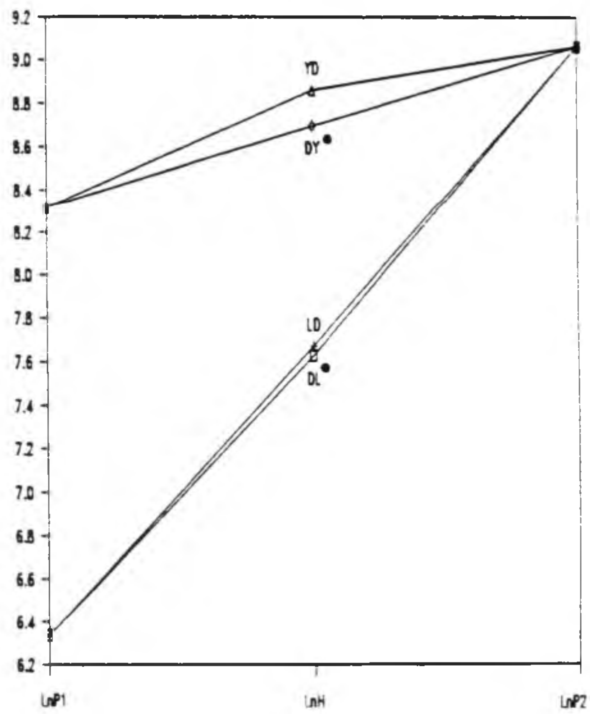

Plate XVc.

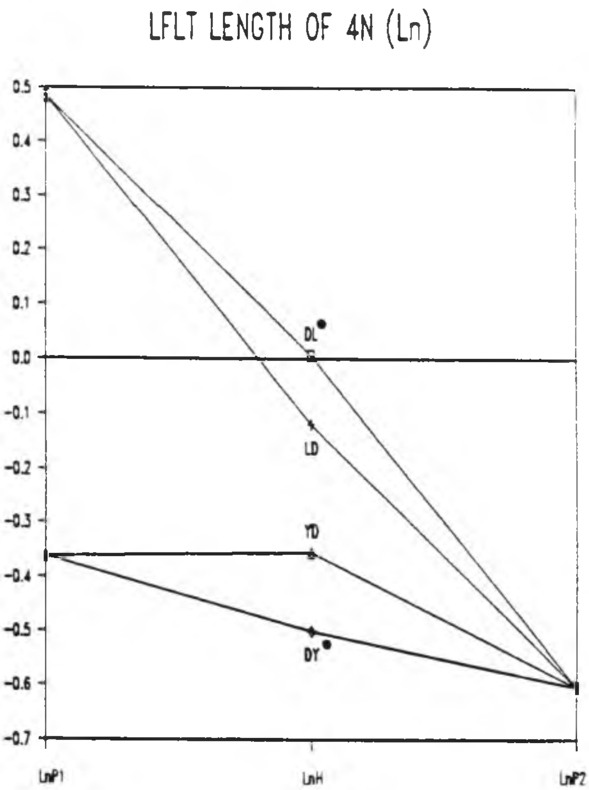

Plate XVd.

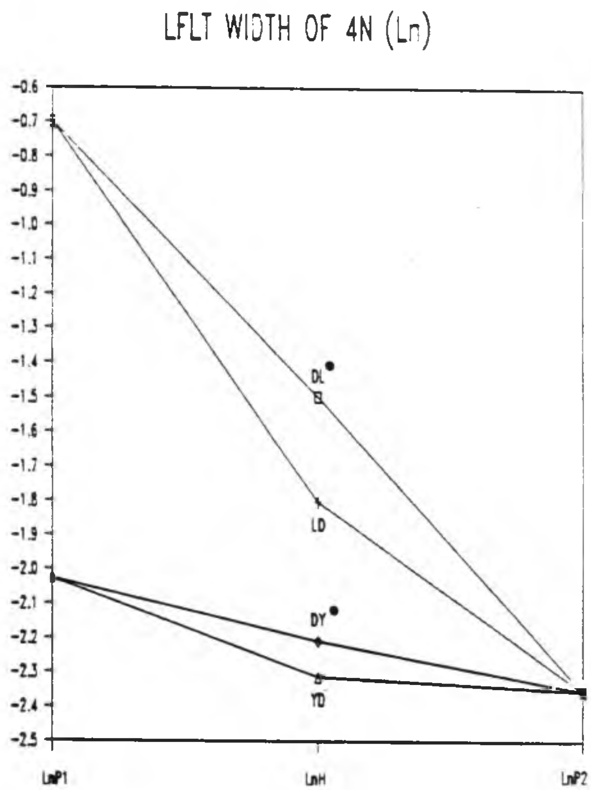

Plate XVe.

