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EDITORS

P .Belletti, L.Quagliotti
DI.VA.P.R.A. - Plant Breeding and Seed Production University of Turin
Via P. Giuria 15 -10126 Turin -Italy
Fax +39 11 650.27.54 - Email: plantbre@pop.fileita.it

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CONTENT

FOREWORD

First of all we would like to welcome Paul Bosland, who has recently joined our Scientific Committee. Thank you, Paul, for your kind availability and good work!

The fifteenth issue of "Capsicum and Eggplant Newsletter" includes two invited papers: the first one, written by P. Pasko, R. Gil Ortega and M. Luis Arteaga, deals with resistance to PVY in pepper, while the second is a review! by P. Nowaczyk and R. Andrzejewski, on the situation of pepper breeding in Poland. Thank you very much to the above mentioned Authors, for their kind willingness to increase the scientific value of our publication.

As usual, the accepted contributions have not been modified and have been printed as received. So, only the Authors themselves are responsible for both the scientific content and the form of their own reports.

The co-operation between the Newsletter and the Food and Agriculture Organisation (FAO) has been renewed also for this year. In this way we are able to distribute the Newsletter to Institutions in about 140 countries allover the world. For more detailed information on distribution of the Newsletter, see the Table in the following page.

Please, remember that this Newsletter highly depends on the financial support of the recipients. Therefore, a subscription fee will be much appreciated. Due to the rise of printing and mailing costs, we have been forced to increase the fees with respect to those of the previous years. In the meantime, to make the payment less time-consuming and to reduce the bank costs, we have introduced the possibility of a 3-year subscription. Remember also that it is possible (and suggested!) to book your own copy, so quickening its delivery. Just fill in the order form on page 79 and send it to us, together with a copy of the payment order, which must always be made to Eucarpia. In case you decide to pay by credjt card, please use the voucher on page 81. Because of the lower banking costs, credit card payment is definetively wellcome.

The deadline for the submission of articles to be included in the next issue of the Newsletter (No. 16, 1997) is February 28, 1997. Please note that it is also possible to submit the paper on diskette. Details can be found in the enclosed sample sheet.

Piero Belletti and Luciana Quagliotti

Turin, 1st June 1995

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Capsicum and Eggplant Newsletter, 16 (1996): 11-27. Invited paper.

RESISTANCE TO POT A TO VIRUS Y IN PEPPERS

P. Pasko*, R. Gil Ortega** and M. Luis Arteaga**
*lnstitute of Vegetables and Potato Crops, Tirana, Albania.
**Servicio de Investigaci6n Agroalimentaria, Apartado 727, ESOO80 Zaragoza, Spain.

SUMMARY

The *Capsicum-potato* virus Y (PVY) interaction is a complicated one. The PVY worldwide, extension, the existence of many strains, their mutation, generally to more virulent ones, - the lack of an accurate characterization using standard *Capsicum* varieties, etc., seem to have increased study difficulties. Besides, it is not yet possible to establish a clear-cut distinction in the relationship between *Capsicum,* potato, tobacco and tomato PVY strains.

Sometimes different denominations are given to the same resistance genes; Other times these genes appear as 'strain-dependent I and another times as I non strain-dependent'. Despite the existence of two main patterns on the genetics of resistance to PVY on *Capsicum,* the monogenic recessive instead of oligogenic theory is more accepted and used in PVY studies and in breeding resistant pepper varieties.

1. INTRODUCTION.

Detected and described first by Smith in 1931 in potato (cited by De Bokx and Huttinga, 1981) potato virus Y (PVY) is widespread allover the world. It affects mainly the Solanaceous species, including important crops as potato, peppers, tomato and tobacco, but also other species of *Amarantaceae, Chenopodiaceae, Compositae* and *Leguminosae* families. Since the 50-ies, it causes real losses in *Capsicum,* alone and especially when associated with other viruses attacking peppers.

PVY is naturally transmitted by at least 25 species of aphids in the non-persistent manner and in the presence of a virus-coded helper component protein factor which assists transmission of the viral code (Brunt, 1988). *Myzus persicae* is considered the most important and efficient vector. Experimentally, PVY is easily transmitted by mechanical sap inoculation (De Bokx and Huttinga, 1981).

1.1. *Serologic propenies*

The PVY group is considered moderately immunogenic and with serologic relationships W among many members (Francki *et al.,* 1991). PVY has a strong immunological reaction, which enables the obtention of high titer antisera, and by using enzyme-linked immunosorbent assay (ELISA) (Clark and Adams, 1977) it is possible to detect it in very low concentrations. Immunodifussion can be applied using degraded virus as antigen (De Bokx and Huttinga, 1981).

considered serologically distant or not related with other potyviruses as tobacco etch virus (TEV), pepper veinal mottle virus (PVMV), bean yellow mosaic virus (BYMV), henbane mosaic virus (HMV), potato virus A (PVA) and passion-fruit woodiness virus (PWV) by De Bokx and Huttinga (1981), Gebre Selassie *et al.* (1985), Kim *et al.* (1987), Buchen- Osmond (1990), Abde1sa1am *et al.* (1989) and Moghal and Franck (1976). On the contrary, serologic relationship was found between PVY and TEV (Nagai, 1984), or between PVY and water melon mosaic virus 2 (WMV-2) (Abdelsalam *et al.,* 1989). According to ~ Caranta and Pal10ix (1996), at least five serologic groups have been reported in pepper potyviruses: PVY, TEV, pepper mottle virus (PeMV), chilli veinal mottle virus (CVMV) and PVMV.

Shukla *et al.* (1989) noted that po1yc10nal antibodies (Pab) are more useful than monoclonal antibodies (Mab) in potyvirus detection; on the other hand, the use of Mab-s has increased the sensitivity of ELISA method in PVY detection (Rose and Hubbard, 1986; Boonekamp *et al.,* 1991), and gives the possibility for PVY strain distinction in potato (Von Weidemann, 1991) but not in peppers (Gebre Se1assie *et al.,* 1985; Soto *et al.,* 1994).

Using the electro-blot immunoassay on reactivities of Pab-s for some potyviruses (PVY, TEV, soybean mosaic virus N (SMV-N), SMV-V, PWV, BYMV, clover yellow vein virus; (CYVV), maize dwarf mosaic virus A (MDMV-A), MDMV-B, MDMV-O and Johnson. grass mosaic virus (JGMV) Shukla *et al.* (1989) reiterate the conclusions of Moghal and Francki (1976) that, unless considerable caution is used in the interpretation of serologic data, serology may be a misleading approach for tracing relationships among potyviruses, and coat protein sequence data analysis are recommended.

1.2. *Moiecularproperties*

After Shukla *et al.* (1989) the coat protein sequence homology between distinct potyviruses was 38 to 71 percent, whereas for strains of individual potyviruses it was greater than 90 percent. Dougherty and Carrington (1988) reported that the amino-acid sequence of the capsid protein showed 60-80 percent similarity in TEV, tobacco vein mottle virus (TVMV), PVY and PeMV, which corresponds with the data of Van Der Vlugt *et al. (1989), who found 51-63 per cent homology between PVY-N and the coat protein ofTEV, TVMV, plum pox virus (PPV) and SMV and 91 per cent between PVY -Nand PeMV.*

1.3. *PVY symptoms on peppers*.

The typical symptoms of PVY on peppers, observed by most of the authors, are **'vein clearing'** which usually progresses into **'mosaic'** or **'mottling'**, and generally in '**veinbanding'** (Cook, 1963; Gebre Selassie *et al.,* 1985; Luis Arteaga and Gi1 Ortega, 1983). Vein and leaf necrosis are frequent, sometimes followed by **stem necrosis**, defoliation and/or even death of the plants (Simmonds and Harrison, 1959; Rana *et al.,* 1971; Ragozzino *et al.,* 1972; Marchoux *et al.,* 1976; Gracia and Feldman, 1977). Symptoms are not always evident on fruits (Lovisolo and Conti, 1976). Necrotic spots and fruit mosaic are observed in some pepper varieties (Ragozzino *et al.,* 1972; Luis

Arteaga and Gil Ortega, 1983) but particular symptoms are not always obtained on fruits. **Chlorotic and necrotic spots, mosaic, deformation and size reduction** are the most frequent fruit symptoms observed (Simons, 1956; Ragozzino *et al.,* 1972; Lockhart and Fischer, 1974).

Other different symptoms are reported on naturally PVY infected pepper plants, **as stunting, severe mosaic, leaf deformation and flower abortion** (Simons, 1956; Rana *et ai.,* 1971; Ragozzino *et ai.,* 1972; Lockhart and Fischer, 1974; Marchoux *et al.,* 1976; Gracia and Feldman, 1977; Luis Arteaga and Gil Ortega, 1983).)

Atypical symptoms are noted on various pepper varieties, as chlorotic or necrotic local lesions (Makkouk and Gumpf, 1976; Nelson and Wheeler, 1981; Gebre Selassie *et ai.,* 1983 and 1985; Marte *et ai.,* 1991), systemic speckling mottle (Zitter, 1972) and chlorotic spots (Erkan, 1986).

Symptoms on pepper plants can vary depending on strain and cultivar, while the symptoms on indicator plants are generally stable and used as a safe method for PVY diagnosis or assay. This permits to distinguish PVY from other possible viruses (De Bokx and Huttinga, 1981). The severity of symptoms depends on the plant age, the young ones being more susceptible (Zitter, 1972). The symptoms are strengthened by cold (Von Der Pablen and Nagai, 1973).

2. **PVY STRAINS AND PATHOTYPES.**

Due to the worldwide expansion of PVY, a large and even upsetting number of strains and pathotypes were reported by many authors. The classification of pepper PVY isolates into pathotypes is based on the differential resistance response presented to them by some particular *Capsicum* cvs. In pepper-PVY, the situation shows to be confused. Various authors have used different standard series of pepper varieties for PVY isolate classification. Furthermore, (i) the use of different methods in classifying pepper varieties as susceptible or resistant, e.g., the systems and genetic patterns used by Yon Der Pablen and Nagai (1973) or by Singh and Chenulu (1985), are very different from those used by Cook (1961 and 1963) and by Gebre Selassie *et al.* (1985) and (ii) the large number of mutations reported on PVY strains (Cook, 1961; Zitter, 1972; Yon Der Pablen and Nagai, 1973; Gebre Selassie *et al.,* 1985; Thomas *et al.,* 1989) increase the identification and classification difficulties.

In the attempt to distinguish and classify pepper PVY strains, much work on pepper PVY has been made in Brazil and Argentina (Nagai and Costa, 1972; Yon Der Pablen and Nagai, 1973), where at least six PVY strains were noted. In vast research led in California on 18 pepper PVY isolates, Makkouk and Gumpf (1974) could distinguish up to nine PVY strains in peppers using eight pepper varieties. After continuous and systematical investigation led in INRA-Montfavet (France) by Marchoux *et al.* (1974), Pochard (1977) and Gebre Selassie *et al.* (1985), the PVY isolates were classified first into two and later into three pathotypes (PVY-O, PVY-1 and PVY-1-2) (Table 1). In these studies mainly

pepper varieties proposed by Cook (1962 and 1963), by Nagai and Smith (1968) and by Smith (1974) were used. Using the same pepper differential series proposed by Gebre Selassie *et al.* (1985), a similar PVY pathotype hierarchy was found in Spain (Luis Arteaga and Gil Ortega, 1983 and 1986, Luis Arteaga *et al.,* 1993), in Australia (Thomas *et al.,* 1989) in Italy (Marte *et al.,* 1991) and in Turkey (palloix *et al.,* 1994). The applicability in breeding makes the system proposed by Gebre Selassie *et al.* (1985) the more commonly used and accepted now for pepper PVY strain classification into pathotypes.

Some pepper differential varieties recommended by Gebre Selassie *et al.* (1985) were occasionally used in other PVY studies, enabling us to make some relative comparisons of PVY strains originating from various geographical areas (Table 2). Anyway, the *Capsicum*
- PVY pathotype relationship in these studies either does not correspond totally with that
found in France, e.g., the different resistance level of 'Puerto Rico Wonder', 'Moura' and 'Ikeda' verified in Spain (Luis Arteaga and Gil Ortega, 1986, Pasko *et al.,* 1995) or often all the differential pepper varieties were not used. These cases do not enable us to identify all the French pathotypes with those found in Spain, Italy, Australia, or elsewhere, but only to find similarities between them.

Table 1. Classification of PVY isolates into pathotypes (Gebre Selassie *et al.,* 1985; Marchoux and Gebre Selassie, 1989).

Pepper varieties	Resistance Genes	**Pathotypes**		
		PVY-0	PVY-1	PVY-1-2
Bastidon	Pvr2+(=y+=vy)	SN	SN/SM	SN/SM
Yolo Wonder	Pvr2+(=y+= vy+)	SM	SM	SM
Yolo Y	Pvr2+(=ya=vy1)	R	SM	SM
Flordia VR-2	Pvr22(+eta=vy2)	R	R	SM
Serrano Veracruz	Vy2s???	R	R	R

S=susceptible, R= Resistant, N= necrosis, M= mosaic. After Palloix and Kyle (1995) and Palloix et al (1996)

In the present situation remains yet actual the objection put by Makkouk and Gumpf (1974), 'development of a standard series of virus indicator pepper cultivars . .. should be continued', 'such series will both ease the strain identification of new isolates and aid the search for new sources of resistance '. A careful control *of* seed origin and their multiplication is also necessary, due to the relatively high allogamy rate reported in peppers mostly in presence *of* resistance of recessive nature as it is the case of most known PVY resistances.

2.1.Atypical strains

In California, an atypical strain called PVY-S (which causes 'speckling' on 'Early Calwonder' pepper cv.) was described by Zitter (1972). In Taiwan, a pepper PVY strain causing not only chlorotic spot lesions, but also systemic chlorotic spots and veinal- spreading lesions on *Chenopodium amaranticolor* and C. *quinoa,* is reported by Kim *et al.* (1987). PVyo-sbp, which causes severe mosaic in bell peppers in India, is also considered as an atypical strain of PVY (Sharma *et al.,* 1989).

2.2. Influence of origin plant on host range of PVY isolate

Most of the PVY isolates infecting peppers originate from pepper plants, but there are some strains originating from other solanaceous crops, as potato, tomato and tobacco, or from non-solanaceous weeds.

Gebre Se1assie *et al.* (1985), after studies led in France presented a situation where the PVY pathotypes PVYO and PVyN from potato, did not infect peppers by mechanical inoculation. Nevertheless, other strains of those groups could be transmitted by vectors (Fereres et al., 1993). In USA, peppers could be infected with potato PVY isolates as, e.g., PVY-P (Cook and Anderson, 1959), or in Italy with the potato isolate Um9 (Marte *et al.,* 1991). Besides, in Italy, the same authors consider potato crops as the main source for PVY infection on peppers in summer.

Other PVY strains, e.g., from tomato (Cook and Anderson, 1959, 1960; Gebre Se1assie *et al.,* 1985; Luis Arteaga and Gi1 Ortega, 1986), tobacco (Cook and Anderson, 1959; Marte *et al.,* 1991), *Solanum nigrum* L. and *Portulaca oleracea* L. (Gebre Se1assie *et al.,* 1985), do infect peppers. According to MacDonald and Kristjansson (1993), tobacco PVY strains PVY-NN and PVY-MN can infect peppers with very strong symptom expression. On the other hand, in France, PVY isolates from peppers, tomato, *S. nigrum* and *P. oleracea,* were shown to be unable to infect potato (Gebre Se1assie *et al.,* 1985), which is confirmed 'for the majority of PVY isolates' from tomato, tobacco and peppers in Australia (Thomas *et al.,* 1989).

2.3. *Necrotic reactions*

Similarly to PVY -N (necrotic) pathotype in potato and tobacco (piccirillo, 1988), PVY isolates causing local or systemic necrosis in certain *Capsicum* cvs. are described by v various authors too (Cook, 1963; Yon Der Pab1en and Nagai, 1973; Makkouk and Gumpf, 1976; Nelson and Wheeler, 1981, Gebre Se1assie *et al.,* 1985; Luis Arteaga and Gi1 Ortega, 1986; Horvath, 1986a; Marte *et al.,* 1991).

Early in the 60-ies, Cook (1963) described the following situation: None of the tested pepper varieties in study presented

TABLE 2. *CAPSICUM* - PVY INTERACTIONS

Capsicum varieties	Cook, 1961; Greenleaf, 1986					Gebre Selassie et al., 1985; Marchoux and Gebre Selassie, 1989				Luis Arteaga and Gil Ortega, 1986; Pasko, 1993				Nagai and Costa, 1972; Von Der Pahlen and Nagai, 1973				
	Resistance Genes[1]	PVY, TEV and PeMV strains				Resistance Genes [1]	PVY pathotypes			Resistance Genes [1]	PVY pathotypes			Resistance Genes [1]	PVY strains			
		PVY-C PVY-N	TEV-C PVY-N^{YR}	PeMV	TEV-S		0	1	1-2		0	1	1-2		PVY^{e}	PVY^{w}	PVY^{f}	PVY^{d}
	Monogenic recessive pattern (genes are allelic and hierarchisized)													Oligogenic theory: gene combination				
Yolo Wonder	Y^{a}	+	+	+	+	vy^{+}	+	+	+		+	+	+	hhWW	+	+	+	+
Yolo Y(=YRP10)	y^{a}	-	+	+	+	vy^{1}	-	+	+		-	+	+				+	+
PI 264281 (P 11)	et^{a} (= ey^{a})	-	-	+	+	(vy^{2})	-	-	+					$y^{a}y^{a}$	-	-	-	+
SC 46252 (P34)	et^{a}	-	-	+	+													
Florida VR2	et^{a}	-	-	+	+	vy^{2}	-	-	+		-	-	+					
Avelar	et^{av}	-	-	-	+T	(vy^{1})	-	+	+					?			?	T
Delray Bell	et^{av}	-	-	-	+						-	-	+					
PI 159236	et^{c1}	-	-	-	+		-	+			-	HR	+					
PI 152225	$et^{c} = et^{c2}$	-	-	+T	-		+	+			HR	-	+					
Serrano Veracruz						vy^{2s}	-	-	-		-	-	-					
SCM 334						Pvr4	-	-	-	(Pr4)	-	-	HR					
Puerto Rico Wonder						(vy^{1})	-	+	+	(vy^{2s})	-	-	-	hhww	+	T	+	+
Casca Grossa						(vy^{1})	-	+	+					HHWW	-	+	+	+
Moura						(vy^{1})	-	+	+	(vy^{2})	-	HR	+	ffhhww	+	T	T	T
Ikeda						(vy^{1})	-	+	+	(vy^{2})	-	-	+	ffHH	T	T	T	T
Agronomico 4														$y^{a}y^{a}$	-	-	-	+
Agronomico 8						(vy^{2})	-	-	+		-	-	HR	$y^{a}y^{a}$ ffww	-	-	-	T
Agronomico 10											-	-	+	$y^{a}y^{a}$ff	-	-	-	T

Note: + susceptible; -, resistant; T, tolerant; HR heterogenous response.

[1] For new nomenclature see Table 1.

had served as parental, showed necrosis when inoculated with PVY -PR strain. Nevertheless, the observed rate did not allow the author to draw any conclusion on the genetic determination of systemic necrosis. Pochard (1977) described another situation where the Fl plants of the crosses between' A velar' (showing light mosaic symptoms) and 'Agronomico 8' (resistant, symptomless) on one side, and 'Yolo Wonder' (showing mosaic) on the other, were totally characterized by necrotic veins. Our own results confirm these situations. A cytoplasmic influence in necrotic symptom expression was also postulated (Pasko, 1993).
In conclusion it could be confirmed the characterization made by Marchoux *et al.* (1987) that 'the necrotic reaction depends on variety, but necrotic aptitude depends on virus strain independently on its virulence'.

2.4. *Pathotype expansion and evolution*

The more mentioned and expanded PVY strains in different pepper cropping areas, are noted as common strains, classified as PVY -0 pathotype. After the introduction of the resistant varieties 'Yolo Y', 'Florida VR2' or 'Agronomico', more virulent PVY strains emerged on peppers (Tables 1 and 2).
After Cook (1962) strains do not only mutate into more virulent but into less virulent pathotypes too. He showed that the mutated pathotype PVY-NYR that can infect 'Yolo Y', and obtained after repeated inoculations of PVY -Non the resistant cv. 'Yolo Y', turned back into a less virulent pathotype after being repeatedly inoculated on tobacco.
Pochard (1977) and Pasko (1993) have also pointed out the strong reaction caused by PVY- 1-2 pathotype on 'Yolo Wonder'. So the most virulent pathotype PVY -1-2 did not obey the general rule of Vanderplank (1968) that most virulent strains would be less aggressive.

3. SOURCES OF GENETIC RESISTANCE

The most used resistance to PVY comes from *C. annuum.* The mutation detected by Cook in the bell shaped variety 'Yolo Wonder', named initially 'YRP10' (from which 'Yolo Y' was bred), is a unique case. Its resistance level was surpassed by more virulent pathotypes in the same area (Cook, 1961). 'Pl1', 'Mogi das Cruzes', 'Casca Grossa' and 'Avelar' are the most used varieties as resistance source both in USA and Brazil and, based on the breeding lines produced, many commercial varieties and hybrids were derived from them (Nagai and Costa, 1972; Greenleaf, 1986). Although less used, another resistance source is the Indian pepper line 'Perennial' (Sharma *et al.,* 1989; Caranta and Palloix, 1996). The Mexican 'Serrano' group which belongs to *C. annuum* too, is also distinguished for its high resistance level to different PVY pathotypes in various areas. The most recent description was on C. *annuum* Serrano Criollo de Morelos-334 (SCM-334) (palloix, 1992; Pasko *et al.,* 1992; Boiteux *et al.,* 1996; Dogimont *et al.,* 1996) (Table 2).

Good resistance to PVY was also reported in C. *chinense,* C. *frutescens,* C. *baccatum* var. *pendulum,* C. *eximium,* C. *flexuosum* and C. *pubescens,* but these species are not used very much in breeding programmes, probably because of crossing barriers, relative low resistance level, low fruit quality or other drawbacks in breeding work.

Tolerance to PVY -0 and PVY -1 has been reported on variety 'Luesia' (Gil Ortega *et al.,* 1986) but the inheritance of tolerance expression had not been reported.

Due to (i) the large differences in virulence checked on the PVY strains in different areas, (ii) the lack of classification of PVY strains used during the genotype screening, (ill) the fact that the studies on PVY deal with local strains, (iv) the lack of information on pedigree or resistance level of new varieties, which tend to be F1 hybrids, and finally, (v) the impossibility to assure the needed information on this subject, neither could we establish a complete list of the possible resistant sources to PVY, nor could we draw definite conclusions about the existence of any totally resistant source to all PVY pathotypes and on the best source combination. Nevertheless, the contribution of the known sources in breeding resistant varieties is considerable and it was shown indispensably for successful pepper growing in the severely attacked areas in the last twenty years in USA, Brazil, Mediterranean basin, etc.

4. GENETICS OF RESISTANCE

After a large scale test of more than 200 pepper accessions for resistance to PVY and TEV led in U.S.A. in the 70-ties and where 'nothing was found which was completely symptom free when tested against the most virulent pathotype', Smith (1974) notes also that 'the large number of strains of both PVY and TEV appears to be matched by a surprising number of genes for resistance in peppers', which fits well to the present situation too.

4.1. *Main patterns*

Two are the main patterns on the genetics of resistance found in *Capsicum* to PVY strains (Table 2). The oldest, the most commented and accepted, is the monogenic recessive pattern with allelic gene series proposed in Florida by Cook (1960, 1961, 1962 and 1963) and by Cook and Anderson (1960). The second one is the oligogenic pattern proposed in Brazil by Nagai and Costa (1972). After this pattern recessive and dominant gene combinations can give different resistance levels.

The first pattern is defended and largely used in breeding not only in U.S.A., but also in France, Italy, Spain and Australia. The second one is used only in South America: in Brazil and Argentina (V on Der Pahlen and Nagai, 1973). Applying both patterns, first in U.S.A, then in Brazil and Europe, valuable resistant pepper breeding lines, cultivars and FI hybrids are bred, which though obtained in different geographic areas, have contributed to the control of PVY epidemics allover the world. Nevertheless, the second pattern seems to have attracted more criticism than acceptance. In spite of valuable pepper varieties obtained in Brazil, which were resistant to PVY strains in U.S.A. and Europe,

this theory is sometimes criticized even based on results obtained from trials led with different pepper varieties and PVY strains (Sharma *et al.,* 1989).

The monogenic recessive theory is based in screening and allelic tests made by Cook (1960, 1961, 1963) and Cook and Anderson (1960). In USA a single gene ya was supposed - to be responsible for PVY -C and PVY -N resistance in 'YRP10' (Table 2) (Cook and Anderson, 1960). This gene proved to be allelic with er that had been previously described by Greenleaf (1956) as giving resistance also to TEV(C). Later, the allele eta was labeled as yea by Cook (1960). Anyhow, 'YRPI0' was susceptible to TEV(C). More over, with the arrival of a more virulent PVY pathotype (pVY-NYR) on 'Yolo Y', it was noted that the gene er gave resistance also to PVY -NYR. Genes ya and er were labeled vyl and vr in France (Gebre Selassie et al., 1985).

In a presentation of pepper resistance gene hierarchy to PVY, TEV and PeMV, Greenleaf (1986), who mentions also that' Avelar' is only tolerant to PeMV (Table 2), suggests the following scheme. The symbol < used by this author means 'not dominant'.

y+ y- < eta < etaV < etcl < etc2

PVY -C TEV –C PeMV TEV-S

PVY-N PVY-NYR

< < is put by us to show the threshold between the susceptible and resistant genotypes)

Based in the same theory and screening different *Capsicum* sp. genotypes against various PVY isolates, classified into three pathotypes, the French group of INRA-Montfavet (pochard, 1977; Gebre Selassie *et al.,* 1985; Marchoux and Gebre Selassie, 1989), assigned a new nomenclature and placed them in the following hierarchical order:

vy+ < < vy^{1} < vy^{2} < (vy:z. ???*)

PVY-O PVY-l PVY-I-2

(* vy^{2s} was never shown to be allelic to the vy series)

Due to similar results obtained using the same differential pepper cvs. carrying their respective resistance genes, this system is found practical not only for classification of PVY strains into pathotypes, but also in screening and breeding in Spain (Luis Arteaga and Gil ,; Ortega, 1986), in Italy (Marte *et al.,* 1991) and Australia (Thomas *et al.,* 1989).

Very recently, Palloix and Kyle (1995) and Palloix *et al.* (1996), after a revision of gene nomenclature for potyvirus resistance genes in *Capsicum,* have proposed the symbols Pvr2+, pvr21 and pvr22 instead ofvy+, vyl and vy2. These authors have also reviewed the present knowledge on monogenic inheritance of pepper resistance to different potyviruses,

showing some complex interactions between the resistances to different potyviruses and underlying that many allelism tests remain to be made.

We tried to construct a similar drawing for the combinations of the three independent genes, one dominant and two recessive, after the oligogenic pattern (Nagai and Costa, 1972; Yon Der Pablen and Nagai, 1973) (Table 2), but we couldn't fix any hierarchical order. The oligogenic pattern seems more a polygenic one, if the presence of resistant genotypes in F2 and F3 generations from susceptible and high susceptible parents is . considered, as reported by Yon Der Pablen and Nagai (1973). These authors concluded
that "based on the additivity of genes any level of resistance is obtainable". This is - reinforced also by the report of Nagai (1984), when he says that in Brazil 'frequently farmers find resistant plants in their farms', which gives one the impression of transgres- sive plants in a typical F2 segregation. Anyhow, this theory shows problems of interpretation.

It is to be noted that the monogenic theory is not able to explain cases of systemic necrosis appeared in F2 and BCs between parents not showing this symptom (Cook 1963), or even in Fl (Pochard, 1977; Pasko, 1993).

It is accepted that the use of different PVY isolates in different areas does not allow the identification of different resistances found in the same genotype, probably because they belong to different pathotypes (Cook and Anderson, 1959). Yon Der Pablen and Nagai (1973) give an example where the variety' Avelar', resistant in Florida, was shown to be susceptible in N.E. Argentina; similarly, accessions 2207 and 2120, respectively resistant in Argentina and California, were shown to be susceptible in Florida. Other alike cases are, e.g., 'Puerto Rico Wonder' which was shown to be susceptible in Trinidad, resistant in Puerto Rico, tolerant to only one PVY strain (PVY^W) in Brazil (Nagai and Costa, 1972), resistant to the commonest pathotype (PVY -0) in France (Gebre Selassie *et al.,* 1985) and to three pathotypes (PVY -0, PVY -1 and PVY -1-2) in Spain (Pasko *et al.,* 1995) (Table 2); 'PI 159236' was shown to be highly resistant in California, resistant to PVY -0 in France, to PVY-O and PVY-l in Spain and to PVY-I-2 in Brazil, while 'PI 152225', susceptible to PVY -0 and PVY -1 in France, was resistant to PVY -0 and PVY -1 in Spain and highly resistant in California (Marchoux *et al.,* 1974; Greenleaf, 1986; Pasko, 1993, Boiteux *et al.,* 1996) (Table 2).

4.2. *Other patterns*

Except these two patterns, there are other reports on resistance expression to PVY and on a- genetic determination as:

- one dominant gene for resistance to three PVY pathotypes (pVY -0, PVY -1 and PVY -1- " 2) was recently reported in 'Serrano Criollo de Morelos 334' (palloix, 1992; Boiteux *et al.,* 1996). Allelism tests confirmed independent segregation with pvr21 and pvr22. The symbol Pvr4 was proposed for this locus (Palloix and Kyle, 1995; Dogimont *et al.,* 1996; Palloix *et* al., 1996).

- complementary recessive combination of two loci (Simmonds and Harrison, 1959);

heterogeneity within virus inocula was supposed to account for such results by Cook (1963);
- two independent recessive genes were reported by Smith (1974) in 'Serrano' group accessions 2207 and 1534;
- partial dominance of resistance was reported in cv. 'Florida VR2' by Shifriss and Marco (1980) based in phenotypic distinction of heterozygous plants (y8+y8) from the homozygous ones and in the 1 :2: 1 rate obtained in *F2.* The virus concentration tested by ELISA was used as criterion. '
- olygogenic resistance (controlled by two recessive independent genes that need the ; presence of modifier genes for complete resistance) was shown in the Indian cv. 'Perennial' to 'PVY 1-2' pathotype, the most virulent one in France (Pochard *et al.,* 1983). More recent data showed that the resistance to PVY-1-2 was partial and poligenically controlled and that Perennial also possesses an oligogenic complete resistance to PVY-O (Caranta and Palloix, 1996). This was further confirmed by molecular mapping of the genes (Caranta et al., 1995). Sharma *et at.* (1989) showed that Perennial carries a recessive gene imparting resistance to $PVY^{o\text{-}sbp}$, an atypical strain described in India.
- two recessive genes were reported to control respectively 'resistance' and 'medium resistance' during an allelic test where some accessions of *Capsicum* spp. as *C. annuum, C. angulosum, C. pubescens, C. fasciculatum, C. praetennissum, and C. microcarpum* were included (Singh and Chenulu, 1985).

In some reports, two ways of interpretation of intermediate resistance (or susceptibility) in Fl are to be noted: one by distinguishing heterozygous allele combination (Shifriss and Marco, 1980) and the other supposing two different genes controlling 'resistance' and 'medium resistance' (Singh and Chenulu, 1985).

After Pochard (1977), Palloix *et at.* (1990) and, PaIloix (1992), considering together the pepper reactions to various potyviruses, it is obvious that in the PVY case, maybe due to larger pathotype diversity, all the types of reaction and genetic control found in other potyviruses are met, which could partially explain the conflictive data and the difficulties in interpreting them.

5. OTHER TRENDS IN PVY RESISTANCE AND PVY INTERACTIONS.

- Resistance to PVY transmission by *Myzus persicae* and *Aphis craccivora* was found on pepper cvs. 'Ikeda and 'Moura' in Israel. It worked also for other non-persistent viruses as cucumber mosaic virus (CMV) and alfalfa mosaic virus (AMV) (Cohen, 1982, cited by Jones, 1987), but no genetic determination was given.
-Inhibitory substances, which were first considered not to affect the virus but the aphids; were reported in the pepper variety 'Italian EI' (Simons and Moss, 1963). Later, Simons (1966), after checking susceptibility differences between varieties 'Italian EI' and 'California Wonder', supposed that the inhibitors in 'Italian EI' plants "could conceivably cause a slower rate of virus multiplication. . . probably making through an effect on the host plant cell rather than on a virus direction". After Pasko et *al. (1992),* 'Italian EI' variety carries the gene $pr2^{1}$ or any other allelic to it.

- Some **weed inhibitors** from *Aeonium haworthia, A. arboreum, Mesembryanthemium caproletum* and *Agave americana* were found till 100 per cent effective against juice inoculation of PVY, but not against aphid transmission (Simons *et al.,* 1963).
- A known protein from pokeweed *(Phytolacca americana)* called PAP (pokeweed **antiviral protein**) is reported to fully protect the plants from various virus infections, including PVY, and transgenic tobacco plants resistant to PVY are being produced (Chen *et al.,* 1991).
- Coat protein-mediated (C-P) resistance producing immunity against PVY, is obtained ,in transgenic potato plants resistant to PVY and tobacco plants resistant to both PVY and TEV, so against heterologous viruses, are successfully obtained, but, as the author puts it, extensive field trials are needed for a full evaluation of this kind of resistance (Beachy *et al.,* 1990).
- Interactions between PVY and *Phytophthora capsici* L., which resulted in the inhibition of the resistance to *P. capsici,* were found in two pepper cvs. Previously PVY infected (pochard *et al.,* 1981). In a similar test, Cristinzio *et al.* (1988) noted increased susceptibility to *Phytophthora* in one pepper cv., but decreased in two others.
- A synergism between tobacco mosaic virus (TMV) and PVY, resulting in severe symptoms was checked in 'Bahamian' hot chile, but not in two other pepper cvs. (Sherwood *et al.,* 1988), so it is not generalized as the PVY -PYX synergism in potato.
- Cross protection between different pepper PVY strains resulting in reduction of the local lesions caused on *N. tabacum* 'Havana 425' has been reported in California by Makkouk and Gumpf (1976).

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DEVELOPMENT OF PEPPER BREEDING IN POLAND

P. Nowaczyk
Academy of Technology
and Agriculture
Poland

R. Andrzejewski
University of Agriculture
Poznan Bydgoszcz Poland

Abstract

Poland is now the most North-East salient area of pepper production in Europe. Pepper breeding in Poland began about 30 years ago. At first, for several years, we had only one, then two pepper cultivars. Now we can observe an increasing interest in pepper breeding in Poland; six breeding centres deal with pepper and. there are 16 registered pepper cultivars on fresh market. Up to now the main breeding method has been the selection of hybrid material, which is necessary to provide the producers with cheap seeds of the settled cultivars. At present we are getting more and more interested in heterosis breeding. One hybrid cultivar is in production now, next cultivars are being tested respecting their registration. Yielding of cultivars increased from 5-6 kg/m2 to 8-9 kg/m2 in unheated plastic greenhouse, which is the main place of pepper production for fresh market because it guarantees good yielding, and good fruit quality in Polish climatic conditions.

1. Introduction

The data and results presented in this paper refer to the cultivars of sweet pepper because only these cultivars are produced for fresh market. Breeding of hot, medium-hot and outdoor-grown cultivars has not been taken into consideration. Breeding of Polish cultivars made the producers get interested in pepper, caused a development of cultivars' variety (Nowaczyk, 1988) and resulted in an increase of pepper-growing area and pepper consumption. It is worth mentioning that Polish market is very conservative and introducing a new species of vegetable is rather difficult. Polish producers got interested in pepper culture only after new, Polish cultivars of high fruitfulness had been registered. Heterosis breeding gives the best effects (Nowaczyk, 1981) but breeding of very fruitful settled cultivars was necessary to quickly develop pepper-growing because of - very low price of the settled cultivars' seeds. Interest in pepper on fresh market was gradually increasing. At present pepper is a vegetable in demand though its - price is high. Pepper on fresh market comes mainly from production in unheated plastic greenhouse. Such a way of production is not an energy-consmning method and it gives good yielding and good fruit quality.

2. Material and methods

All the data presented in this paper refer only to the registered cultivars of sweet pepper which are grown in unheated plastic greenhouses. The results of the

experiments are based on this kind of pepper culture. Growing of pepper in plastic greenhouses in Poland lasts from mid-May till the end of September.

The first part of result presents the information concerning the number and the dates of registrations of new Polish cultivars. The information has been based on literature about cultivar investigation and registration, and on the author's own data. The information on the methods used in Polish pepper-breeding has been prepared on the same basis. Five of the registered cultivars have been bred by the first of the two authors of this paper.

Cultivar yielding has been determined on the basis of the results of experiments carried out under plastic cover. Only market yield has been taken into consideration, in the presented data. Data concerning the period 1984 - 1993 come from experiments carried out by Research Centre of Cultivars Testing every year in several experiment stations situated allover the country. The yield results of the most and the least fruitful cultivars have been presented with regard to each year of experiments.

3. Results ,

The first pepper cultivar was registered in 1972 (figure 1). It was the cultivar 'Poznanska Slodka' and its registration was the beginning of Polish breeding of sweet pepper. The second cultivar, 'Remi', was registered in 1978. Ten years later both of them were withdrawn from plastic greenhouse production because of introducing new cultivars.

Next cultivars, 'Jantar' and 'Kujawianka', coming from newly established breeding centres were introduced into production in 1986. The third of the registered cultivars, 'Stano', was bred by the author of this paper and up to now has been the most fruitful settled cultivar since the beginning of registration testing. The end of the 80-ties was an especially favourable period in pepper breeding. In 1987 the next three new cultivars 'Zefir', 'lno' and 'Kano' were registered. Two cultivars were registered in each of the two following years. In 1988 the cultivars 'Bryza'" and 'Passat' were introduced into production. In 1989 the cultivar'Monsun' and the first Polish yellow cultivar 'Sono' bred by the 'author of this paper, began to be produced.