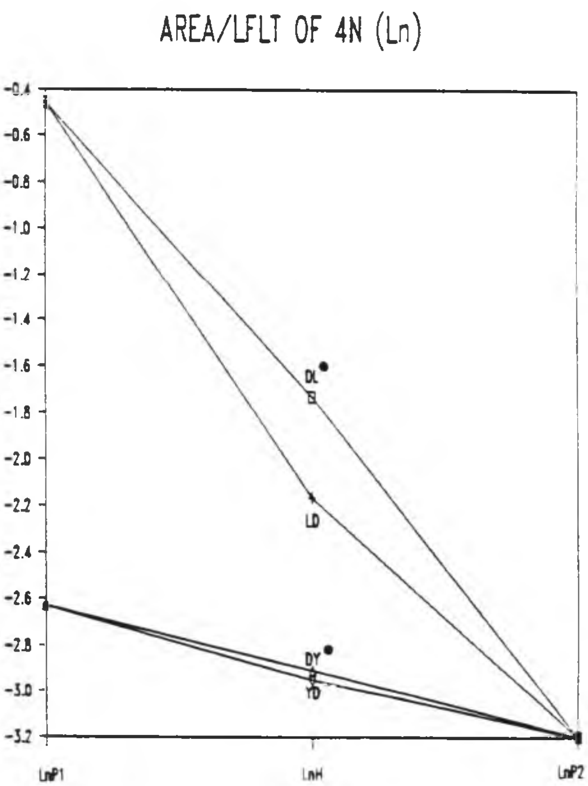

Plate XVf.

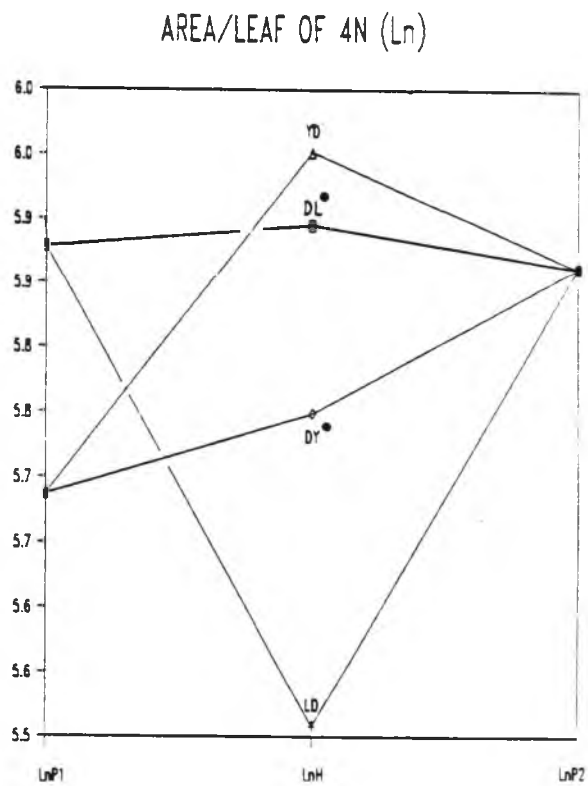

Plate XVg.

Appendix 5. Agronomic Characteristics of *Leucaena* Species.

5.1. Wood Yield of *Leucaena* Species.

Species with the highest wood production at Cali, Colombia included lines of *L. diversifolia* ssp. *trichandra*, *L. leucocephala*, and *L. trichodes* (Hutton, 1981). *L. pulverulenta*, *L. lanceolata* ssp. *lanceolata* and *L. esculenta* gave poor wood yields. The high-yielding "*L. collinsii*" reported by Hutton (1982b) was later reidentified as *L. leucocephala*. Panjaitan and Blair (1984) noted that *L. leucocephala* slightly outyielded *L. diversifolia* ssp. *diversifolia* K156 in Indonesia.

Table 51.-- Maximum tree height and diameter at basal height (DBH), typical tree shape, and estimated wood production potential of *Leucaena* species. Data based on observations of trees in Mexico and Hawaii.

Species	Tree Height	Max. DBH	Tree Shape	Wood Potential
	m	cm		
collinsii	15	20	wide tree	medium-high
divers. trichandra	18	16	slim tree	medium-high
divers. diversifolia	20	35	slim tree	high
esculenta	15	28	spreading tree	medium-high
greggii	8	15	shrub	low
lanceolata lanceolata	8	20	shrubby tree	low-medium
lanceolata sousae	13	20	spreading tree	medium-high
leucocephala glabrata	22	41	slim tree	high
leuc. leucocephala	15	30	shrubby tree	medium-high
macrophylla	8	13	shrubby tree	medium
pallida	8	7	shrubby tree	medium-high
pulverulenta	20	50*	slim tree	medium-high
retusa	8	7	shrub	low
shannoni	10	26	spreading tree	medium-high
trichodes	8	11**	spreading tree	medium

* = from Hook. J. Bot. 4:417. 1842.
** = "*L. multicapitulata*" (=*L. trichodes*; Table 3) grew to 20 m (Schery, 1950).