At the beginning of the 90-ties three new cultivars 'Buran', 'Mira' and 'Zorza' began to be produced. Last year the next cultivar bred by the author of this paper was registered; it was 'Stanola F I' - the first Polish heterosis hybrid cultivar. In respect of quality, a new stage in Polish breeding of pepper was begun.

Up to now the selection of hybrid material has been the most effective method used for improving cultivars (table 1). First of all original hybrids were used, and Bulgarian, Hungarian, Italian and Dutch cultivars were the materials to make them. One of the parent materials for new cultivars was the first registered cultivar 'Poznanska Slodka' which at the same time was a source of mutants: two mutants appeared to have such economic value that they were registered as original cultivars. Mutation changes ware mainly in the shape and size of fruit. Only one of Polish cultivars was the result of selection of offspring of foreign

heterosis hybrid. One cultivar, recently registered, was obtained as a result of heterosis breeding.
Comparing yielding of the registered cultivars seems to be most interesting (figure 2). It should be remembered that only market yield, not total yield, has been presented in this paper. Fruits, which are not products for fresh market, have not been taken into consideration. Maximum and minimum yields from among all the estimated cultivars have been presented for each year of the last decade. Yields of the first Polish cultivar, estimated in 1976 in the author's own ,experiments, have been shown, too.
The cultivar 'Stano' proved to be the most fruitful in each of the years of, experiments. The moment the hybrid cultivar 'Stanola F I' began to be tested, it proved to be the most fruitful one. Differences between yields in particular years of investigations are worth considering; they were especially significant between the years 1985 and 1986.

4. Discussion

Polish pepper breeding began about 30 years ago while pepper production for, fresh market started only in the middle of the last decade, which was possible due to introducing new, fruitful cultivars. The question is if the number of cultivars designed for culture under plastic cover and produced for fresh market is sufficient. Polish pepper breeding seems to be satisfactory in this respect and what is more, several new cultivars are now being tested respecting their registration. The situation concerning cultivar variety seems to be worse. There is only one yellow cultivar in the register though this is not the real problem. There is a very little variation of cultivars in respect of the shape of fruits. Nearly all fruits are cone-shaped while those, which are trapezium-shaped, are in greater demand on fresh market. The hybrid 'Stanola F l' meets these requirements in some extent.

Using heterosis is a new element in breeding Polish cultivars of pepper. This method makes it possible to increase the variety of cultivars and to improve quality characteristics. It is worth mentioning that 'Stanola F l' is characterized by great vitamin C content, also when in rock wool culture (Konys, 1994). Additionally, this cultivar can be grown in different regions of the country, including Northern Poland (Nowaczyk and Michalak, 1994).

It can be expected that heterosis hybrids will soon remove the settled cultivars from production for fresh market. This conclusion seems to be even more justified when we consider the fact that next hybrids are being tested with respect to their registration. Their economic value, estimated by Research Centre of Cultivars Testing, will decide about their being registered and introduced into production. Research Centre of Cultivars Testing is the Polish Centre dealing with testing cultivars and making decisions about their registration. Testing of cultivars lasts 2 - 3 years and a decision about their registration is made when the cultivar is original, even and solid. Each of the registered cultivars must meet all these requirements.

The registered cultivars designed for breeding under unheated plastic cover come from three centres. At present, breeding is conducted in six centres, mainly in central regions of the country. An increasing number of breeding centres shows a great interest in pepper. There were only two Polish cultivars at the end of the 70-ties and at the beginning of the 80-ties. Their yields ranged from 5 - 6 kg/m2 and this level of yielding remained characteristic for less fruitful cultivars. Breeding progress can now be observed very clearly. The most fruitful cultivars give the yields of 8 - 9 kg/m2 and this level of yielding can be regarded as very satisfactory in Polish climatic conditions. With such fruitfulness of cultivars the production for fresh market is very profitable. The results of other experiments (Nowaczyk and Nowaczyk, 1990) show that obtaining higher yields is difficult.

The number of registered cultivars does not give complete information about the importance of pepper as a kind of vegetable and about the scale of production. It is difficult to estimate the pepper growing area of both outdoor culture and plastic cover culture. Information about seed production could be of some help but again, we do not have complete data in this field. Breeding and trade centres are unwilling to present this kind of data. Information gained through personal contacts is of estimated value; seed production can be estimated as amounting to several hundred kilograms per year.

Stable though less intensive increase of seed production can be expected because the pepper-growing area is getting bigger. Four new hybrid cultivars are being tested respecting their registration. It can be expected that they will meet the market requirements in a greater extent. Only cultivars of good quality can win the competition on fresh vegetable market. At present, improving pepper quality is the main task of pepper breeding in Poland.

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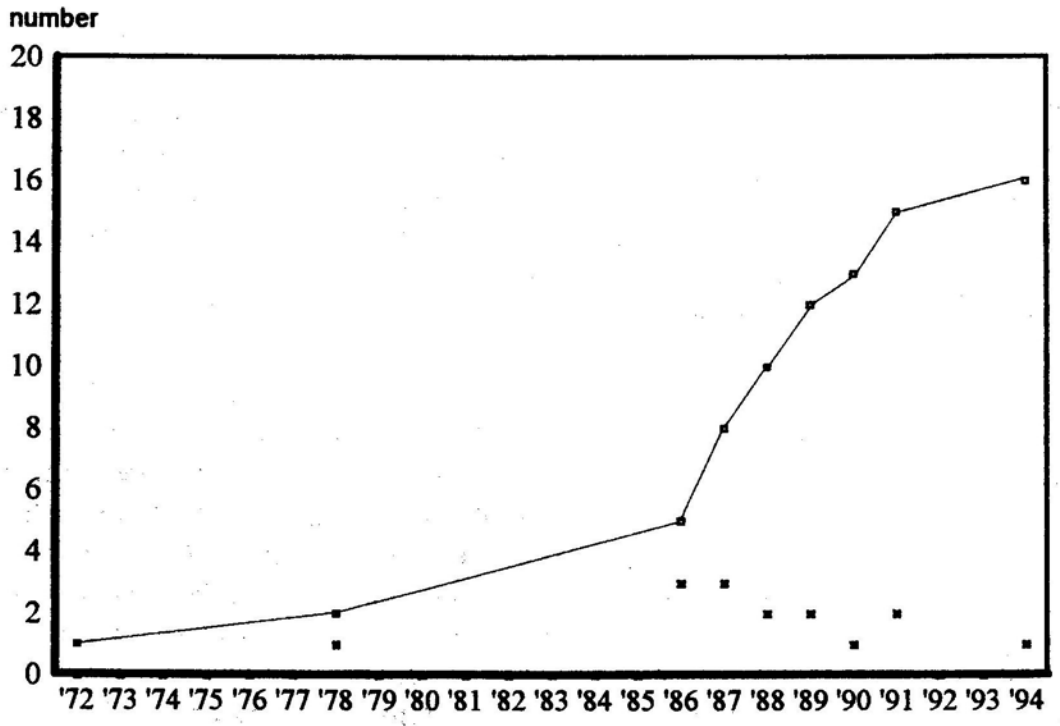
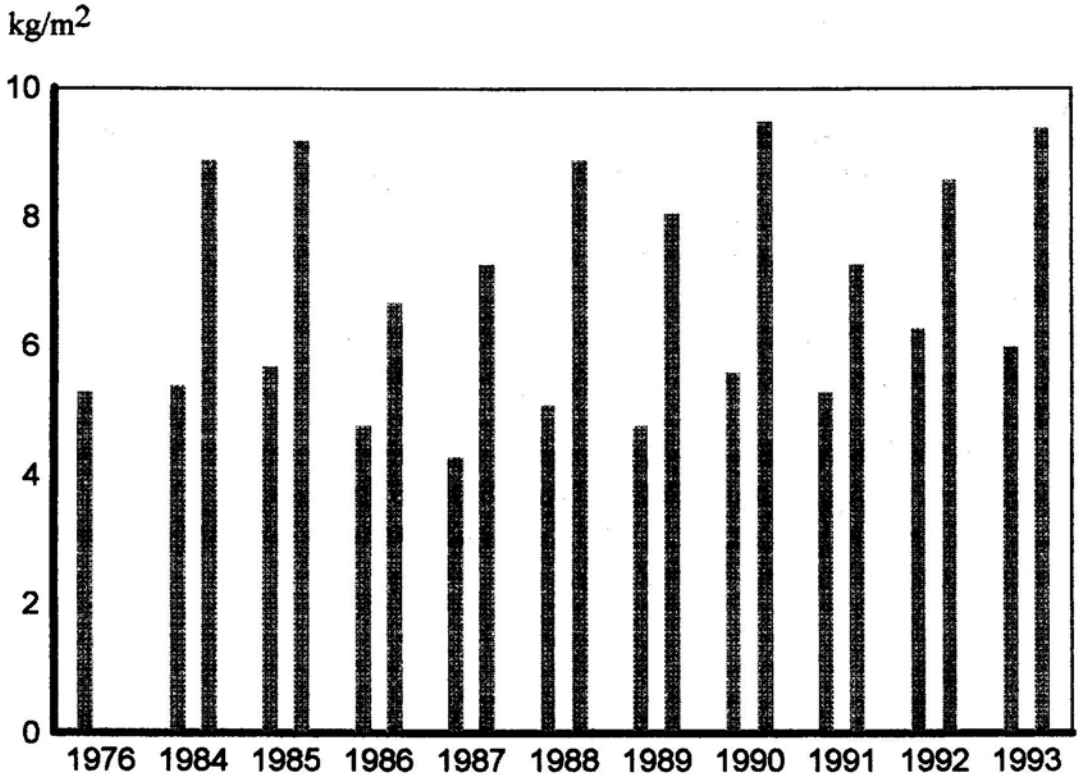


Figure 1 - The number of registered cultivars in years 1972 - 1994

Table 1 - The breeding methods and number of registered cultivars.

Total	Mutations	Selection of hybrids	Heterosis
16	2	13	1



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CELL CYCLE SYNCHRONIZATION IN ROOT -TIP MERISTEMS OF *CAPSICUM ANNUUM*

P. Belletti, C. Marzachi and S. Lanteri

DI.VA.P.R.A. - Plant Breeding and Seed Production
University of Turin, via P. Giuria 15, 10126 Torino, Italy
Tel.: ++/11/65.73.00 - Fax: ++/11/650.27.54 - EmaiJ: pJantbre@pop.fileita.it

Introduction

The availability of isolated and intact plant chromosomes is of large interest in many research areas, ranging from chromatin structure study to the detection of low copy sequences by *in situ* hybridization (Dolezel *et al.,* 1994). Furthermore, suspensions of chromosomes make it possible to analyse and sort single chromosome types by flow cytometry, which can be used for the construction of chromosome-specific gene libraries and for gene mapping (Gray and Cram, 1990).

In plants, it is rather difficult to obtain high-quality suspensions of chromosomes suitable for further analysis, mainly due to the low degree of mitotic synchrony in plant tissues and the tendency of chromosomes to stick and clump after treatment with methapase-blocking 'agents. Notwithstanding this, the isolation of plant chromosomes has already been reported in several species, among which tomato (Arumuganathan *et al.,* 1991). In most cases the chromosomes were obtained from *in vitro* cultured cells, through protoplast isolation and cell wall lysis. Since chromosome instability of cultured cells is frequent (Lee and Phillips, 1988) and protocols for protoplast obtention are not available for many species, the use of vegetative material appears to be more advantageous.

In this paper we describe a procedure for the obtention of large quantities of intact mitotic chromosomes from root-tips of *Capsicum annuum,* in view of subsequent isolation and sorting. To synchronize the cell cycle, we used hydroxyurea (HU), which reversibly inhibits the enzyme ribonucleotide reductase and therefore the production of deoxyribonucleotides, so preventing DNA synthesis (Kornberg, 1980). Following the removing of HU, the cells progress more or less synchronously through subsequent mitosis phases.

Material and Methods

Seeds of *Capsicum annuum* cv 'Corno di Toro' (Semencoop, Cesena, Italy) were germinated at 25 °C in the dark. At radicle protrusion, the seeds were transferred into Petri dishes containing perlite imbibed with a 2.5 mM hydroxyurea (HU, Sigma H8627) solution for 18 hours at 25 °C. Concentration and time length of imbibitions were adopted on the basis of preliminary tests (data not reported). Seeds were then rinsed in distilled water and transferred in a HU-free medium. Samples of root tips were collected at one-hour intervals up to 10 hours and analysed for mitotic activity.

To further accumulate mitotic cells in methapase, germinating seeds after 3, 4, 5 and 6 hours of incubation in HU-free medium were transferred into Petri dishes containing perlite imbibed for 4 hours at room temperature with a saturated solution of 1,4-Dichlor-benzol (PDCB, Fluka 35370), a tubulin polymerization inhibitor. This treatment was found to be optimal for metaphase block (data not reported). Mitotic activity and methapase frequency were analysed on squash preparation: samples of root tips were fixed overnight at 5 °C in Carnoy (ethanol-acid acetic 3: 1 in volume) and then stained according to the standard Feulgen method (lanteri, 1991). On each slide, at least 500 cells were recorded. Five meristem per treatment were analysed and the whole experiment was repeated four times.

For flow cytometric analysis, root meristems were homogenyzed in icecold nuclear extraction buffer (Saxena and Kimg, 1989) and filtered through a 25l.tm mesh nylon filter. The intact released nuclei were stained with propidium iodide and treated with DNAse-free RNAse (Sigma R5O0o). Fluorescence was measured using a FACScan flow cytometer (Becton and Dickinson, USA) equipped with a 488 nm light source (argon laser). Two filters were used to collect the red fluorescence due to PI staining the DNA, one trasmittting at 585 nm and the other above 620. The flow rate was set at about 100 nuclei/sec and at least 5,000 nuclei were analysed for each sample. Data were recorded in a Hewlett-Packard computer (HP 9000, model 300) using CellFit software (Becton and Dickinson).

Results

Mitotic activity of meristem cells in untreated root tips varied among replicates, the mitotic index ranging from 3.00 to 7.59%, with an average of 4.98%. A possible explanation is the different vigor, which is peculiar for each seed. Furthermore, the size of the meristem taken for analysis could have also influenced the mitotic index, being the mitotic activity limited in a very small portion of the apex. Flow-cytometric analysis of nuclear DNA content showed that most of the cells were in G2 phase (50.3%), being the frequency of cells in G1 and S phase, respectively, 30.4 and 19.3%

The treatment with HU resulted in a considerable block of DNA. Synthesis: after 18 hours treatment, a very low number of cells were found in mitosis. The flow cytometric analysis proved that most of the cells were accumulated at the G1/S interface and that the frequency of cells in G2 phase was very low. After the release from HU, meristem cells started synthetising DNA and entered the S phase: the frequency of cells in mitosis gradually increased and reached the maximum 5 hours after block releasing, when the frequency of cells in mitosis was, on average, about four times that of the control (Fig. 1). Subsequently, the frequency of mitotic ce11s decreased and reached, after about 9 hours, the value of the control.

The frequency of cell blocked in mitosis was furtherly increased by the PDCB treatment (Tab. 1): moreover, in this case, most of the cells were in methapase, which is the optimal stage for further chromosome analysis.

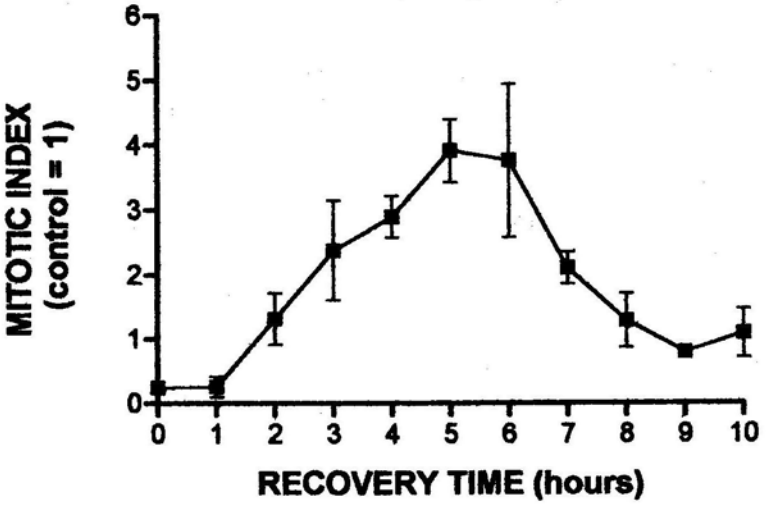

Fig. 1 - Mitotic indices in Capsicum annuum *root tips (mean ± standard error) during the recovery from the Hydroxyurea block.*

RECOVERY TIME (h)	A	B
3	2.39	2.69
4	2.91	4.81
5	3.92	4.39
6	3.78	4.27
LSD (5% level)	**0.29**	**0.46**

Tab. 1 - Frequency of cells in mitosis (expressed as reference to the control) following HU treatment for 18 hours, recovered from HU for different times and submitted (B) or not (A) to a pre-treatment with 1,4-Dichlor-benzol for 4 hours.

Discussion

The results of our study show the possibility to obtain a relatively high frequency of metaphase cells by a combined treatment with a DNA-synthesis inhibitor and a tubulin-polymerization inhibitor. In other species, as *Vicia faba*, it was possible to reach higher values of mitotic index than ours (Dolezel *et al.*, 1992): this is probably due to differences in physiological behaviour among species. In fact, in *Vicia faba*, the highest frequency of cells in mitotis was reached 8 hours after the release from the DNA-synthesis block, while in our study this occurred only after 5 hours. Moreover, Dolezel *et al.* worked on

material characterized by a higher mitotic index of untreated tissue: 9.1 *versus* 4.98% in our study. *It* should be emphasized the need for an accurate definition of the experimental procedures and the great importance of the physiological stage of donor material: possibly this explaines the large variability among replicates observed in our study and makes it very difficult to compare results obtained in different experiments.

In order to define a complete procedure for chromosome isolation, the next step of our 'work will be to perform research on chromosome isolation, purification and sorting. Protocols are available for other species, as *Vida faba (Lucretti et al.,* 1993), where it was possible to sort, through flow cytometric - techniques, more than 25,000 chromosome of *a* single type (corresponding to 0.2 J.tg of DNA) with a purity of more than 90% during a working day. A difficulty, which will be probably encountered when working on pepper, will be the high similarity of chromosomes.

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RAPD FINGERPRINTING OF PEPPER (Capsicum annuum.) BREEDING LINES I

F. J. Las Heras Vazquez, J. M. Clemente Jimenez, F. Rodriguez Vico,
I University of Almeria, Department of Biochemistry and Molecular Biology, La Canada de San Urbrano, .I 04120 Almeria, Spain.

INTRODUCTION

Knowledge of genetic similarity between genotypes is useful in a breeding program because it. Facilitates efficient use of inbreds and helps the design of crosses. The breeder can use genetic similarity information to make informed decisions regarding the choice of genotypes to cross for development of new segregating populations, or to facilitate the identification of diverse parents to cross in hybrid combinations in order to maximise the expression of heterosis.

Estimates of genetic similarity are based in the detection of polymorphism at the DNA level. The most widely used technique is restriction fragment length polymorphism analysis (RFLP). Base substitution in a restriction end nuclease site or insertions or deletions between sites result in detectable differences in the fragment length of restriction enzyme-digested DNA These polymorphisms already have been shown to be consistent with expectations based on known breeding behaviour and pedigrees in numerous crops (Smith et al. 1990, Nienhuis et aI, 1992). More recently, the random amplified polymorphic DNA (RAPD) technique (Williams et al. 1990, Welsh et al. 1990), based on the polymerase chain reaction (PCR), has resulted in a potentially useful tool for cultivar discrimination. RAPD involves the amplification of DNA segments using random sequence primers, generally of ten bases, to find polymorphic regions within the genome defined by the primer sequence. The products formed and separated by agarose-gel electroforesis reveal sequence variation in the form of variable numbers of bands of variable length, which may be characteristic of species and/or cultivars within species. RAPD requires no previous sequence information for the fingerprinting of cultivator genomes.

The Purpose of this work is to make use of DNA polymorphisms to study genome relationships among different pepper (Capsicum annum L.) inbred lines and to use this information to aid in plant breeding decisions in pepper. A variety of computer programs have also become available for generating phylogenetic trees based on DNA information from different individuals, making the task of studying genome relationships more efficient and accurate. The ability to extract and analyse DNA from plant is an essential aspect of plant molecular biology. The isolation of plant DNA must to ensure that significant amounts of DNA are not trapped in the cell debris, and that the DNA is completely dissociated from proteins and other contaminants that might copurify and interfere with subsequent analyses. The preparation of high quality DNA from polyphenolic-containing plants such as pepper is difficult, because of DNA degradation mediated by secondary plant products such as phenolic terpenoids and tannins, which may bind to DNA and/or RNA after cell lysis (John 1992). The method described here is based on modified protocols of John (1992), Murray et al. (1980) and Pich et al. (1993), It combines the complexation of polyphenolic compounds by polyvinyploy rrolidone (PVP) and complex carbohydrates by cetyltrimetylammonium bromide (CT AB), following cell lysis and selective precipitation for remove of PVP and CT AB complexes and DNA recovery.

Table 1. List of peppers lines with type designation.

Line	original cross	cross code	type inbreed	
I	yellow 'california' x yellow 'california.	A	yellow 'california'	F7
2	yellow 'california. x yellow .california'	A	yellow .california'	F7
3	yellow 'california. x yellow.california.	A	yellow 'california'	F7
4	orange 'california. x orange 'california.	B	orange 'california'	F7
5	red 'california. x red 'california'	C	red .california'	F9
6	red 'california' x red 'california'	D	red 'california'	F9
7	red lamuyo. x yellow "california.	E	yellow lamuyo.	F7
8	red "lamuyo' x red 'california'	F	red rocky	F9
9	red lamuyo. x red larnuyo.	G	red lamuyo.	F6
10	red lamuyo. x red lamuyo.	H	red lamuyo'	F6
11	chilli cultivar .Serrano criollo de Morelos		(population)	

MATERIALS AND METHODS

Growth of plants

All lines were field grown at the Pioneer's Agricultural Research Station in Almeria. Eleven genotypes *of* pepper *(Capsicum annuum* L.) were choosed for this study (table I), A set *of* eight 'california' type inbred lines, two 'lamuyo' type inbred lines and one chilli cultivar, 'Serrano Criollo de Morelos', were used to ascertain their degree *of* similarity

DNA isolation

Young leaf tissue samples were used immediately after collection for DNA ex1raction or were stored " at -80°C prior to DNA extraction. Fresh or frozen tissue (3 g) was ground in liquid nitrogen with a mortar and pestle. The powder was transferred to a 35 mL-centrifuge tube and 10 mL *of* extraction buffer (100 mM Tris-HCI pH 8, 50mM EDT A pH 8, 500 mM NaCl2% CT AB, 1 % PVP-40, 2% SDS and 10 mM DTT) was: added. After 10 min at 65°C 4 mL *of* 5M potassium acetate was added. After 10 min at O°C, the sample was centrifuged for 20 min at 10.000 rpm. The supernatant was filtered through 2 layers *of* miraclore and transferred to a new 35 mL tube. The DNA was precipitated by the addition *of* 8 mL of isopropanol and recovered by centrifugation for 15 min at 10.000 rpm after incubation on ice for 30 min. The pellet was dried and redissolved in 0.7 mL *of* TE (10 mMTris-HCI pH 7.4, 1 mM EDT A). After the sample was transferred to a eppendorf tube and centrifuged at 10.000 rpm during 10 min to remove the insoluble things. The supernatant was transferred to a new eppendorf tube and 75, uL *of* 3M sodium acetate and 0.5 mL *of* isopropanol were added. The pellet was washed with 70% ethanol after centrifugation for 30 sec at 10.000 rpm. After the pellet was dried and resuspended in 0.3 mL *of* TE. Contaminating RNA was removed by , digestion with 30 ,ug Ribonuclease A for 20 min at 37°C. The DNA was purified by extracting once with an equal volume *of* phenol followed by extraction with an equal volume *of* chloroform/isoamyl alcohol (24: I). The DNA was precipitated by the addition *of* NaCI to a final concentration *of* 0.2M and 2 volumes *of* cold ethanol. After 10 min at DoC, the sample was centrifuged at 10.000 rpm for 15 min. The final pellet was washed with 70% ethanol, dried and dissolved in 0.3 mI *of* TE. DNA was quantified by fluorometry with a Hoefer *TKO* 100 mini fluometer and following procedures supplied by the manufacturer. All samples were diluted to a DNA concentration *of* 0.2 *ng/uL.*

Amplification of DNA

42 random decamer oligonucleotide primers obtained from Operon Technologies, Inc, Alameda, CA, USA, were used as single primers for PCR. DNA amplification was based on the method described by Williams et al. (1990) with minor modifications. The reaction mix was carriedout in 15 ILL reactions containing 30 ng template DNA; 10 mM Tris-HCl pH 9.0, 50 mM CIK, 2.5 mM MgClz; 0.2 mM each *of* dATP, dCTP, dGTP and dTTP; 4 pM primer; 1 U Taq DNA polimerase (Pharmacia Biotech). Amplification was performed in a Techne PCH-3 termociclator programmed as followed: 1 min 94°C for denaturing, 1 min at 34°C for annealing, 1 min at 72°C to synthesis, repeat for 45 cycles. Amplified samples were kept at 4°C until further use. Amplified products were separated electroforetically in 1.4% agarose gels in TBE buffer (0.09 M Tris-borate, 0.002 M EDTA pH 8) at 135 V constant voltage for 3 h, stained with ethidium bromide and photographed under transiluminated UV light.

Statistical Analysis

Data from PCR amplification *of* the 11 lines with 42 different oligonucleotide primers were analysed as follows. A number was assigned to each scorable polymorphism and the presence *or* absence *of* a band was coded by 0, or I respectively. Similarity coefficients were calculated using the equation (Nei and Li, 1979):

$$S = \frac{2nxy}{nx + ny}$$

where nx and ny are the numbers *of* markers observed in individuals *x* and *y,* respectively, and 2nxy is the number *of* markers shared by the two individuals. The data were entered into Microsoft Excel v 5.0 for Windows. The data matrix was read by NTSYS-PC (Numerical Taxonomy and Multivariate Analysis System for Personal Computer v.l 80, Exeter Software, Seautek, N.Y.). A dendogram was constructed using UPGMA (unweighted pairgroup method with arithmetic averages) with the SAHN (sequential, agglomerative, hierarchical and nested clustering) routine.

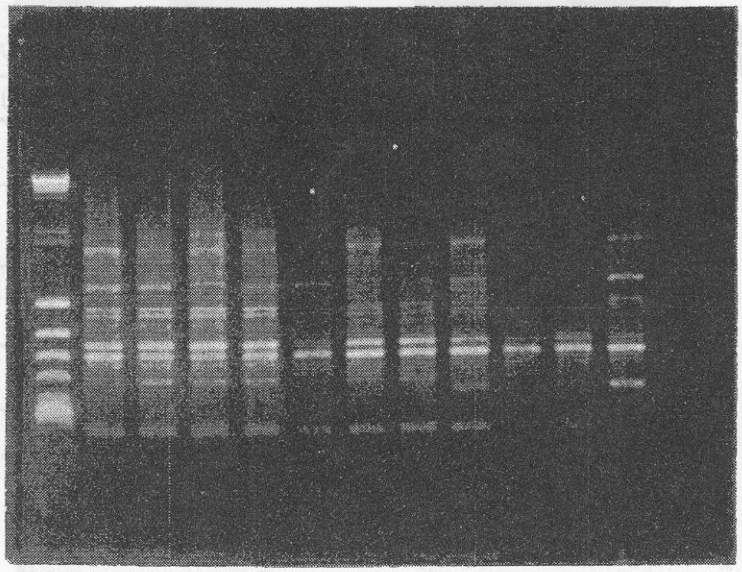


Figure 1.- Random amplified polymorphic DNA analysis with primer T04 (5′-CACAGAGGG A-3′). DNA was fractionated on a 1.4 % agarose gel and stained with ethidium bromide. Lane 1 DNA marker (lambda DNA-Hind III/ΦX-174 DNA- Hinc II digest. Pharmacia Biotech). Lanes 2 to 9 are `california′ type inbred lines of peppers; lanes 10 and 11 are `lamuyo′ type inbred lines of peppers; lane 12 is the chilli cultivar `Serrano Criollo de Morelos′; and lane 13, negative control .

RESULTS AND DISCUSSION

Fifty primers of arbitrary sequences were tested on 11 lines of *capsicum annuum L.* Of these, 42 showed bands in all lines). The other 8 primers failed to amplify. A total of 219 fragments were visualised across all lines investigated, and each primer produced approximately five to six fragments from each line (figure 1). Among 219 fragments, 144 (65,75 %) were *monomorphic* (all lines had the band), 52 (23.74 %) of the bands were *polymorphic* (bands were absent from at least one line), and 22 (10.04 %) of the total bands were *unique* to a single line. The cultivar chilli inclusion in bands variations data obtained with differents primers, table 1, diminishes the percentage of monomorphics bands from 76,24% to 65,75 %, which shows the higher distances of this population from the rest of the studied genotypes. The number of bands generated by specific primer varied from 1 to 10. These values indicate that a very large number of RAPDs can be generated from a small number of reactions, reducing the cost of using RAPD in marker assisted selection in a breeding program.

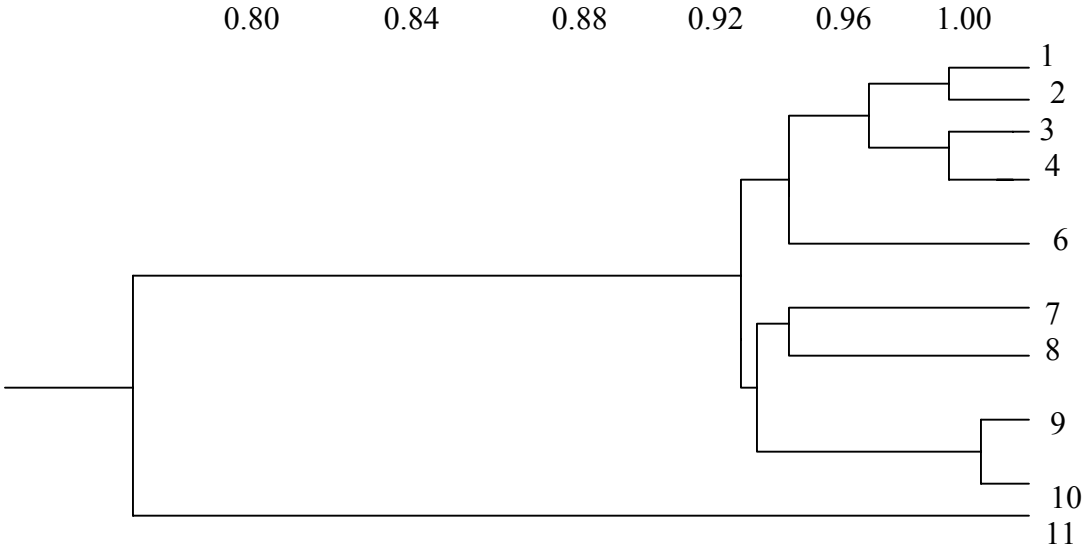
Only 3 of the 42 primers amplified only one band (*unique*) to a single line. Twenty-four of the total primers failed to amplify only one band. The percentage of *unique* band to a single line was very low, and at the same time the percentage of common bands to all the lines (*monomorphic* bands) was greater than the 50 % of the total bands. This suggest that the genetic base of the lines is very narrow.

Table 2.- Matrix of similarity coefficients among 11 lines of pepper.

Genotype	1	2	3	4	5	6	7	8	9	10	11
1	-										
2	0,98016	-									
3	0,96111	0,96935	-								
4	0,94915	0,98016	0,97222	-							
5	0,93593	0,95530	0,95342	0,95821	-						
6	0,94586	0,95428	0,94677	0,95726	0,94943	-					
7	0,91573	0,95774	0,95027	0,96067	0,94736	0,93484	-				
8	0,94413	0,95798	0,95054	0,94972	0,96418	0,92957	0,95555	-			
9	0,93333	0,94707	0,93442	0,94444	0,95890	0,92997	0,95027	0,94505	-		
10	0,93370	0,94182	0,93478	0,93922	0,95367	0,92479	0,94505	0,94535	0.98913	-	
11	0,87292	0,87534	0,86956	0,86740	0,88828	0.85793	0,88461	0,88524	0.88043	0.87567	-

A similarity matrix for all lines was calculated for their RAPD bands (Table 2). The mean similarity index value from all of these comparisons was 0.9423. The lowest similarity index value, 0,8579, was observed between the cultivar 11 and line 6. The genotype 11 showed low similarity index values (mean value is 0,8770) when compared to all of the other `california′ and `lamuyo′ type lines (mean value is 0.9520.) and appeared as the most divergent line. The highest similarity index value was 0,9891 and was observed between `lamuyo′ type lines 9 and 10, which are from the same origin.

Figurs 2. Pepper dendogram generated using UPGMA clustering



Based on the rectangular matrix dates showed in the table 2, a cluster analysis was realised using the computer program above mentioned (NTSYS-pc)? Then dendogram built *for* the genotypes using UPGMA cluster is showed in figure 2. It is observed a high genetic diversity in the chilli cultivar in this dendogram. The rest genotypes are grouped in two subgroups (california' and 'lamuyo' types). The root of which has a similarity index of 0.9458. The composition of these subgroups is highly homogeneous, with the discrepancy of the line 5 of 'california' type. This result is supported by the crossing studies between 5 and 3 that produce a hybrid with a high vigour. The lines 2, 3 and I form a high genetic similarity cluster due to their common origin, in which the line 4 is also included. Crosses between the last one and tile other components of the cluster produce no specially vigorous hybrids, which is in agreement with the genetic similarity predicted by RAPD analysis.
The' lamuyo' cluster consists on two clearly differentiated subgroups. One of them formed by peppers of pure 'lamuyo' type (lines 9 and 10) and the other consisting on peppers proceeding from a crossing between' california' and' lamuyo' parental types, subsequently selected with the' california' pattern (7 and 8). These subgroups have a similarity rate of 0.95. As it is showed in the dendogram the pure, lamuyo' genotypes are found genetically further from the pure' california' genotype than the components of the other subgroup (lines 7 and 8).

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EVALUATION OF FRUIT EDIBLE RATE OF HOT PEPPER GERMPLASM

De Yuan Wang and Ming Wang

Department of Horticulture, Northwestern Agricultural University,

Yangling, Shaanxi, 712100, P. R. C.

Introduction

I. *Capsicum* varieties are widely cultivated in China. There are three distinct groups of varieties, i. e. hot pepper used for dried chile powder, hot pepper suitable for the fresh market, sweet pepper. The goals of the *Capsicum* breeding in China are as follows, 1) superior fruit quality, 2) resistance to virus (TMV and CMV) and *Phytophthora capsici,* 3) high yield (including earliness yield). Each kind of *Capsicum* requires different quality. Quality means different things to different people (Bosland, 1993). Hence different aspects of fruit quality standard vary according to uses by growers, shippers, sellers, and consumers. As *Capsicum* fruits move through market channels, the fruit quality parameters demanded by the consumers should be considered. For hot pepper for fresh market and sweet pepper, the consumers judge fruit quality not only in fruit size, colour, nutrition, but also in fruit edible rate, which is becoming more and more emphasized as time goes on.

Fruit wall (or fruit flesh) is the edible component of hot and sweet pepper fruits. About 25 % of the raw fruit of Truhart Perfection Pimiento variety was waste (Cochran, 1963). According to our investigation (Wang, 1993), fruit edible rates of the cultivars for fresh market, newly bred in China, were not too high (80 % - 85 %). Breeding hot pepper with high edible rate (more than 90 %) will have been concerned in the near future breeding programmes. This preliminary study investigated fruit edible rates of hot pepper germplasm, aiming to provide information associated with breeding for high fruit edible rates.

Materials and Methods

Twenty-two hot pepper accessions were planted in completely randomized design with one replication in the field, twenty plants per accession. At green maturity, ten fruits were randomly chosen from five plants per accession. For the individual fruit, the measurement of fruit weight, fruit flesh weight, placenta weight, fruit stem weight, and seed weight were undertaken. The character means were used for analysis. Then fruit edibles rates (FERs) (ratio of fruit flesh weight to fruit weight) were determined. Fruit edible characteristics of the germ plasm were graded as extremely high, high, intermediate, low, extremely low with more than 90 %, 80 - 90 %, 70 - 80 %, 60 - 70 %, less than 60 % fruit edible rate (FER), respectively.

Results and Discussion

These germ plasm showed wide spectrum of variation in fruit edible rate (Table 1). Following the above grouping criteria, the accessions fell into three groups, I. e. high FER Group, intermediate FER Group and low FER Group, and the number of the accessions in these three groups was 12, 9, and 1, respectively. In high FER Group, the variety 'WP 199-1-2' had the highest fruit edible rate (86. 04%) , followed by R841 (84.18%) and R408 (83. 76%). The accession '93- 19' had the lowest. Fruit edible rate (62. 85 %). For most of the germplasm tested, fruit edible rates range from 77 % to 86 %. None of the accessions with the edible rate more than 90 % was found in our study, suggesting that the elite germplasm with extremely high fruit edible rate was in the minority, and needed to be widely collected and explored. It could also be seen that, ratio of placenta weight to fruit weight was higher than that of fruit stem weight to fruit weight, usually higher than that of seed weight to fruit weight. This indicated that

Placenta was a major componet of fruit non- edible parts. Hence, the strategy of breeding hot pepper for extremely high frit edible rate (>90%) should be focused be on 1) increasing the fruit flesh weight and 2) reducing the non edible part weight, especially placenta weight.