Wood production is related to both wood volume and wood density. Wood density of L. leucocephala ranges from 0.4-0.7, increasing with age (Bawagan, 1982). Trees with slow growth rates may have high wood densities (Bawagan, 1982). Graham and Harris (1982) reported the wood density of L. diversifolia ssp. diversifolia K156 was 0.55. L. pulverulenta's common name, "little-leaf lead tree", implies that its wood is extremely dense, but it was about 0.67 (Hook. J. Bot. 4:417, 1842).

5.2. Forage Yield of Leucaena Species.

Relatively few studies have been made on the forage quality of other species other than L. leucocephala. Bray (1982) found L. diversifolia ssp. trichandra CPI 46568 (a Guratemalan accession) at four sites in Australia yielded from 11-151 % of the edible dry matter (leaf plus young shoot) of the control L. leucocephala K500. Kirmse (1986) observed "good" coppice regrowth of L. retusa in a forage trial in Texas.

Hutton (1986, personal communication) concluded from extensive research that the primary requirement of a good leucaena species for forage was consistently high edible dry matter yields over several cutting periods. He suggested that in vitro dry matter digestibility (IVDMD), shortened internode length, and multiple stems were desirable traits of fodder leucaenas.

Telek (1982) reported the procyanidin level was too high for economic extraction of protein concentrates from leaves. D'Mello and Fraser (cited in Hegde, 1982) reported tannin contents from 2.0-3.4 % in leucaena forage. Lowry et al. (1984a) noted that the tannin content was about 1 % tannic acid equivalent, while the total phenolics averaged 5 % dry wt in L. leucocephala foliage. Hegde (1982) found no evidence that growth of Japanese quail was suppressed by the tannin content of leucaena forage.

5.3. Foliar Mimosine Content of Leucaena Species.

L. leucocephala has a higher foliar mimosine content than most other Leucaena species (Brewbaker and Kaye, 1981; Brewbaker et al., 1972). As some lines in these studies were later reidentified taxonomically, their data were modified accordingly in Table 52. Mimosine is no longer technically a problem in ruminant diets (Jones and Lowry, 1984) because of recently discovered rumen microflora able to digest mimosine and dihydroxypyridine (DHP).

Megarrity (1980) reported that mimosine levels in L. trichodes (CPI 74793) averaged four times that of L. leucocephala K500. Mimosine levels were higher following applications of nitrogen fertilizer alone (20kg N/ha weekly) than only with rhizobial inoculation of strains NGR8 and CB81.

Table 52. -- Foliar mimosine percentages of *Leucaena* species. Data mostly from Brewbaker and Kaye (1981) and Brewbaker et al. (1972).

Leucaena Species	Number of Entries	Mean Mimosine % ± Std. Dev	Range
collinsii	8	1.85 ± 0.56	1.05 - 2.66
diversifolia trichandra	14	2.43 ± 0.55	1.47 - 3.31
diversifolia diversifolia	10	2.05 ± 0.57	1.22 - 3.00
esculenta	5	1.69 ± 0.78	0.45 - 2.40
lancolata lanceolata	7	3.85 ± 0.73	2.75 - 4.87
lanceolata sousae	4	3.76 ± 0.24	3.51 - 4.06
leucocephala	29	approx. 4.0**	1.0 - 7.0*
macrophylla	1	2.84 ± 0.00	2.84
pallida	3	1.81 ± 0.48	1.32 - 2.27
pulverulenta	3	1.53 ± 0.87	0.60 - 2.32
retusa	1	3.94 ± 0.00	3.94
shannoni	8	1.56 ± 0.77	1.03 - 3.35
trichodes	1	4.44 ± 0.00	4.44

* Gonzalez, 1966.
** Brewbaker and Hylin, 1965.

Young and old plant tissues vary widely in mimosine content (Wong and Devendra, 1982). Unexpanded leaves of *L. leucocephala* and *L. trichodes* averaged 270 and 231 % more mimosine, respectively, than the first expanded leaf in 18 replications (Megarrity, 1980) and ranged from 1.4-11.6 % D.M in tissues of various ages. Mean mimosine content calculated in terms of the water content of the leaf (Lowry, 1981) was nearly constant, and correlations between mimosine percentages of green and dry leaves had r=0.971 (Jones, 1980). Two examples of recently developed methods of mimosine determination are those of Megarrity (1978) and Lowry et al. (1984b).

Gupta and Patil (1981) initiated a mutation breeding program aimed at mimosine-free leucaenas. The critical level for viability of dry seeds was 100-140 krad gamma rays. No reduction of mimosine was gained, and the mean seed set was reduced. Since mimosine was determined to be under polygenic control (Gonzalez et al., 1967) and because mimosine genes may be carried on each basic set of chromosomes (x=13 or 14) in L. leucocephala, radiation breeding for reduced mimosine may be very difficult. Results of the study were not published to our knowledge.

5.4. Rhizobial Root Nodulation of Leucaena Species.

Most Leucaena species can be nodulated effectively with the same strain of fast-growing rhizobia. Halliday and Somasegaran (1982) were not able to nodulate four lines of L. retusa (K501, 502, 504, and 506, all from Big Bend, Texas), with rhizobial strains TAL 309, TAL 310, TAL 582, TAL 583, TAL 600 and TAL 658. L. pulverulenta also had poor nodulation with some strains (Table 53). Thoma (1983), however, was able to effectively nodulate L. retusa using two rhizobial strains collected in Texas (Table 54). Schroder and Alameda (1986) also reported the isolation of an effective rhizobial strain for L. retusa.

Table 53. -- Nodule numbers on roots of *Leucaena* species raised in sterile growth pouches (Halliday and Somasegaran, 1982).

Specific Epithets	K#	Mean Number of Nodules per Plant — Rhizobium Strains: TAL 1145	TAL 582	TAL 600
leucocephala glabrata	K8	16.75	13.75	15.75
diversif. diversifolia	K156	17.50	8.00	22.00
lanceolata lanceolata	K10	21.00	19.75	21.00
shannoni	K405	10.00	0.00	5.75
pulverulenta	K19	0.50**	1.25*	4.50**
retusa	K501	0.00	0.00	0.00

* only one of three replicates nodulated.
** only two of three replicates nodulated.

Table 54. -- Average weight and nitrogen content in *Leucaena* species with and without inoculated rhizobia. Data modified from Thoma (1983).

Specific Epithets	Number of Accessions	Mean Dry Wt. Per Plant (g): Control	With R1C	With R7A
collinsii	1	218	732	732
diversif. trichandra	1	65	338	318
esculenta	1	339	1278	997
leucocephala	13	245	799	757
pulverulenta	2	63	175	118
retusa	1	178	320	205

Rhizobial strain R1C from near Edinburgh, Texas.
Rhizobial strain R7A from Brownsville, Texas.

Ineffective nodulation may be the primary cause of the complete field mortality of *L. retusa* planted in three trials-- International Germplasm and Forestry Institute (IGFRI) at Jhansi, India (Gupta and Patil, 1984a), on a Colombian oxisol (Hutton, 1984), and in Bogalusa, Louisiana (Table 30), where all *L. greggii* and *L. retusa* died.

5.5. Vegetative Propagation.

Leucaenas can be propagated using tongue, whip, and cleft grafts (Zabala, 1977; Versace, 1982; Pecson, 1985). Tongue and whip grafts were made using three-month old scion wood. Intergeneric grafts of *Acacia* or *Lysiloma* with *Leucaena* failed, but all species combinations tested among *Leucaena* were intercompatible (Versace, 1982). Dijkman (1958) reported that common *L. leucocephala* grafted onto *L. pulverulenta* rootstocks grew 100 % bigger than control *L. leucocephala* over a four year period.

Rooting *Leucaena* cuttings is considered to be difficult, although some researchers have reported excellent success. Hu et al. (1982) reported over 90 % rooting in one week using one cm diameter woody cuttings maintained under mist spray. Zabala (1977) found the best rooting (the level was not reported) was with cuttings averaging 1.5-2.0 cm in diameter. Sands (1986, personal communication) noted that in several regions of Australia, leucaenas were commonly propagated by simply pushing stakes into the ground. Leucaena posts up to a meter long are sometimes used in the Philippines to establish fences (Logrono, 1986, personal communication). Takahashi and Ripperton (1949) had only 26.7 % survival of their rooted cuttings in the field. Ghatnekar et al. (1982) had some success (unreported level) with air-layering of *L. leucocephala*.

5.6. Tissue Culture of *Leucaena* Species.

Plantlet regeneration using tissue culture techniques has been achieved to varying degrees (Venketeswaran and Romano, 1982; Ravishankar et al., 1983; Kulkarni et al., 1984; Datta and Datta, 1984; Goyal et al., 1985; Dhawan and Bhojwani, 1985).

Dhawan and Bhojwani (1985) reported that shoots could be multiplied 6-7 fold in three weeks using certain napthalenacetic acid (NAA) and indole-3-butyric acid (IBA) concentrations. Olvera and West (1980) found that the highest root elongation of seedlings occurred at 160 ppm of indoleacetic acid (IAA). Both Goyal et al. (1985) and Dhawan and Bhojwani (1985) determined that the optimal temperature for *in vitro* propagation was 30^{o}C.