Table 1 Fruit edible rate of hot pepper germplasm

Accessions	Fruit Weight (g)	Fruit Edible Rate	Placenta Weight to fruit weight	Ratio Of Stem	seed
WP 199-1-2	53.0	86.04%	6.81%	2.59%	4.56%
R841	25.5	84.18	4.17	3.97	7.14
R408	52.8	83.76	7.95	3.61	4.68
WP 119-1-12	43.3	82.78	8.42	3.19	5.61
E22	18.0	82.42	6.62	5.38	5.58
R401	14.9	81.87	7.03	3.67	7.43
6C-63	16.7	81.60	6.72	4.30	7.38
E18	14.6	81.54	7.68	3.32	7.56
R168	22.1	81.41	7.80	4.31	6.48
R610	34.0	81.13	7.37	3.54	7.96
6C-376	17.0	81.10	6.67	6.07	6.16
E6	33.4	80.88	8.12	4.89	6.11
6C-37	28.2	79.78	7.96	4.16	8.10
E3	45.8	78.66	9.68	7.70	3.96
R850	17.4	78.59	7.90	4.86	8.65
R33	34.6	78.28	10.52	4.00	7.20
F21-1	17.0	77.51	8.70	3.65	10.14
E18	17.5	76.37	9.79	3.42	10.45
R85036	22.1	75.85	11.51	4.38	8.26
Yiliniujiao	39.9	74.18	13.44	5.82	6.56
6C- 1278	22.6	72.62	12.40	4.84	10.14
93-19	22.4	62.85	16.08	8.75	11.32

Ratio of placenta weight to fruit weight was extremely significant, significant positive correlated with that of stem weight to

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EFFECT OF pH ON PEPPER SEEDLING GROWTH

J. Diaz & F. Merino
Department of Animal Biology and Plant Biology. Faculty of Sciences. University of A Coruna. Campus da Zapateira sin. 15071. A Coruna. Spain.

Introduction

Soils in Galicia (NW of Spain) usually have an acid pH (Macias, 1993). The "Padron" pepper *(Capsicum annuum* L. var. *annuum)* is a local variety with great commercial value, which is grown in various parts of Galicia. There is no general rule about optimum pH for growing peppers, but values from 6 to 8 are usually recommended (Andrews, 1995; DeWitt & Bosland, 1993; Zapata et al., 1991.). However there is little information on the influence of rhizosphere pH on pepper seedling growth and development (Stoffella et al., 1991). The purpose of this research is to determine the effects of pH on pepper seedling growth.

Materials and methods

Two days old seedlings were grown for a week in perlite soaked with nutritive solutions composed of 6mM KNO3, 4 mM Ca (NO3)2, 2 mM NH4H2PO4, 1 mM MgSO4, 50 11M KCI, 25 11M H3BO3, 2 11M MnSO4, 2 11M ZnSO4, 0.5 11M CUSO4, 0.5..JlM H2MoO4, 20 11M EDTA and 20 11M Fe(NH4)2(SO4). Solutions were adjusted to desired pH adding appropriate quantities of 10 mM PO4HK2 and 10 mM PO4H2K. Experiments were carried out using solutions buffered at pH 5.1, 6.6 and 7.3, which were renewed every day. After a week roots, hypocotyl, cotyledons and leaves were collected, weighed and extracted using 0.1M potassium phosphate buffer pH 7.4 containing 0.5 mM DTT, 2 mM cysteine, 2 mM EDTA and 8 mM 2-Mercaptoethanol. In addition 1 mg PVPP per. each 20 mg of fresh weight was added to the sample. Crude extracts were' centrifuged and supernatants were analyzed. Soluble proteins were determined according to Sedmak & Grossberg (1977), total chlorophyll as per Arnon (1949), and shikimate dehydrogenase as previously described (Diaz et al., 1994).

Results and discussion

Most of the organs of the seedlings grown at pH 7.3 had a higher fresh weight than those of plants grown at pH 6.6 and 5.1 (Fig. 1). These differences are similar in all the organs because they represented a similar percentage of the total fresh weight of seedling in all the treatments (Fig. 2). As previously stated by Stoffella et al. (1991), our results suggest that all of the organs of seedlings were affected in the same degree by the different pH treatments. However our data showed that seedlings reached the highest fresh weight at pH 7.3, but Stoffella et al. (1991) found that pH 5.9 was a more favourable pH for seedling growth. Differences between the two studies could be due to the fact

That different ways used to buffer the solution. Another differnce was the starting stages: Stoffella etal (1991) applied the pH treatment from seed germination, whereas we used two days old seedling.

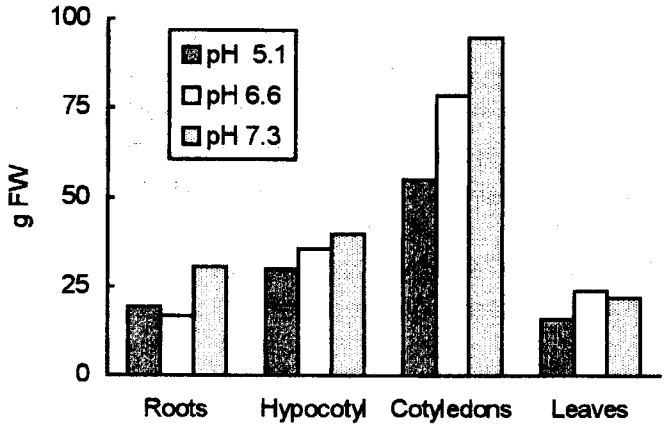

Fig 1 Fresh weight (FW) of seedling organs after different pH treatment

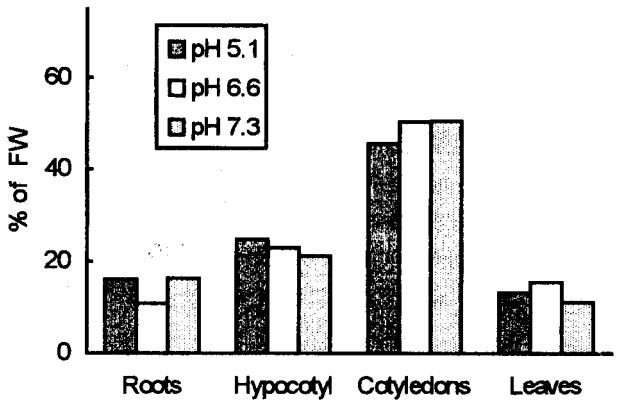

Fig Distribution of fresh weight of seedling after different pH treatments

Protein and cholophyll content was determined on order to obtain additional information about the status of seedlinling In assertions shikimate dehygenase activity was measured because it had been previously observed that the enzyme level is affected by different kind of abiotic stresses

(Diaz & Merino, unpublished results). Table 1 shows that the more acid the pH was, the more protein, chlorophyll and shikimate dehydrogenase levels per gram of fresh weight occurred in most organs. However there are not as many differences between treatments if data per organ are considered (Table 1). The fatter results suggest that differences in fresh weight are due to differences in- water content in the plant. Therefore plants at pH 7.3 contained more water than the others. An explanation of this phenomenon could be that some nutrients are less available at neutral pH than at an acid one, and plants have to absorb more water to maintain their needs. Further research will be carried out in order to clarify this effect and examine the effect of different pH on plants in the breeding stage.

Table 1. Protein and chlorophyll content, and shikimate dehydrogenase activity related to pH treatments.

Organ	**pH**	**Protein**		**Chlorophyll**		**Shikimate dehydrogenase**	
		mg/g FW	*ma/organ*	*mglg* FW	*mg/organ*	nkat/g FW	nkaUoraan
Roots	5.1	0.78	15.1	nd	nd	1.18	23
	6.6	0.57	9.6	nd	nd	0.70	12
	7.3	0.56	17.1	nd	nd	1.49	46
Hypocotyl	5.1	0.48	14.5	nd	nd	0.43	13
	6.6	0.40	14.5	nd	nd	0.28	10
	7.3	0.24	9.7	nd	nd	0.12	4.8
Cotytledons	5.1	2.35	129.4	91.4	5.03	3.63	295
	6.6	1.56	122.6	54.7	4.29	2.71	315
	7.3	1.67	158.5	62.2	5.89	2.46	273
Leaves	5.1	4.80	76.8	90.6	1.45	18.45	200
	6.6	2.93	70.4	64.6	1.55	13.12	212
	7.3	2.95	64.8	77.1	1.70	12.43	233

nd= not determined. FW= fresh weight.

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EFFECTS OF DIFFERENT FRUIT MATURITY STAGES AND STORAGES CONDITIONS OF CHEMICAL COMPOSTION AND MARKET ACCEPTIBLITY OF FRUIT IN DIFFERENT VRIETIES OF SWEET PEPPER

N. Ahmed; M.I. Tanki; M. Mir and G.A.Shah
Division of Olericulture, S.K. University of Agricultural *Sciences* and Technology,Srinagar, 191121,J&K,India

INTRODUCTION

Importance of sweet pepper has gradually increased not only by nutrition conscious people of India but has gained popularity among vegetables growers because of it high export value. Keeping in view its export importance and nutrition a 1 qualities, in the present study an attempt was de to know the effect of different fruit maturity stages and storage conditions on chemical composition and market acceptability of fruits. Secondly to assess and identify cultivars which are rich in nutrients and can store well for longer period with minimum loss of nutrients and markets acceptability.

MATERIALS and METHODS

The experiment with 15 cu1tivars (cv.) was conducted *at* Vegetable Experimental Farm, S.K.U.A.S.T., Srinagar during kharif 1993 following RBD with 3 replications Seedlings were planted in 3.1.1 x 2.4 in plots at spacing 50cm x 30cm and a healthy crop was raised. Fruits of different maturity stages (green edible, matured green, breaker and ripe/yellow) from 8 cvs. and green edible fruits from all the 15 cvs were harvested separately, washed and used in triplicate for estimation of total chlorophyll (TC), total soluble solids (TSS), ascorbic acid (AA) dry matter content (DM) and market acceptability (MA). TC mg/g was estimated as per Mackinney (1941). TSS matter determined from fruit juice using hand refractor meter and expressed as °B. A.A was determined using'6 2,6 dichlorophenol indophenol dye method (A.O.A.C. 1975). DM was determined by drying the fruit samples at. 60:t2^{o}C a constant weight. MA was determined considering & colour, Shape, size, texture and over all appearance and graded as excellent (5), good (4), fair (3), poor (2) very poor (1) unacceptable (0). For Storage studies, edib1e green marketable fruits from 8 cvs were stored under ordinary room temperature (20,8^{0}C, 70-72% RH) and at controlled condition (80 C, 85 90 % R H). Fruits from two storage condition were analyzed for T3S, AA, cumulative weight loss .CWL) and MA at weekly interval and changes in these chemicals and MA were noted.

Results and Dicussion

Significant difference exceeded among cultivars in respect to chemical composition (table1). DM varied from 7.17 to 14.67 percent and TSS from 2.83 to 5.08. DM and TSS were significantly high in cv. Oskash and KSP-3 followed by KSPS –461. AA content varied from 56.43 to 114.73mg/100g fresh fruit. CV oskash recorded significantly high AA (114.73 mg;100g) followed by KSPS 3 (106.50) and KSPS-201 (91.42). AA was mininimun in Arka Gaurav and hybrid KT-1. The total chlorophyll which indicates green fruit colour was highest in cv. World beater (8.97mg/g) followed by KSPS-2, HC 201 and KSPS 401 and were dark green. The other hand hybrid MA 1 in general was excellent except hybrid KT1 Oskash and KSPS- 461. These cvs owing to their poor colour and among different cultivar Oshash and KSPS-3 by having superior nutritional qualities could be considered as the petentail genotypes for future exploitation. Varietal variation for DM and AA in Chilli was also observed by Bajaj et al (1980)

Table 1 Chemical composition and market acceptability of some sweet pepper cultivars

Culitvars	DM%	TSSoB	TC mg/g	AA (mg/100g)	MA
Cal. Wonder	8.94	3.83	4.42	66.53	5.0
KT-1 f1	8.85	2.83	0.84	58.20	4.0
HC-201	10.20	2.91	6.48	67.29	5.0
Oskash	13.21	5.08	1.72	114.73	4.0
Arka Gaurav	8.83	3.33	5.02	56.43	5.0
Bull nose	7.45	4.58	6.24	68.39	5.0
World Beater	9.82	3.50	8.97	66.66	5.0
Chinese Giant	8.57	2.19	6.24	61.37	5.0
KSPS-1	8.70	3.66	5.66	61.37	5.0
KSPA2	9.82	3.83	6.70	74.03	5.0
KSPS3	14.67	4.66	4.57	106.50	5.0
KSPS 401	7.78	5.00	6.44	67.53	5.0
KSPS 206	9.54	3.41	6.37	82.39	5.0
KSPS461	10.63	4.58	4.18	84.60	4.0
KSPS201	7.17	3.14	4.40	91.42	5.0
CD at 5%	.53	.25	.29	6.35	

Table 2. Chemical compositon and market acceptability of some cultivars of sweet pepper as affected by different fruit maturity stages (average of triplicate estimations).

	Maturity stages																			
	Green edible					Matured green				Breaker stage					Red ripe/yellow					
	TC	DM	TSS	AA	MA	DM	TSS	AA	MA	TC	DM	TSS	AA	MA	DM	TSS	AA	MA		
C.Wonder	4.4	8.9	3.8	66.5	5.0	9.3	4.1	62.8	4.0	3.3	9.5	4.8	58.0	2.0	9.8	5.3	50.7	0.0		
KT-1(F_1)	0.8	8.8	2.9	58.2	4.0	9.2	3.3	57.0	3.7	0.6	9.0	4.6	50.9	2.3	9.5	4.8	49.3	0.6		
HC-201	6.5	10.2	2.8	67.3	5.0	10.5	3.3	71.5	4.0	4.9	10.4	6.1	64.6	2.0	10.8	6.0	60.0	0.0		
Oskash	1.7	13.2	4.8	114.7	3.7	14.6	4.9	100.8	3.0	1.0	13.9	6.0	91.0	2.3	14.6	6.0	71.0	0.0		
Arka Guarav	5.0	8.8	3.6	57.4	5.0	9.5	4.0	55.3	4.3	3.7	9.4	4.6	51.0	2.0	10.4	5.0	50.3	0.0		
KSPS-1	5.7	8.7	4.0	83.7	5.0	9.9	4.6	78.3	4.0	4.2	10.5	5.1	69.7	2.0	10.9	5.1	64.2	0.0		
KSPS-2	6.7	9.8	4.1	74.0	5.0	10.7	5.4	20.2	4.3	5.0	10.9	5.5	69.3	2.0	11.5	5.8	64.0	0.0		
KSPS-3	4.6	14.7	4.7	106.4	4.0	15.3	5.1	89.0	3.0	3.5	14.9	5.1	83.2	2.0	15.8	5.9	68.7	0.0		
Mean	4.4	10.4	3.8	78.4	4.6	11.1	4.3	23.1	3.8	3.3	11.1	5.2	67.2	2.1	11.7	5.5	59.8	0.1		
% change over green edible	-	-	-	-	-	7.1	13.0	-6.7	-17.4	-25.4	6.5	36.3	-14.3	-54.8	12.5	43.1	-23.8	-98.2		

Note: TC was estimated only at green edible stage and breaker stage.

Table 3. Chemical composition and market acceptability of some cultivars of sweet pepper as affected by storage conditions (average of triplicate estimates).

	Storage conditions																	
	Ordinary room temperature(20.8°C,70-72% RH)								Controlled conditons (8°C 85-90% RH)							
	After one week				After two week				After two week				After four week			
	TSS	AA	CWL	MA	TSS	AA	CWL	MA	TSS	AA	CWL	MA	TSS	AA	CWL	MA
C.Wonder	4.6	40.8	14.5	2.0	5.1	33.1	26.6	1.0	3.9	61.8	5.1	5.0	3.7	57.4	8.0	4.0
KT-1(F_1)	3.2	34.8	20.8	2.0	3.8	29.5	36.9	1.0	2.9	57.9	3.9	4.0	3.1	61.0	5.4	3.0
HC-201	3.3	45.3	10.9	2.0	3.8	33.4	19.0	1.0	3.2	58.8	3.2	5.0	3.3	60.4	5.6	4.0
Oskash	5.4	74.5	19.5	2.0	5.8	61.2	31.4	1.0	4.8	105.5	3.0	4.0	5.0	101.4	4.7	3.0
Arka Gaurav	3.6	41.6	11.4	2.0	3.9	30.7	18.8	1.0	3.5	62.9	2.8	5.0	3.6	57.7	5.5	4.0
KSPS-1	4.1	64.7	10.5	2.0	4.9	41.3	17.0	1.0	3.7	84.0	2.7	5.0	3.9	79.9	4.3	4.0
KSPS-2	4.5	52.0	14.6	2.0	5.4	52.1	24.3	1.0	4.0	67.3	4.9	5.0	4.0	63.4	7.4	4.0
KSPS-3	5.1	75.0	9.4	2.0	5.9	64.3	16.9	1.0	4.7	107.8	2.3	4.0	5.0	99.7	4.9	3.0
Mean	4.2	53.5	13.9	2.0	4.8	43.2	23.8	1.0	3.8	75.7	3.4	4.6	3.9	72.6	5.7	3.6
% change over fresh harvested green edible	12.2	-31.6	13.9	-56.7	28.2	-44.9	23.9	-78.3	2.1	-3.4	3.5	0.0	5.0	-7.4	5.7	-21.6

Edib1e stage but thereafter both increased gradually and were maximum at ripe stages in all the cultivars. Changes .in chemical composition of fruits under storage condition of is given in Table 3. The' results indicated that fruits stored under control\ed conditions irrespective of cultivars showed no appreciable change in chemical composition old MA. After four weeks of storage the TSS slightly increased by 5.0% while AA decreased to an extent of 7.4%. MA of fruits was excellent Among different cvs., the minimum weight loss "..as ln 'KSPS-1' and 'HC- 201'. On the contrary, fruits stored at ordinary room temperature showed drastic changes in chemical c.lsition and fruits were unacceptable after one to two weeks of storage. The CWL was as high as 36.98% in 'KT-1' after two weeks of storage (followed by 'Oskash' (31.40%), where as it was minimum in cv.'KSPS-3' followed by 'KSPS-1' (17.0%) 'HC-201' (18.97%) and 'Arka Gaurav' (18.76%). TSS in all the cultivars gradually increased from one week to two weeks of ordinary storage where as it was reverse with AA which decreased gradually and rapidly to ~n extent \-,f 44.9% with no MA uftei- two weeks at ordinary storage. D~Gr~ase of AA level by 75% after 18 days of storage
at *chilli.* was also reported in Brinjal (Esteban 1989).

Among two storage conditons, the controlled storage condition (8°C, 85-90% RH) ""as considered besr as fruits could stored for four weeks ~ith minimum effect on chemi- cal composition and MA. Amvng cultivars, 'KSPS-1' and 'HC-201' under both the storage conditions showed minimum toss i. weight Rn~ ascorbic acid content along with good market acceptability. These cultivars can therefore be best utiltzed for storage purposes.

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A SIMPLE METHOD FOR DETERMINING THE DEGREE OF PUNGENCY OF PEPPERS

T. Anan, H. Ito, H. Matsunaga and S. Monma
National Research Institute of Vegetables, Ornamental Plants and Tea,
Ano, Mie 514- 23, Japan

Introduction

Plant breeders and seed growers who work with hot peppers often encounter difficulty in determining the pungency of various lines and individual plant selections. For this, tasting has generally been employed. However, direct tasting of fruit has proved unsatisfactory because taste ability is quickly" destroyed", and non- pungent fruits cannot then be identified. Attempts to determine pungency by tasting diluted fruit extracts have also proved unreliable. On the other hand, various instrumental methods, including spectrophotometry (Bajaj, 1980; Mori, 1976), gas- liquid chromatography (Todd, 1977) and high-performance liquid chromatography (Weaver, 1986) have been employed for the determining content of capsaicin. However, since these methods involve complicated in sample preparation and the instruments necessary are expensive, they are not suitable for determining the pungency of a large number of plants. A simple chemical test for pungency in peppers using vanadium salts as an indicator has been reported (Ting, 1942). However, a dried sample must be prepared, and so fresh fruits cannot be tested directly. Therefore, to determine the degree of pungency of peppers, a simple method allowing direct testing of fresh fruits and rapid sample preparation was developed.

Materials and Methods

(1) A piece of fresh pepper fruit containing the placenta was treated with diethyl ether to extract the pungency agent, capsaicin, and the extract was mixed with 0.5 N sodium hydroxide solution. Then a mixture of 1% ferric chloride solution, 1% potassium ferricyanide solution and concentrated hydrochloric acid was added to the solution as an indicator. The degree of pungency of the pepper fruits was roughly determined by comparing the green color intensity of the lower layer of the solution with that of a standard solution containing reagent-grade capsaicin with the naked eye. The absorbance of the lower layer was measured at 750 nm with a spectrophotometer, and was then compared with the capsaicin content determined by the colorimetric method (Mori, 1976) to investigate the correlation between color intensity and capsaicin content.

grade capsaicin with the naked eye, and the
ng. The tasting panel included seven persons.

a faint greenish- yellow color reaction,
he content of capsaicin. The coefficient of

the lower layer. From these results, a method
n in Scheme 1. In this method, fresh fruits can
s ihe degree of pungency of the pepper fruits
tion with the naked eye, the method is a
on are also shown in Scheme 1.

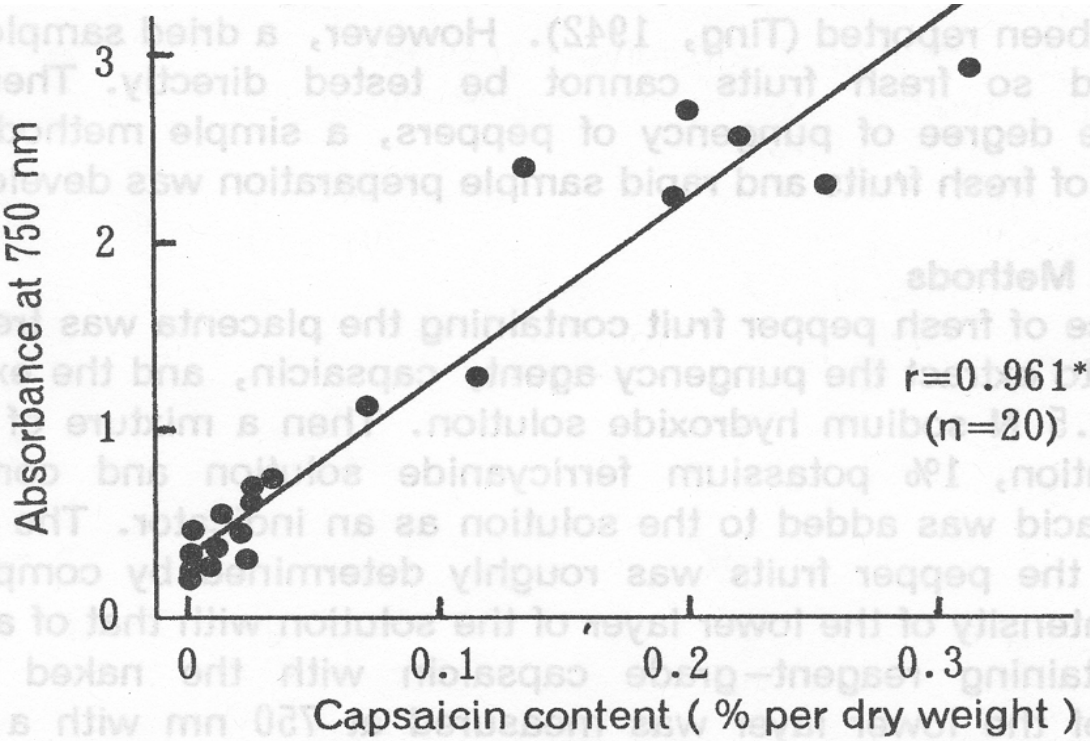

Figure 1. Correlation between absorbance and capsaicin content. The solution was prepared by the method shown in Scheme 1

Place a section of fresh fruit including the placenta (about 1 g) into a test tube.

After adding 5 ml of diethyl ether, mix for about
10 s with a lab. mixer.

- Transfer 1 ml of diethyl ether extract solution to another test tube.

After adding 1 ml of reagent A, mix for about
10 s using a lab. mixer.

After adding 3 ml of reagent B, mix for about
10 s using a lab. mixer.

Evaluate the degree of pungency by comparing the intensity of the green color of the lower layer with that of the standard solution with the naked eye. ' Scheme 1. A simple method for determining the degree of pungency of peppers.

Reagent A : Dissolve 2 g of sodium hydroxide and 2 g of sodium chloride in 100 ml of water.
Reagent B : Solution 1 (dissolve 1 g of ferric chloride in 100 ml of water), solution 2 (dissolve 1 g of potassium ferricyanide in 100 ml of water) and concentrated hydrochloric acid are mixed equivalently. The indicator is relatively unstable and it is undoubtedly best to make it up fresh just before the test.
Standard solution: One milliliter of 0.001% capsaicin in reagent A and 3 ml of reagent B are mixed. The solution is relatively unstable and it is undoubtedly best to make it up fresh just before the test.

(2) The green color intensity prepared by the method shown in Scheme 1 and the degree of pungency determined by tasting for the F 2 population are shown in Table 1. The green color of non- pungent plants was lighter than that of the standard solution, whereas the color of highly pungent plants was darker. These results indicate that this method can be applied for selecting sweet plants from segregating populations between sweet and hot peppers.

Table 1. Relation between the degree of pungency and the intensity of the color of the lower layer in two F z populations. .

	Number of plants			
Degree of pungency	**Test 1**		**Test2**	
	Lighter	Darker	Lighter	Darker
None	14	0	34	0
Very low or faint	26	23	16	28
Moderate	4	34	1	25
High	0	12	0	9

. Sample solutions were prepared by the method shown in Scheme 1. The tasting panel included seven persons.

Y 113 plants of the Fz population between' Shin-sakigake 2' (sweet, pepper) and' CB17 - 2- 2- l' (hot pepper) were used for Test 1, and 113 plants of the F z population between' Shin-sakigake 2' (sweet pep per) and' CH 4- 4- 3 ' (hot pepper) were used for Test 2.

x The intensity of the green color of the lower layer was lighter than that of the standard solution.

W The intensity of the green color of the lower layer was darker than that of the standard solution.

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SCREENING OF CHILLI CULTIVARS AND ACCESSIONS FOR RESISTANCE TO CUCUMBER MOSAIC VIRUS AND POTATO VIRUS Y

Poonam Dhawan,J.K. Dang,M.S. Sangwan ad S.K.Arora
Chaudhary C haran Singh Haryana Agricultural University, H isar-125004 (INDIA)
Key Words: Screening, access ions, ChiIli, mosaic

Introduction

Chilli (Capsicum annum L.) is a common vegetable crop in India. Its cultivation is severely-affected by many viruses including cucumber mosaic ~ virus, potato virus x, potato virus y, tobacco mosaic virus and leaf curl (1,3,4,5) which have potential to cause heavy yield losses. It was therefore, decided to screen out accessions/cultivars resistant to CMV and PVY.

Materials and Methods

a) Screening under natural conditions

Forty-six accessions were transplanted on ridges in the month of July each year 1992-94. Two 5 m rows of each accession (3 replicates) were transplanted 60 cm apart with a distance of 45 cm between plants. For high inoculum build up, a row of highly susceptible cultivar Pusa Jwala' was planted between every two rows of the test material and around the edges of the trial. Observations on disease incidence were recorded regularly at 10 days interval until crop maturity.

b**) Screening under artificial conditions**

Two batches of 25 seedings each of the nineteen access ions rated as highly resistant and moderately resistant on the basis of field response were transplanted in pots at 2-leaf stage. The pots were kept in the green house, under insect proof conditions and inoculated mechanically, after the paints had established well. One batch was inoculated with CMV and the other with PVY using carborundum (600 mesh) as abrasive. The supernatants (centrifuged 6000 rpm, 15 mts) of the saps prepared in 0.2 M phosphate buffer (pH 7.0), using young leaves of chilli plants showing bright symptoms of CMV and PVY individually were used as inoculum.

c) Serological testing

OAC-ELI SA using CMV and P VY antisera was done (2) to confirm the presence of CMV/PVY in the artificially inoculated plants. Sampling was done by taking one top leaf per plant from each of 25 plants compraising one batch. The observations were based on visual colour changes.

d) Reaction category

On the basis of percent disease incidence, the cultivars/accessions were given the following grading:

Reaction	Disease incidence (%)
Highly resistant	**0.0**
Moderately resistant	Up to 10
Moderately susceptible	11-20
Susceptible	21-50
Highly susceptible	51 and above

Results

On the basis of per cent disease incidence in field trials (1992-94), eight genotype viz., I HC-1-1', 'HC-151, 'HC-22', 'HC-28', 'HC-691, 'HC-226', 'Pusa Sadabahar' and 'Virus Free-11 were found to be highly resistant both under fie Id conditions and artificial inoculation with CM V and PVY (Table). These accessions/cultivars were negative for the presence of CMV or PVY by ELISA testing. Out of the eleven accessions which were categorized moderately resistant under natural conditions, for remained so to CMV and PVY after artificial inoculation.

Discussion

Studies pertaining to reaction of different genotypes of Capsicum annuum L. to CMV, TMV and PVY have been carried out by many workers (4, 6, 7). During the present studies, seven accessions/cultivars found highly resistant have the potential of being used in resistance breeding programme. Two accessions viz., I HC-28' and 'HC-44' possessing multiple disease resistance and good agronomic traits with a yield potential of 17.9 and 18.7 tonnes ha-1 respectively, have been released by Haryana Agricultural University, Hisar as varieties 'Hisar Vijay' and 'Hisar Shakti' for cultivation.

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Table. Reaction of Capsicum annuum. L. germplasm to mosaic disease.

Germplasm			
Disease Reaction	Natural Field condition	Artificial Inoculation Conditions	
		CMV	PVY
Highly resistant	HC1-1, HC-15, HC-22, HC28 HC-69, HC226, Virus Free 1, Pusa Sadabhar	HC1-1, HC-15, HC-22, HC28 HC-69, HC226, Virus Free 1, Pusa Sadabhar	HC1-1, HC-15, HC-22, HC28 HC-69, HC226, Virus Free 1, Pusa Sadabhar
Moderately resistant	H- 13, HC-44 ,HC-46-2, HC-47, HC-58, HC-71, HC-74-1, HC-102-1, HC-109-2, HC-250, HC-174-1	HC-44 HC-58, HC-109-2, HC-174-1, HC-250,	HC-44, HC-58, HC-109-2, HC-250 , HC-46-2
Moderately susceptible	HC-4, HC-6, HC-12, HC-42-3, HC-46, HC-48, HC-51, HC-79-2, HC-164, P-47	HC-47, HC-71, HC-74-1, HC-102-1	HC-47, HC-71, HC-74-1, HC-102-1, HC174-1
Susceptible	HC-20-5, HC-29, HC,102, HC-259, P27		
Highly susceptible	HC-8-2, HC-17-1, HC-17-3, HC-27, HC-27-1, HC-50-1, HC-70, P-14, P-16, P20,P52		

Data based on average of three years (1992-94)
Reaction based on visual symptoms
Reaction based on ELISA test.

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SCREENING *OF CAPSICUM CHACOENSE* ACCESSIONS FOR TSWV RESISTANCE BY MECHANICAL INOCULATION

Rosellol, S., Diezl, M.J., Jorda, C., Nuezl, F.

Biotechnology Dept., Polytechnic University of Valencia, Spain Plant Protection Dept., Pathology, Polytechnic University of Valencia, Spain.

Genetic resistance to TSWV has been reported in several species of *Capsicum:* C. *chinense* (Black *et al.,* 1991; Boiteux *et al.,* 1993), C. *frutescens* (Diez *et al.,* 1993), C. *baccatum* (Boiteux *et al.,* 1993; Gil, 1993), C. *pubescens* (Diez *et al.,* 1993; Nuez *et al.,* 1994). Nevertheless, the authors have not found reports on TSWV resistance in C. *chacoense.*

This paper shows the response of eight C. *chacoense* accessions to mechanical inoculation with TSWV. The trials were carried out in a climatic room at 28/18 °c, (day/night) tempemture, 70-90% of relative humidity, 65-80 ~mol m-2s-lofirradiance and 14 hours of photoperiod. The inoculum L-93940 (JordA et al., 1994) was used. The plants were inoculated at the 4-6-leaf stage and a second inoculation was repeated a week afterwards. C. *annuum* cv. 'Negral' was used as susceptible control. The plants were maintained in the climatic room for 60 days after inoculation. Symptoms were noted and samples for ELISA analysis were taken each 10-15 days. Later, the resistant plants were transplanted to greenhouse and the evolution was followed for 20 days. Plants with evident TSWV symptoms and/or ELISA positive were considered as infected.

The first symptoms in control plants appeared as necrotic lesions, these plants became wilt later, dying 20 days after inoculation. Accessions C-152 and C-279 were highly susceptible, all of the plants dying 15 days after first inoculation. Local lesions appeared after inoculation on the other accessions. From 2 to 4 plants of accessions C-151, C-154, C-175 and C-176 became infected, showing a delay in symptoms appearance and a heterogeneous behaviour (Table 1). Accessions C-153 and C-280 showed a higher level of resistance. Necrotic lesions and apical death appeared in one single plant of C-15 3 after inoculation, but it regrewed and developed a new bud, which showed no symptoms and was found to be ELISA negative. Only one plant of accession C-280 showed TSWV symptoms and died before the end of the trial.

The previous results suggest that the resistance found in C. *chacoense* C-153 can be interesting for its introgression in C. *annuum.* The response of these accessions to TSWV inoculation by *Frankliniella occidentalis* Perg. is currently in course.

Table 1. Number of infected plants and symptoms observed in eight accessions of C. *chacoense* mechanically inoculated with TSWV.

Accession	infected plants/total plants	Symptoms
C-151	4/7	NA, NS, NL,W
C-152	7/7	NA, NS, W
C-153	0/9	NA-+Regr
C-154	4/8	NA-+Regr-+W
C-175	4/7	Nt, NA-+Regr
C-176	2/8	NA, NA-+Regr
C-279	8/8	NA, NS -+W
C-280	1/7	NS-+W

NA: Necrotic lessions on the apex.
NL: Necrotic lessions on the leaves. NS: Necrotic lessions on the stem. W: Wilt.
Regr: Regrew.
-+: Evolution of symptoms.

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INHERIT ANCE OF RESISTANCE TO PHYTOPHTHORA BLIGHT IN HOT PEPPER

De Yuan Wang and Ming Wang

Department of Horticulture, Northwestern Agricultural University, Yangling, Shaanxi,712100,P. R. C

Abstract Genetic analysis of resistance to *Phytophthora capsici* in hot pepper *(Capsicum annuum* L) with 4 X 4 half- diallel cross revealed the importance of both additive and dominant component in the inheritance of the disease index character. However. Dominant component was higher than additive one. The mean degree of dominance indicated overdominance for the disease index character. To exploit both the additive and dominant genetic component, the use of biparental mating in early generation among the selected lines and use of heterosis breeding method are possible in breeding for resistance to *Phytophthora capsici.*

Introduction

Disease is a major factor limiting the production of hot pepper in China, and Phytophthora blight caused by *Phytophthora capsid* is one of the most serious problems. It is common allover the country and severely causes pepper yield loss. Presently, the disease is controlled by routine fungicide applications that have limited success. Primary infections also can be reduced by using well- drained soil. providing good weed con trot, and following crop rotations that exclude susceptible plants. Currently, no Phytophthora blight - resistant pepper cultivars are available in China. However, some researchers have screened pepper germplasm for sources of Phytophthora blight resistance in China. The inheritance of Phytophthora blight resistance was reported to be genetic diversity (Wang *et al,* 1995). Our research was designed to study the inheritance of resistance to Phytophthora blight in hot pepper breeding lines.

Materials and Methods

Four homozygous hot pepper genotypes were selected. Representing different levels of resistance to *Phytophthora capsici.* Given in order of increasing resistance. the following three lines and one cultivar were selected: 408, E9. F21 - 1 and 8212. All possible crosses were made among the 4 genotypes, excluding reciprocals. All the 6 F1s along with 4 parents were raised in greenhouse in completely randomized block design with two replications; each plot consisted of 6 culture pans, 2 plants per culture pan.

Screening for resistance to *Phytophthora capsici* was conducted in the greenhouse at 25 to 28'C. When the sixth true leave were expanded. The plants were inoculated by soil- drench method with inoculation suspension of 2,000 zoospores per milliliter, one milliliter per plant.

Reaction of plants was scored on a 0 to 9 scale (Wang *et al, 1995*) for disease severity seven days " after inoculation. Then the disease index was determined. The genetic analysis of disease index was carried out using the method of Singh *et al* (1981) and Virk *et al* (1983).

Resul s and Discussion

The results of analysis of variance for disease index revealed significant difference among parents and hybrids. The *f* estimate to test the uniformity of the Wr, Vr values were not significant, and the regression coefficient of Wr to Vr was O. 9245. Compared with 1, and is not significant. Indicating fulfillment of diallel assumptions. The estimates of genetic parameters for disease index character was given in Table 1, which confirmed the importance of additive as well as dominate gene action.

Table 1 Estimates of genetic parameters of the disease index character

Genetic parameters	Estimates	Genetic parameters	Estimates
D	75. 56	(HI/D)T	1. 678
F	24.18	$H_2/4H_1$	0.231
H_1	212.91	$K=h^2/H_2$	0.532
H^2	196.32	[(4DH1)T+F]/[4DHI)T-F]	1.211
h_2	104.52	r. (Wr+ Vr)Yr	0. 7917
t_2	3.06	Broad heritability (%)	73.18
		Narrow heritability (%)	29. 94

Analysis of genetic components showed that dominance component was larger than additive component. H1 greater than D inferred that manifestation of disease index character is mainly governed by dominant gene action. The value of (H1/D) t was bigger than 1. Indicating the operation of over dominance. The positive correlation between the mean values of the parents Y r and the order of dominance Y(Wr+Vr) suggested that the dominant genes were associated with low mean expression.