The method of Goyal et al. (1985) gave the highest rooting success (80 %) reported to date, as far as we know. They used 3 ppm of BA (N-6 benzyladenine) and 5 ppm of NAA in Murashige and Skoog (MS) media to stimulate shoot multiplication of *L. leucocephala* K67 (4-5 weeks). Removal to one-half strength MS media with three milligrams per liter IBA stimulated root formation, and 3 x 10^{-6} M BAP and 5 x 10^{-6} M IAA plus adenine or glutamine helped reduce leaflet drop. Venketeswaran's report (1983) of successful regeneration from callus may need validation since he may have obtained regeneration from meristematic regions embedded in the callus. His method of isolating protoplasts from leaves could be utilized in somatic hybridization via protoplast fusion.

5.7. Flowering Induction of *Leucaena* Species.

Hormone application was not successful (Pan, 1985) in inducing flowering. Grafting, however, may supply an alternative method; for example, flowering twigs of *Pistachio* which had been stored for six weeks at 5°C continued flowering after being grafted (Vithanage, 1984). Grafting scionwood on florific *L. leucocephala* ssp. *leucocephala* rootstocks could promote heavier or earlier flowering of scionwood.

5.8. High Elevation Tolerance of *Leucaena* Species.

Most reports suggest *L. leucocephala* can grow vigorously to about 1000 m at the equator and 500 m at 20°N (or S). *L. leucocephala* generally does not grow in regions north of 30°N (Hegde, 1982; Houming, 1982). One of the highest sites where *L. leucocephala* grew reasonably well (10.4 dry t/ha/yr forage) was at Medellin, Colombia at 1425 m (Hervera, 1967).

Hill (1971) reported *L. leucocephala* grew well at 1800 m in Indonesia. These "*L. leucocephala*", however, could be naturalized *L. pulverulenta* x *L. leucocephala*, like those reported by Lowry et al. (1984a). Prussner (1982) noted that yield reduction to *L. leucocephala* occurred above 500 m elevation in Indonesia.

In most areas in Mexico it is not common to find *L. leucocephala* growing well above 500 m; however, many *Leucaena* species are endemic to higher elevations above 500 m (Table 55). Species found exclusively above 500 m are *L. collinsii*, both *L. diversifolia* subspecies, *L. esculenta*, *L. greggii*, *L. pallida* and *L. retusa*. Cultivation of some species may have artifically raised and/or lowered native elevation ranges of some species, particularly those like *L. esculenta* which were favoured foods of ancient Mexican peoples (Zarate, 1984).

Table 55. -- Elevation range, latitudinal range, and estimated high elevation tolerance of *Leucaena* species. Modified from Appendix 1.

Species	Elevation	Latitude°N	Tolerance
	meters		
collinsii	675-850	15'50-16'46 N	medium
div. ssp. trichandra	550-3000	13'49-17'05 N	medium high
div. ssp. diversifolia	75-1600	18'52-19'35 N	medium high
esculenta	500-2350	16'45-21'38 N	medium high
greggii	550-1830	24'40-26'30 N	high*
lanc. ssp. lanceolata	30-910	17'58-23'18 N	low
lanc. ssp. sousae	90-1075	16'13-16'36 N	low
leucocephala	0-1700	0'00-27'56 N	low
macrophylla	250-1800	15'59-19'31 N	medium
pallida	1400-2000	17'05-19'30 N	medium high
pulverulenta	5-900	24'50-26'25 N	medium high
retusa	400-1460	29'18-30'40 N	high*
shannoni	5-900	13'33-19'47 N	low
trichodes	10-950	0'00-11'16 N	low

* Withstands frost without dieback.

L. diversifolia performed better at 1450 m than Salvador- and Peru-type *L. leucocephala* in Indonesia, (unpublished report of Balai Penelitian Ternak, 1982). At

Haleakala, Maui (610 m, 21°N), L. *diversifolia* ssp. *diversifolia* K156 significantly outperformed L. *leucocephala* K8 and L. *macrophylla* K158 (unpublished data of Brewbaker, 1985, 1987); however, poor performance of L. *leucocephala* at the site could also be attributed to its inability to handle the soil pH (pH 4.0, low Al saturation).

5.9. Cold Temperature Tolerance of *Leucaena* Species.

Poor growth of L. *leucocephala* due to cold temperatures is well documented. For example, wood yields in Taiwan were limited primarily by low temperatures (Hu and Kiang, 1982). The critical temperature for growth of L. *leucocephala* was 10°C (Hutton and Gray, 1959, Houming, 1982), and the minimum temperature it could withstand without dieback was -1 to -5°C (Houming, 1982; Pathak, 1983; Hegde, 1982; Jones, 1980) for varying, but short, lengths of time. Pound and Martinez C. (1983) cited -10°C as the highest temperature which can still kill L. *leucocephala* rootstocks. L. *leucocephala* grew reasonably well (10.4 dry t/ha/yr forage) at Medellin, Colombia at 1425 m, but mean annual temperature at the site was 21°C (Hervera, 1967).