The Hz

Component was smaller than H1. Indicating the unequal proportion of positive and negative alleles in the loci governing the character. The asymmetrical distribution of genes in the parents was evidenced by the value of Hz/4H1, which was less than O. 25. F value was positive. indicating that dominant alleles were more frequent than recessive ones in the parents. This was also corroborated by the value of [(4DH1) T+F]/[(4DH1) T- F]

The number of blocks of genes influencing the disease index character was one as revealed by the hz I Hz value. Heritability in broad. narrow sense was 73. 18%. 29.94%, respectively. H/Hi value was 409, which clearly showed that additive gene effect accounted for 40. 9 % of total genetic effect.

In the present study. since both additive and dominant genetic components were important in governing the disease index character. biparental mating in early generation among the selected lines can be adopted in breeding programmes for the improvement of resistance to *Phytophthora capsici.* Thinking about the value and direction of dominant gene effect in gene system of the disease index character. it is suggested that breeding for resistance to *Phytophthora capsici* should be carried out by heterosis breeding method.

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REACTION OF ASIAN GERMPLASM OF PEPPER *(CAPSICUM ANNUUM* L.) TO IT AlJAN POPULATIONS OF ROOT-KNOT NEMATODES *(MELOIDOGYNE* SPP.)

M. Di Vito., G. Zaccheo. and J.M. Poulos..
Institute of Agricultural Nematology, C.N.R., Via Amendola, 165/ A 70126 Bali, Italy
Asian Vegetable Research and Development Center, Shanhua, Tainan, P.O. Box 42, - Taiwan 74199 (present address: ASGROW-ITALIA, 04014 Pontinia-Latina, Italy)

SUMMARY. The reaction of accession of Capsicum annuum to four Italian populations of *Meloidogyne incognita, M javanica, M. arenaria and M. hapla* were evaluated in a glass-house at 27 :t2°C. Groups of seven plants of each line were transplanted in plastic trays with 10 dln3 of steam-sterilized sandy soil artificially infested with 10,000 eggs and juveniles of each nematode population per plant. All accessions from Indonesia, Malaysia, Philippines, Taiwan, Thailand and three accessions from France were resistant to *M. incognita, M. javanica* and *M. arenaria.* The accessions C 00602 "Black Cluster" and CO1171 "PM 687" were resistant to *M. incognita* and *M. javanica* but susceptible to *M. arenaria.* All accessions tested were susceptible to *M. hapla.*

The root-knot nematodes *Meloidogyne incognita* (Kofoid *et* White) Chitwood, *M. javanica* (Treub) Chitw., *M. arenaria* (Neal) Chitw. and *M. hapla* Chitw., cause severe damage to pepper *(Capsicum annuum* L.) in greenhouses and outdoors in sandy soil (Di Vito *et al.,* 1985). The control of these nematodes on pepper is based mainly on the use of nematicides, but this control is expensive and may cause pollution. Few pepper varieties are known to be resistant to only *M. javanica* (Di Vito *et al.,* 1991). Therefore, an I; experiment was undertaken for evaluating the reaction of some accessions of mostly an
Asian germplasm collection of pepper, to Italian populations of *M eloidogyne* spp.

MATERIALS AND METHODS

Nineteen accessions of C. *annuum* (Tab. 1), from the genoplasm collection of the Asian Vegetable Research and Development Center of Taiwan (A VRDC), were sown in plastic trays containing steam sterilized sandy soil. These accessions had previously been evaluated as resistant to a Taiwanese population of *M. incognita* by the AVRDC (1989). At the two-leaf stage, four sets of seven seedlings of each accession were transplanted in other trays with the same substrate. A week later the plants were inoculated with 10,000 eggs and juveniles per plant of one Italian each per set. The populations used as inoculum were: *M. incognita* host race 1 (Di Vito and Cianciotta, 1991) from Castellaneta (Apulia), *M. javanica* from Torchiarolo (Apulia), *M. arenaria* host race 2 from Verona (Veneto) andM. *hapla* from Ferrara (Emilia Romagna). All nematode populations had been rearely extracted from infested roots by using the NaOCI method (Hussey and Barker, 1973). Seven seedlings of pepper "Como di Toro Rosso", for each nematode population, were used as a susceptible control. All plastic trays were randomly arranged on benches in a glass-house maintained at 27:t2°C. Forty days after inoculation the plants were uprooted, the roots gently washed and galls and egg masses counted after staining by dipping the roots in a 0.015% Phloxin B solution for 15 min (Dickson and Ben Struble, 1965). Gall (GI) and egg mass index (EI) was then assessed according to a 0-5 scale, where 0 = no galls or egg masses, 1 = 1-2 galls or egg masses, 2 = 3-10,3 = 11-30, 4 = 31-100, and *5* =

more than 100 galls or egg masses (Taylor and Sasser, 1978). The data were then statistically analyzed by ANOV A and LSD's calculated. A pepper plant was considered resistant when the GI and EI was S 2.

RESULTS AND DISCUSSION

All accessions from Indonesia, Malaysia, Philippines, Taiwan, Thailand and the !
accessions "Serrano VC (pM 164)", "Criollo de Morelos 334 (pM 702)" and "PI 201234" "" r from INRA, France were resistant to *AI. incognita, M. javanica* and *M. arenaria* (Tab. 1- 2). The accessions "Black Cluster" (Hungary) and "PM 687" (France) were resistant to *M. . incognita* and *M. javanica* but susceptible to *AI. arenaria.* All germplasm tested, including the control "Como di Toro Rosso", was susceptible *to1\tf. hapla. The results obtained with this experiment are interesting because we have confirmed new sources of resistance to M. incognita, .IV. jm'anica* and *lv/. arenaria,* which can be useful for future breeding programmes to introduce resistance to root-knot nematodes in pepper. The inheritance of these sources of resistance is not known. More studies are needed, therefore, to understand the genetics of this character; and further screening is necessary to find sources of resistance to *M. hapla.*

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TABLE 1. Gall index and reaction type of 19 accessions of *Capsicum annuum* inoculated with four species of root-knot nematodes (*Meloidogyne* spp.) in glass-house.

Accession and cultivar	Name	Origin	Gall index (GI)(0 - 5) and reaction type (RT)							
			M. incognita		*M. javanica*		*M. arenaria*		*M. hapla*	
			GI*	RT**	GI	RT	GI	RT	GI	RT
C 00573	Pangalegan-1	Indonesia	0	R	0	R	0	R	4.4	S
C 00104-1	MC 4	Malaysia	0	R	0	R	0	R	3.6	S
C 00543	Unnamed	Philippines	0	R	0	R	0	R	4.4	S
C 00490	Hot Pepper	Taiwan	0	R	0	R	0	R	3.3	S
C 00466	L.P. 2	Thailand	0.4	R	0	R	0	R	3.6	S
C 00474	L.P. 1	"	0	R	0	R	0	R	4.6	S
C 00476	Kradee Kao	"	0	R	0	R	0	R	3.5	S
C 00550	Unknown 5	"	0	R	0	R	0	R	4.5	S
C 00551	Unknown 6	"	0	R	0	R	0	R	4.8	S
C 00561	Unknown 16	"	0	R	0	R	0	R	3.4	S
C 00563	Unknown 18	"	0	R	0	R	0	R	4	S
C 00584	Unknown 30	"	0	R	0	R	0	R	4.6	S
C 00585	Unknown 31	"	0.9	R	0	R	0	R	3.1	S
C 00590	Unknown 36	"	0	R	0	R	0	R	5	S
C 00602	Black Cluster	Hungary	0.3	R	0	R	4.1	S	4.9	S
C 01171	PM 687	France-INRA	0.1	R	0	R	3.6	S	4.1	S
C 01173	PM 164	"	0	R	0	R	0.6	R	4	S
C 01175	PM 702	"	0	R	0	R	1.5	R	4	S
C 01176-A	PI 201234	"	0	R	0	R	0	R	4	S
Corno di Toro Rosso		(Check) Italy	4.8	S	4.4	S	4.7	S	5	S
LSD P < 0.05			0.42		0.11		0.36		0.57	
P < 0.01			0.56		0.14		0.47		0.76	

* 0 = 0 gall; 1=1-2 galls; 2=3-10; 3=11-30; 4=31-100; and 5=more than 100 galls

** R = Resistant, gall index ≤ 2; and S = Susceptible, gall index > 2.

TABLE 2. Egg mass index and reaction type of 19 accessions of *Capsicum annuum* inoculated with four species of root-knot nematodes (*Meloidogyne* spp.) in glass-house.

Accession and cultivar	Name	Origin	Egg mass index (EI)(0 - 5) and reaction type (RT)							
			M. incognita		*M. javanica*		*M. arenaria*		*M. hapla*	
			EI*	RT**	EI	RT	EI	RT	EI	RT
C 00573	Pangalegan-1	Indonesia	0.4	R	0.1	R	0.4	R	4.6	S
C 00104-1	MC 4	Malaysia	0	R	0	R	0.2	R	4.4	S
C 00543	Unnamed	Philippines	0	R	0.3	R	0.4	R	4.6	S
C 00490	Hot Pepper	Taiwan	0.5	R	0.3	R	0.6	R	4.3	S
C 00466	L.P. 2	Thailand	0.4	R	0.4	R	0	R	4	S
C 00474	L.P. 1	"	0.3	R	0.3	R	0.3	R	4.9	S
C 00476	Kradee Kao	"	0.4	R	0.2	R	0	R	4	S
C 00550	Unknown 5	"	0.4	R	0.2	R	0.4	R	4.7	S
C 00551	Unknown 6	"	0.3	R	0.2	R	0.2	R	4.8	S
C 00561	Unknown 16	"	0	R	0.3	R	0	R	4.6	S
C 00563	Unknown 18	"	0	R	0.3	R	0.3	R	4.6	S
C 00584	Unknown 30	"	0	R	0	R	0.1	R	4.9	S
C 00585	Unknown 31	"	1	R	0	R	0	R	4.7	S
C 00590	Unknown 36	"	0.1	R	0	R	0.3	R	4.9	S
C 00602	Black Cluster	Hungary	0.7	R	0	R	4.6	S	4.9	S
C 01171	PM 687	France-INRA	0.6	R	0.4	R	4.3	S	4.7	S
C 01173	PM 164	"	0	R	0.4	R	0.9	R	4.6	S
C 01175	PM 702	"	0.3	R	0.7	R	1.6	R	4.6	S
C 01176-A	PI 201234	"	0.2	R	0.6	R	0.2	R	4	S
Corno di Toro Rosso		(Check) Italy	5	S	4.8	S	5	S	5	S
LSD $P \leq 0.05$			0.54		0.43		0.51		0.49	
$P \leq 0.01$			0.71		0.57		0.88		0.64	

* 0 = 0 egg mass; 1=1-2 egg masses; 2=3-10; 3=11-30; 4=31-100; and 5 = more than 100 egg masses.
** R = Resistant, egg mass index ≤ 2; and S = Susceptible, egg mass index > 2.

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FIELD EVALUATION OF BRINJAL VARIETIES AGAINST BACTERIAL WILT (Pseudomonas solanBcearum E. F. smith.)

N.K.Pathania, Yudhvir Singh, P.Kalia and A.Khar Deptt. of Vegetable Science and Floriculture, HPKV, .- Palampur-176 062 (INDIA)

The bacterial wilt cau5ed by Pseudomonas solanacABrum smith. limits brinjal cultivation in humid tropical, subtropical and warm temperate areas of the world (Kelman, 1953). In India this di5ea5e has become a serious problem (Gowda el al. 1974). Of late, it has become a major bottleneck in succe5sful cultivation of brinjal during Kharif in humid areas of Himachal Pradesh. Since the bacterium is soil borne, its chemical control through soil treatment i5 both cumbersome and uneconomical (Madalageri el al., 1983). That is why, breeding varieties for bacterial wilt resistance combined with high yields and acceptable quality is the present day need. Therefore. a 5tudy on all the bacterial wilt resistant varieties of brinjal developed in India was undertaken at HPKV, Palampur so as to identify a stable genotype posses5ing bacterial wilt resistance and other desirable horticultural attributes.

MATERIAL AND METHODS

Fourteen varieties of brinjal including 'Pusa Purple Long' (susceptible check) were grown in randomized block design with 3 replications. The disease intensity wa5 recorded under natural epidemic field conditions. The wilting of su5ceptible check indicated the presence of virulent inoculum. The disease rating wa5 done as per scale suggested by Mew and Ho (1976).

Resistant (R) : <20% wilting
Moderately Resistant (MR) : 20 to 40% wilting
Moderately Susceptible (MS) : 41 to 60% wilting
Susceptible (S) : > 60 % wilting

Data on plant survival was recorded after 30, 0 and 90 daY5 of tran5planting. Observation5 were also recorded on number of fruits per plant and yield.

RESULTS AND DISCUSSION

Highly significant differences were observed among the different varieties for bacterial wilt incidence, number of fruits per plant and yield (Table 1&.2).

Table 1: Bacterial wilt incidence (%) in brinjal varieties after 30, 60 and 90 days of transplanting

Variety	Bacterial wilt incidence (%) after		
	30 days	60 days	90 days
Arka Neelkanth	0.00	0.00	0.00
SM 6-7	0.00	8.33	8.33
Pant Rituraj	26.67	100.00	100.00
Arka Nidhi	1.67	1.67	1.67
Pant Samrat	28.33	98.33	100.00
Arka Keshav	0.00	0.00	0.00
HOK 444	38.33	96.67	100.00
SM 6-6	0.00	8.33	8.33
APAU Sel.1	53.33	100.00	100.00
H-8	5.00	30.00	30.00
Pusa Purple Long	81.67	100.00	100.00
Pusa Purple Cluster	1.83	10.17	10.17
BB-7	0.00	56.67	59.31
BB-44	0.00	13.33	16.67
S.E.	5.90	7.67	8.58
C.D.* (0.05)	12.13	15.77	13.54

*C.D. was calculated for angular transformed data

Table 2: Mean performance and disease reaction of brinjal varieties under humid subtemperate conditions

Variety	Number of fruits per plant	Yield (q/ha)	Disease Reaction
Arka Neelkanth	12.63	136.41	R
SM 6-7	9.31	137.65	R
Pant Rituraj*	-	-	S
Arka Nidhi	19.85	176.38	R
Pant Samrat*	-	-	S
Arka Keshav	8.10	66.82	R
HOK 444*	-	-	S
SM 6-6	18.71	147.06	R
APAU Sel. 1*	-	-	S
H-8	4.75	120.83	MR
Pusa Purple Long*	-	-	S
Pusa Purple Cluster	25.31	170.52	R
BB-7	2.14	11.88	MS
BB-44	10.45	147.99	R
S.E.	1.51	1.37	
C.D. (0.05)	3.19	2.90	

Perusal of Table 1 indicates that 'Arka Neelkanth' and 'Arka Keshav' showed 100 per cent resistance to bacterial wilt whereas 'Pant Rituraj', 'Pant Samrat', 'HOE 444', 'APAU Sel.l' and 'Pusa Purple Long' (susceptible check) recorded 100 percent susceptibility. There was marginal increase in wilt incidence after 60 days of transplanting. High incidence of this disease after 60 days of transplanting could be due to the prevalence of higher temperature, humidity and rainfall during July. Bacterial wilt resistant genotypes viz. 'HOE 444' and 'BB-7' recorded 100 and 59.31 per cent wilt incidence, respectively, indicating the prevalence of different races. Seven varieties were observed to be resistant and five as susceptible. 'H-8' and 'BB-7' were observed to be moderately resistant and moderately susceptible, respectively.

Perusal of Table-2 indicates that 'Arka Nidhi' recorded the highest yield (176.38 q/ha) followed by 'Pusa Purple Cluster' (170.52 q/ha). 'Pusa Purple Cluster' (25.31) recorded highest number of marketable fruits per plant followed by 'Arka Nidhi' (19.85) and 'SM 6-6' (18.71). Among round types, 'H-8' has been found to be promising genotype having desirable horticultural traits along with moderate resistance to bacterial wilt. 'SM 6-7', a collection from Kerala Agricultural University was also observed to be potential genotype by virtue of its high resistance to bacterial wilt and reddish purple oblong fruits. The highly resistant varieties viz. 'Arka Neelkanth' and 'Arka Keshav' were found to be poor yielder. These can be utilised in hybridisation programme for transferring resistance and other desirable horticultural traits (like dark purple colour) in otherwise recommended susceptible varieties.

Keeping in view the bacterial wilt resistance, fruit colour and other desirable traits, 'Arka Nidhi' and 'Pusa Purple Cluster' among long types, 'H-8' and 'SM 6-7' among round and oblong types, respectively appear to be promising for varietal improvement and for cultivation in wilt prone areas of western Himalayas.

SUMMARY

Fourteen varieties of brinjal including 'Pusa Purple Long' (susceptible check) were grown in randomised block design with 3 replications at a spacing of 60cm * 45cm in uniformly wilt sick soil. Highly significant differences were observed among the varieties for bacterial wilt incidence, number of fruits per plant and yield. Seven varieties were observed to be resistant and five as susceptible. 'H-8'

and 'BB-7' were observed to be moderately resistant and moderately susceptible, respectively. 'Arka Nidhi. recorded the highest yield (176.38 quintals per hectare) followed by .Pusa Purple Cluster' (170.52 quintals per hectare). Maximum number of fruits per plant were recorded in .Pusa Purple Cluster'(25.31) followed by 'Arka Nidhi. (19.85) and 'SM 6-6. (18.71). Among long varieties, .Pusa Purple Cluster.and 'Arka Nidhi' (purple fruited) seem to be promising for cultivation in wilt prone areas of western Himalayas. 'H-8. (round fruited) and .SM 6-7. (oblong fruited) " also offer a promise.

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EVALUATION OF RESISTANCE TO BACTERIAL, FUSARIUM AND VERTICILLIUM WILT IN EGGPLANT AND EGGPLANT-RELATED SPEC IES COLLECTED IN GHANA

S. Monma, T. Sato and H. Matsunaga
National Research Institute of Vegetables, Ornamental Plants and Tea (NIVOT),
Ano, Mie 514-23, Japan.

Nine accessions of eggplant, *S. melongena* and 62 accessions of eggplant-related species, *s. gila, S. aethiopicum, s. integrifolium, S. macrocarpon* and *s. anguiyj* collected in Ghana were used for the evaluation of resistance to bacterial, fusarium and verticillium wilt. Inoculations were conducted by dipping roots of seedlings into bacterial or spore suspensions of the diseases. Seedlings were then planted to a bed whose temperature was maintained at 30°C for bacterial wilt, 28°C for fusarium wilt and 22°C for verticillium wilt. Disease severity of each plant was evaluated using a symptom index of 0 (no symptom)-4 (death) scale at about one month after inoculation. Ten plants were used for bacterial wilt, 20 plants for fusarium and verticillium wilt.

Disease indices and percentage of diseased plants of eggplant and eggplant-related species accessions inoculated with bacterial wilt were 2.60-4.00 and 75.0-100.0%, respectively. The disease index of 'GJ93/042' of *S. macrocarpon* was the lowest, but finally all plants of the accession died of the disease. There were no bacterial wilt- resistant accessions in eggplant and eggplant-related species.

All eggplant accessions inoculated with fusarium wilt showed a high disease index and high percent of diseased plants, and were susceptible to fusarium wilt, whereas there were no diseased plants in the accessions of eggplant-related species showing high resistance to fusarium wilt.