L. *retusa* and L. *greggii* are frost tolerant. A severe winter freeze in Kingsville, Texas in 1983 allowed Glumac and Felker (1984) to compare the frost tolerance of 25 lines of L. *leucocephala*, 37 lines of L. *pulverulenta* (all from southern Texas) and one line of L. *retusa*. The temperature fell to -12°C and stayed below freezing for 115 consecutive hours. Both L. *retusa* seedlings (8 cm) and trees (1.5 m) showed no damage. L. *leucocephala* and L. *pulverulenta* were killed to the ground.

We (1985, unpublished data of Van Den Beldt and Sorensson) observed that frost damage from a 1984 winter storm was less on L. *pulverulenta* than on L. *leucocephala* in Rio Grand City, Texas. In Nuevo Leon, Mexico, where the temperatures dropped to -8°C, L. *pulverulenta* in the canyon from Linares to Galeana at 1100-1300 m were killed to the ground, but L. *greggii* was not damaged.

Kirmse (1985), of Energy Development/International, reported the tree survival following their 1985 winter of several L. *leucocephala* lines and L. *diversifolia* ssp. *diversifolia* K156 planted in New Mexico. Minimal winter temperatures were not reported. Tree survival of L. *leucocephala* K6, K8, K28, K29, K62, K67, K132 and "Peru" K500 by May, 1986 ranged from 3.1-12.5 %; of these, K62 had the best survival. L. *diversifolia* ssp. *diversifolia* K156 had 15.6 % survival. L. *leucocephala* K636 had the highest tree survival (50.0 %) of all species tested.

5.10. High Temperature Tolerance of *Leucaena* Species.

Most species withstand tempreatures above 40°C without damage. At the International Germplasm and Forestry Institute (IGFRI) in Jhansi, India, L. *lanceolata* ssp. *lanceolata* K10, L. *lanceolata* ssp. *sousae* K468, L. *shannoni*

K405 and CIAT 78-40 and L. leucocephala K8 and K28 were undamaged even though the mean maximum temperature in May and June, 1984 was 43°6 C. Young foliage of L. diversifolia ssp. diversifolia K156 and L. trichodes CIAT 78-55 died (Gupta and Patil, 1984a).

The optimum air temperature range for L. leucocephala is 25-30°C (Houming, 1982). Pathak and Patil (1982) and Houming (1982) both found L. leucocephala could withstand air temperatures of 46°C, but growth was reduced. Root scorching occurred on L. leucocephala when soil temperatures exceeded 50°C (Houming, 1982).

5.11. Drought Tolerance of Leucaena Species.

Deeply-rooted L. leucocephala survived with only 150 mm annual rainfall (Singh et al., 1983) or 250 mm annual rainfall and ten months of drought (NAS, 1977). L. leucocephala, however, needs substantially more rain to sustain economic growth. Hegde (1982) and Brewbaker et al. (1982a) both reported that over 100 mm/month was necessary to support vigorous regrowth of leucaena which had been cut for forage. Wide variation among reports for the water requirements of leucaenas vary due to such factors as rooting and water table depth, salinity, and conditions which could permit water uptake into the leaflets from the air (Brewbaker and Hutton, 1979). Although there is less resistance to water taken up by leaflets than by roots, the significance of this water source is not known. L. leucocephala varieties varied in drought tolerance. Sheikh (1982) noted that K8, K28, K29 and K67 performed significantly better than <K132> at Peshawar, India, with 360 mm annual rainfall.

5.12 Waterlogging Tolerance of *Leucaena* Species.

No studies of waterlogging tolerance are known to have been reported for *Leucaena* species, except for *L. leucocephala*, which usually performs poorly. Exceptions include observations by Brewbaker (1985, personal communication) that *L. leucocephala* ssp. *leucocephala* grew well along waterlogged canal soils in Thailand, and Hill's report (1971) that *L. leucocephala* grew well in Indonesia with 5080 mm/yr rainfall. Balai Penelitian Ternak Institute (1982) reported that growth of *L. leucocephala* in Indonesia was inhibited in areas receiving over 3500 mm rainfall/yr. Liming a waterlogged Australian soil from pH 5.4 to 6.0 increased yields 300 % (Jones, 1984). It is not known if inhibition of calcium uptake in other waterlogged soils is a primary limiting factor of growth.

5.13. Salt Tolerance of *Leucaena* Species.

Of the species, only *L. leucocephala*'s growth on saline soils has been reported to our knowledge. Most species are believed to be salt-sensitive. Some *L. leucocephala* ssp. *leucocephala* in Thailand appeared to be salt-tolerant (Chaturvedi, 1981), and in Hawaii (Brewbaker, 1985, personal communication). Eavis et al. (1974) reported the maximum salt tolerance of *L. leucocephala* was 1.6 meq/100 g soil on a reclaimed soil. Although high pH is commonly associated with salinity, high pH tolerance of *L. leucocephala* appears to be good. *L. leucocephala* withstood pH 9 (Chaturvedi, 1981) and over pH 10 (Pathak, 1983).

5.14. Soil Acidity Tolerance of *Leucaena* Species.

Several species have better "acid" tolerance than *L. leucocephala*. Low pH tolerance per se, however, is not probably the primary limitation of growth of leucaenas on "acid" soils. This, for example, was evident by the satisfactory growth of *L. leucocephala* in high calcium pH 4.2 soils in Thailand and in laboratory tests of seedling growth at pH 4.0 (Koffa and Mori, 1986). Growth problems in acid soils may be related to toxic levels of minerals like high Al and Mn as well as too low levels of minerals like Ca, P, S, Mo and Zn.

Hutton (1981, 1984) and Hutton and de Sousae (1985) have done most of the published research on acid tolerance breeding in *Leucaena*. Hutton concluded that tolerance to low Ca was more of a problem than high Al tolerance from his work with *L. pulverulenta* x *L. leucocephala* hybrids (Hutton, 1984). Brewbaker (1986, personal communication) noted that Al toxicity was clearly secondary to Ca deficiency in trials at Townsville, Australia. Ahmad and Ng's data (1981), however, showed that in some high-calcium acid soils in

Thailand, Al was the primary problem. As pH decreased from 4.95 to 4.20, Al and Mn uptake was increased with a concommitant decrease in plant growth. Foliar Ca was not reported.

Hutton (1984) planted several Leucaena species in an attempt to locate better sources of tolerance than that of L. leucocephala and L. pulverulenta. L. esculenta, L. pulverulenta, and L. trichodes were too sensitive to low Ca in the Colombian oxisol to be maintained in the breeding program. Other species which often died when grown in the oxisol were L. retusa (probably complicated by nodulation problems) and some accessions of L. diversifolia ssp. trichandra, L. leucocephala, L. lanceolata ssp. sousae and L. shannoni. Foliar Ca contents were reasonably high, in L. leucocephala K420 (0.40-0.46 %) and L. diversifolia ssp. trichandra K454 (0.54-0.60 %). After one season K420 was 1.2 m tall, had yellowish leaves, and had root penetration to 20 cm.

Hutton (1981) ranked the Leucaena species by acid tolerance, based on their performance in a Carimagua Colombian oxisol using a 0-5 scale with increasing acid tolerance. Hutton ranked L. esculenta the lowest (0), followed by L. pulverulenta (0-2), L. leucocephala (1), and L. diversifolia (2-3). Oakes and Foy (1984) tested Leucaena species on acid Monmouth fine sandy loam soil in their laboratory. Their results are similar to Hutton's (1981) except for L. esculenta's high acid tolerance. Liming from pH 4.8-pH 6.6 decreased the root and top yields of L. esculenta 156 % and 108 %, respectively. This unexpected result was hypothesized to be due to nutrient deficiencies induced by the high pH.

L. leucocephala generally performs poorly in low pH soils. For example, dry matter yield of L. leucocephala at pH 4.5 was 6 % of that at pH 6.0 (Halliday and Somasegaran, 1982). Reports of L. leucocephala ssp. leucocephala growing well on acid soils probably suggest the soils had alkaline subsoils (Benge and Curran, 1975), such as those soils on which "L. multicapitulata" Schery were growing (Alvarez, 1986, personal communication). Although Ahmad and Ng (1981) reported the critical pH for survival was pH 4.45-4.75, the optimal pH typically cited for L. leucocephala was 5.5-8.0 (Kushalappa, 1980; Van Den Beldt, 1982).

Mycorrhizal associations in leucaena do not increase Ca absorption (Huang et al., 1985), but sulfur from gypsum increased Ca and Mg uptake (Sanzonowicz and Couto, 1981) and was a beneficial nutrient (Hutton, 1986, personal communication).

5.15. Insect Tolerance.

5.15.1. Psyllid Tolerance of Leucaena Species.

The psyllid, Heteropsylla cubana Crawford, has become the most important pest of leucaenas in most areas where it is grown. The psyllid problem was extensively reviewed in Leucaena Research Reports (1987, Vol. 7(2)).

Several reports (Brewbaker, 1986b; Othman and Prine, 1984; Sorensson and Brewbaker, 1984; Sorensson, 1987) noted the high tolerance of several *Leucaena* species to the psyllid *Heteropsylla cubana* Crawford. Lowry et al. (1986) suggested the resistance was correlated to high leaf phenolic contents in *L. pulverulenta* and *L. diversifolia* since psyllids did not appear to be inhibited by high mimosine levels in plant sap (about 10 % w/w (Tangendjaja et al., 1983)). Several other insects commonly found eating leucaena foliage, including moth caterpillars, coccids and beetles, apparently also ingest mimosine with no apparent ill effect.

Most of Othman and Prine's data on psyllid damage in Florida (1984) were similar to those of Sorensson and Brewbaker (1984) in Hawaii. The level of infestation in Florida was probably less than in Hawaii, however, since the average damage to *L. leucocephala* was only 4 on an increasing damage scale of 0-10. If two of their lines were misidentified, "*L. pulverulenta*" PI 443727 <=*L. diversifolia* ssp. *diversifolia*> and "*L. esculenta*" PI 443546 <=*L. leucocephala*>, it would account for the relative damage reported on their *L. esculenta* which were highly resistant in Hawaii and the relative tolerance of their *L. pulverulenta* which were all susceptible in Hawaii (Sorensson and Brewbaker, 1984). Taxonomic errors are not impossible, especially in accessions being grown for the first time. Lowry et al. (1986), however, also reported lower levels of damage on L. pulverulenta than on L. leucocephala, and the L. pulverulenta collections at Hawaii are limited somewhat geographically.

Psyllid damage in Hawaii was greatest soon after the introduction of the psyllid in 1984. At that time the Leucaena species with the least damage were L. collinsii, L. esculenta, L. pallida and L. retusa (Sorensson and Brewbaker, 1984). Hollingsworth et al. (1985) noted that L. collinsii (CSIRO 46567 and 46570) had high resistance. Some L. leucocephala, including K584 and K636, had moderate psyllid resistance (Sorensson and Brewbaker, 1984).

The ladybird beetle, Curinus coeruleus Mulsant, emerged as the primary psyllid predator in Hawaii, although the minute pirate bug, Paratriphleps laevisculus Champion, was also effective (Nakahara and Lai, 1984). In The Barbados the ladybird beetles, Cycloneda sanguinea L. and Diomus spp., as well as the lacewing, Chrysopus sp., were predatory on H. cubana (Proverbs, 1985). The psyllid can also be attacked by fungi during periods of rainy weather (Hsieh et al., 1987).

5.15.2. Other Insect Pests of Leucaena Species.

Reports on the resistance of Leucaena species other than L. leucocephala to insect pests other than psyllids are scant. Twig girdling beetles, Oncideres pustulata (Benge and

Curran, 1975), mole crickets, Gryotalpa africana (Quiniones, 1981) and mealybugs, Nipaecoccus vastator (Muniappan et al., 1981) are the only insects other than psyllids, which have been reported to kill L. leucocephala, as far as we know. Researchers have noted the seriousness of the damage to seeds caused by seed beetles, Araecerus levipennis and Araecerus fasciculatus (unpublished report of Singh et al., 1981; Vaivanijkul and Haramoto, 1969; Quiniones, 1981) and the bruchid beetle, Bruchidius mendosus (unpublished report of Singh et al., 1981). Seed beetle larvae often damaged over 90 % of the seeds in pods of L. leucocephala in the Philippines (Quiniones, 1981), and similarly levels of damage frequently occured in Hawaii (Sorensson, 1986, personal observation).

5.16. Disease Tolerance of Leucaena Species.

Few reports exist on the disease susceptibility of Leucaena species other than that of L. leucocephala. L. leucocephala was susceptible to Camptomeris leaf spot disease, Camptomeris leucaenae, but L. diversifolia, L. esculenta, L. pulverulenta and L. shannoni were resistant (Lenne, 1980). Numerous fungal and bacterial diseases have been reported on L. leucocephala and a few other Leucaena species, but most, like Camptomeris leaf spot, have only infrequently caused economic damage. Inadequate seedling care, insect and rodent damage, and/or harsh weather may contribute to the susceptibility of leucaenas to diseases.

Based on the literature, it appears the most damaging and frequent disease was gummosis, also called brown spot, caused by Fusarium semitectum. Singh et al. (1983) isolated F. semitectum from infected L. leucocephala and was able to reinfect undiseased trees using the inoculum. Van Den Beldt and Hodges (1980) attributed gummosis in Hawaii to Phytopthora dreschsleri. Ganoderma lucidum was occasionally a serious fungal disease in India (Pathak, 1986). In the Philippines, a Cercospora spp. and Colletotrichum graminicola were particularly damaging fungal diseases of leaves and seeds, respectively (Quiniones, 1982).