Percentage of diseased plants of all eggplant accessions inoculated with verticillium wilt were 100.0% and disease indices were 3.70-4.00, and none of the eggplant accessions showed resistance to verticillium wilt. Disease indices and percentage of diseased plants of eggplant-related species accessions inoculated with verticillium wilt were 2.55-4.00 and 90.0-100.0%, respectively. Disease indices of 'GJ93/040' and 'GJ93/090' in *S. gilo* and 'GJ/094' in *S. aethiopicum* were lower than those of the other accessions. This suggests that these accessions may have some degree of ~ resistance, but the disease indices of the accessions were higher than the resistant control cultivars, 'Meet' or 'Taibyo VF', which are used practically as rootstocks in Japan.

Table 1. Reaction of eggplant and eggplant-related species to bacterial, fusarium and verticillium wilt.

Accession	Bacterial wilt		Fusarium wilt		Verticillium wilt	
	DI[y]	PD[x]	DI[y]	PD[x]	DI[y]	PD[x]
		%		%		%
S. melongena						
1 GJ93/033	3.20	80.0	3.95	100.0	4.00	100.0
2 GJ93/068	3.30	90.0	4.00	100.0	3.70	100.0
3 GJ93/091	3.60	100.0	3.75	100.0	4.00	100.0
4 GJ93/092	3.70	100.0	4.00	100.0	4.00	100.0
5 GJ93/108	3.30	90.0	4.00	100.0	4.00	100.0
6 GJ93/121	4.00	100.0	3.62	90.5	4.00	100.0
7 GJ93/137	3.40	100.0	4.00	100.0	4.00	100.0
8 GJ93/226	3.90	100.0	4.00	100.0	4.00	100.0
9 GJ93/261	3.60	90.0	4.00	100.0	3.90	100.0
S. gilo						
10 GJ93/007	3.70	100.0	0.00	0.0	3.70	100.0
11 GJ93/024	4.00	100.0	0.00	0.0	3.75	100.0
12 GJ93/040	3.60	90.0	0.00	0.0	2.75	95.0
13 GJ93/049	3.60	90.0	0.00	0.0	3.85	100.0
14 GJ93/057	4.00	100.0	0.00	0.0	2.80	95.0
15 GJ93/063	4.00	100.0	0.00	0.0	3.48	100.0
16 GJ93/071	4.00	100.0	0.00	0.0	3.65	100.0
17 GJ93/072	4.00	100.0	0.00	0.0	3.30	100.0
18 GJ93/085	4.00	100.0	0.00	0.0	3.70	100.0
19 GJ93/086	4.00	100.0	0.00	0.0	3.96	100.0
20 GJ93/089			0.00	0.0	4.00	100.0
21 GJ93/093	4.00	100.0	0.00	0.0	2.75	90.0
22 GJ93/095	4.00	100.0			3.75	100.0
23 GJ93/118	4.00	100.0	0.00	0.0	3.40	100.0
24 GJ93/119	4.00	100.0	0.00	0.0	3.10	92.9
25 GJ93/122	4.00	100.0	0.00	0.0	3.50	100.0
26 GJ93/123	4.00	100.0	0.00	0.0	3.55	100.0
27 GJ93/129	4.00	100.0	0.00	0.0	3.40	95.0
28 GJ93/130	4.00	100.0	0.00	0.0	3.12	94.4
29 GJ93/132	4.00	100.0	0.00	0.0	3.45	95.0
30 GJ93/136	4.00	100.0	0.00	0.0		
31 GJ93/145	4.00	100.0	0.00	0.0	3.75	95.0
32 GJ93/146	4.00	100.0	0.00	0.0	3.84	100.0
33 GJ93/151	3.60	90.0	0.00	0.0	4.00	100.0
34 GJ93/156	4.00	100.0	0.00	0.0	3.60	90.0
35 GJ93/157	4.00	100.0	0.00	0.0	3.84	100.0
36 GJ93/158	4.00	100.0	0.20	5.0	3.85	100.0
37 GJ93/159	3.90	100.0	0.00	0.0	3.95	100.0
38 GJ93/166	4.00	100.0	0.00	0.0	4.00	100.0
39 GJ93/169	4.00	100.0	0.00	0.0	3.70	100.0
40 GJ93/170	4.00	100.0	0.60	16.3	3.75	100.0
41 GJ93/173	3.50	90.0	0.00	0.0	3.75	100.0
42 GJ93/175	4.00	100.0	0.00	0.0	3.75	100.0
43 GJ93/186	4.00	100.0	0.00	0.0	3.90	100.0
44 GJ93/189			0.00	0.0		
45 GJ93/191	4.00	100.0	0.00	0.0	3.78	100.0
46 GJ93/198	4.00	100.0	0.00	0.0	3.80	100.0
47 GJ93/206	4.00	100.0	0.00	0.0	3.60	100.0
48 GJ93/210	4.00	100.0	0.00	0.0	3.95	100.0
49 GJ93/220	4.00	100.0	0.00	0.0	4.00	100.0
50 GJ93/221	4.00	100.0	0.00	0.0	3.90	100.0
51 GJ93/241	4.00	100.0	0.00	0.0	3.90	100.0
52 GJ93/305	4.00	100.0	0.00	0.0	3.29	92.9
S. aethiopicum						
53 GJ93/058)	4.00	100.0	0.00	0.0	3.46	100.0
54 GJ93/062	3.80	100.0	0.00	0.0	3.19	100.0
55 GJ93/077	4.00	100.0	0.00	0.0	3.80	100.0
56 GJ93/094	4.00	100.0	0.00	0.0	2.55	100.0
57 GJ93/124	4.00	100.0	0.00	0.0	3.95	100.0
58 GJ93/131	4.00	100.0	0.00	0.0	3.70	95.0
59 GJ93/153	4.00	100.0	0.00	0.0	4.00	100.0
60 GJ93/154	4.00	100.0	0.00	0.0	3.85	100.0
61 GJ93/155	4.00	100.0	0.00	0.0	3.80	100.0
S. integrifolium						
62 GJ93/286	4.00	100.0	0.00	0.0	3.35	100.0
S. macrocarpon						
63 GJ93/042	2.60	80.0	0.00	0.0	3.80	100.0
64 GJ93/298	3.30	90.0	0.00	0.0	3.25	100.0
S. anguivi						
65 GJ93/044	4.00	100.0	0.00	0.0	3.30	95.0
66 GJ93/135	4.00	100.0	0.00	0.0		
67 GJ93/139	4.00	100.0	0.00	0.0		
68 GJ93/147	4.00	100.0	0.00	0.0	4.00	100.0
69 GJ93/148	4.00	100.0	0.00	0.0		
70 GJ93/150	3.00	75.0	0.00	0.0		
71 GJ93/211			0.00	0.0		
72 LS1934[x]	0.40	10.0	0.00	0.0	3.70	100.0
73 Meet[w]			0.00	0.0	1.75	85.0
74 Taibyo VF[w]			0.00	0.0	1.80	90.0
75 LS2436[w]			0.00	0.0	2.45	95.0
76 Kitsuta[x]	4.00	100.0	3.95	100.0	3.95	100.0

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1996 NATIONAL PEPPER CONFERENCE (Naples, Florida, USA - 8-11 December 1996)

The Conference will be held on the beach of the Naples Beach Hotel & Golf Club, 851 Gulf Shore Blvd. North, Naples, Florida 33940. Deadline for room reservation is November 8, 1996. The cost for the Conference is $ 150 (participants) and $ 125 (accompanying persons).

The aim of the Conference is to bring together those with interest in the current status of research, extension and technology in *Capsicum* spp. Topics of interest include:

. Germplasm evaluation and utilization
. Crop physiology and ecology
. Production methods and cultural systems
. Alternative and sustainable approaches to production
. Quality standards and post harvest physiology and technology.
. Economics, marketing and trade.
. Pest management

All conference papers will be published in a bound proceeding book to be distributed at the Conference. To assist in planning the program, paper titles, author names and affiliation as well as the format of presentation (oral, poster or printed) must be received by June 15, 1996. Completed manuscripts are due by September 20, 1996.

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LITERATURE REVIEW

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Institute of Vegetable Growing, University of Horticulture, 1118 BUDAPEST Library, Seed Production and Trading Company, 6601 SZENTES Library, Vegetable Crops Research Institute, 6001 KECSKEMET
National Institute for Agricultural Quality Control, 1024 BUDAPEST
Plant Breeding Center, Vetomag, Trading House Co. Ltd., 6601 SZENTES Plant Healths and Soil Protection Station, HODMEZOVASARHEL Y
Plant Protection Institute, Hungarian Academy of Sciences, 1525 BUDAPEST Research Centre for Agrobotany, N.I.A.V.I.T., 2766 TAPIOSZELE
Research Station of Agricultural University, 4014 PALLAG-DEBRECEN
Szegedi Paprika Food processing and Trading Company, 6725 SZEGED
University of Agricultural Sciences, Faculty of Agricultural Sciences, Institute for Plant Protection, 8361 KESZTHEL Y
University of Horticulture and Food Industry, Department of Plant Pathology, 1118 BUDAPEST
Vegetable Crops Research Institute, Research Station Budapest, 1724 BUDAPEST
Vegetable Crops Research Institute, Research Station Kalocsa, KALOCSA 6300 .I VETOMAG Seed Growing and Trading Enterprise, J.Malik, 1364 BUDAPEST
ILE DE LA REUNION
IRA T --CIRAD-Reunion, REUNION
INDIA

Central Experimental Station, DAPOLl415 711 (Dist.Ratnagiri-Maharashtra)
CHES HINOO HOUSE, RANCHI - Biharstate .,
Chillies Export House Ltd., VIRUDHUNAGAR - 626001 .
College of Agriculture, Orissa University of.Agriculture and Technology, ORISSA *i;*.
Cotton Research Units, CRS, Punjabrao Krishi Vidyapeeth, AKOLA - 444 104 (Maharashtra) Dept. of Botany, Dharmpeth Science College, NAGPUR 440010
Dept. of Botany, Cytogenetics Laboratory, Nagarjuna University, Guntur Dist. (A.P.) Dept.. of Botany, Kakatiya University, Mutation Breeding, WARANGAL 506 009 A.P. Dept. of Botany, University of Rajasthan, JAIPUR - 302 004
Dept. of Horticulture, Banaras Indu University, VARANASI 221 005
Dept. of Horticulture, College of Agriculture, HYDERABAD 500 030 A.P.
Dept. of Plant Pathology, J.N.Agricultural University, Zonal Agric. Research Station, CHHINDWARA 480002 (MP) Dept. of Plant Pathology, Punjab Agricultural University, LUDHIANA Punjab 141 004
Dept. of Vegetable Crops Landscaping and Floriculture, Punjab Agricultural University, LUDHIANA - 141 004 ::
Dept. of Vegetable Science, College of Agriculture, Himachal Pradesh, PALAMPUR - 176 062 Div. of Mycology and Plant Pathology, I.A.R.I., NEW DELHI 110 012
Div. of Plant Genetic Resources, Indian Inst. of Hortic. Res., 255 Upper Palace Orchards, BANGALORE 560 080 ~ (Kamataka)
Div. of Vegetable Crops, Indian Inst. of Horticultural Res., BANGALORE 560 089
Haryana Agricultural University, Department of Plant Pathology, Prof. Narayan Rishi, HISAR - 125004 I.A.R.t. Library, NEW DEHLI-110 012 I.C.A.R., NEW DELHI 110 001
Indian Agricultural Research Institute, KATRAIN - Kullu Valley - HP 175 129
Indo-American Hybrid Seeds, Research and Development, 214 Palika Bhavan R.K Puram, NEW DELHI-110 066 Kerala Agricultural University, Dept. of Olericulture, College of Horticulture, THRISSUR - KERALA Library, MAHATMA PHULE Agricultural University, Dist.Ahmednagar [M.S} Library, Punjabrao Krishi Vidyapeeth, AKOLA - 444 104 (Maharashtra)
Library, Tamil Nadu Agricultural University, Horticulture College and Research Inst., PERIYAKULAM 626 501 Library, Tamil Nadu Agricultural University, COIMBATORE 641 003
Library, University of Horticulture and Forestry, SOLAN (P.O.: NAUNI) - 173230 H.P..
Maharashtra State Seeds Corporation, AKOLA (M.S.)
MUKADA SEEDS, Boman Baug Kher Pada, GHOL V AD - Dist. Thane (W. RL Y.) '1~! NATH SEEDS Ltd., AURANGABAD 431005
National Research Centre for Spices, I.C.A.R., Post Bag No. 1701-Marikunnu P.O., KERALA NEHRU Library, Haryana Agricultural University, HISSAR 125004
Pioneer Overseas Corporation, Dr. N. Anand, 61/A - 14th cross -1st Block, BANGALORE 560 032 Regional Agric. Research Station, Lam - GUNTUR 522 034
Regional Fruit Research Station, ANANTHARAJUPET 516105
Self Employment Training Inst., Pudupudur S..R.K.V. Post, COIMBATORE 641 020 (Tamil Nadu)
Sher-e-Kashmir, University of Agricultural Sciences and Technology, Division of Olericulture and Floriculture, SRINAGAR KASHMIR 191121
Tamil Nadu Agricultural Univ., Agricultural Research Station, TAMILNADU - PALUR 607113 Tamil Nadu Agricultural Univ., Horticultural Research Station, UDHAGAMANDALAM 643 001 V. Ramsundar, 7 Karia Kara Vilai, NAGERCOIL 629001

INDONESIA

Central Research Inst. for Horticulture (CRIH), Head office, PASAR MINGGU, JAKARTA LEHRI, library Project ATA, 395 Kotak Pos 1427, BANDUNG 40 014
LERIH, Research Institute for Horticulture, Jln. Tangkuban Perahu 517, WEST JAVA
PT. EAST WEST SEED INDONESIA, CAMPAKA PURWAKARTA 41181

IRAN

College of Agriculture, KARAJ - TEHRAN

IRAQ College of Agriculture, University of Baghdad, JADIRIY A., BAGHDAD

ITALY
AGROTEC, 00192 ROMA RM
Azienda Agricola MFN di Mario Faraone Mennella & C., 80100 NAPOLI NA
Biblioteca, Istituto Agronomia Generale, 40126 BOLOGNA BO
Cattedra di Miglioramento Genetico, Facotta di Agraria. 80055 PORTICI NA
CLAUSE IT ALIA, 10078 VENARIA REALE TO
Consorzio VITROCOOP, Centrale ortofrutticola, 47027 CESENA FO
DI.VAP.R.A., Plant Breeding and Seed Production, 10126 TORINO TO
DI.VA.P.R.A" Pathology, 10126 TORINO TO
Dipartimento di Agronomia e Genetica Vegetale, Facolta di Agraria, 80055 PORTICI NA .
Dipartimentodi Agronomia Selvicoltura e Gestione del Territorio, 10126 TORINO TO
Dipartimento di Biologia, Sezione Genetica e Microbiologia, 20133 MILANO MI
Dipartimento di Genetica e di Microbiologia, Universita, 27100 PAVIA PV
Dr. Jean M. Poulos, ASGROW ltalia, 04014 PONTINIA l T ENEA Casaccia, Dipartimento FARE, 00100 ROMA RM
ENEA, Biblioteca, c/o CRE Casaccia, 00060 S. MARIA 01 GAlERIA RM
ESASEM, 37052 CASALE ONE VR
FAO/IPGRI, Plant Production and Protection Division C 706,00100 ROMA RM
Istituto del Germoplasma, 70126 BARI BA
Istituto di Agronomia, 07100 SASSARI SS
Istituto di Agronomia, 20133 MILANO MI
Istituto di Agronomia, 35100 PADOVA PO
Istituto di Agronomia, 50144 FIRENZE FI
Istituto di Agronomia, 70126 BARI BA
Istituto di Agronomia Generale e Coltivazioni Erbacee, Facolta di Agraria, 40126 BOLOGNA BO
Istituto di Allevamento Vegetale, 06100 PERUGIA PG
Istituto di Botanica Agraria e Genetica, Facolta di Agraria, Universita Cattolica, 29100 PIACENZA PC . ,
Istituto di Coltivazioni Arboree, 50144 FIRENZE FI
Istituto di Genetica, 40126 BOLOGNA BO
Istituto di Miglioramento Genetico, Facolta di Agraria, Universita Tuscia, 01100 VITERBO VT
Istituto di Nematologia Agr. Appl., C.N.R., 70126 BARI BA
Istituto di Orticoltura e Floricoltura, 56100 PISA PI
Istituto di Orticoltura e Floricoltura, 90122 PALERMO PA
Istituto di Orticoltura e Floricoltura, 95123 CATANIA CT
Istituto di Patologia Vegetate, 40126 BOLOGNA BO
Istituto di Patologia Vegetale, Facolta di Agraria, 80055 PORTICI NA
Istltuto di Patologia Vegetale, Facolta di Agraria. Prof. M.Marte, 06100 PERUGIA PG
Istituto Ricerche Orto-Floro-Frutticoltura, 22070 MINOPRIO CO
Istituto Sperimentale per l'Orticoltura, Sezione Operativa, 20075 MONTANASO LOMBARDO - MI
Istituto Sperimentale per rOrticoltura, Sezione Operativa, 63030 MONSAMPOLO D. TRONTO AP
Istltuto Sperimentale per l'Orticoltura, Dr. V. Magnifico, 84098 PONTECAGNANO SA
Istituto Sperimentale Valorizzazione Tecnologica Prodotti Agricoli, 20133 MILANO MI Laboratolio Fitovirologia Applicata,C.N.R" 10135 TORINO TO
Laboratorio Valorizzazione Colture Industrial,i ENEA-CASACCIA, 00060 S. MARIA 01 GALERIA ROMA Metapontum Agrobios, 75011 MET APONTO MT
NUNHEMS SEMENTI s.r.i., 40019 SANTAGATA BOLOGNESE BO OlTER Sementi,14100ASTI AT
ORIS, Dr. F.Vecchio, 20090 SAlERANO SUl LAMBRO MI
PETO ITAlIANA s.r.i., Centro Ricerche, 04010 BORGO SABOTINO LT
S.A.I.S. S.p.A., Centro Ricerche e Miglioramento Genetico, 47023 CESENA FO SEMENCOOP S.c.r.i., 47020 MARTORANO 01 CESENA FO
Stazione Sperimentale Industrie e Conserve AJimentari, 84012 ANGRI SA
IVORY COAST
Compagnie lvoirinne pour Ie Developpement des Cultures Vivrieres (CIDV), BOUAKE Faculty of Science, ABIDJAN 04
Institut des Savanes, Department des Cultures Vivrieres, BOUAKE
JAMAICA
Bodies Agricultural Research Station, ST. CATHERINE
National Agriculture Research Institute, Ministry of Agriculture, KINGSTOM

Dept. *of* Breeding, Vegetable & Ornamental Crops Research Station, KUSAVA - AGE - MIE 514-23 Dept. *of* Greenhouse Cultivation, V.O.C.R., TAKETOYO -CHISTA - AICHI Faculty *of* Agriculture, Kagawa University, KAGAWA - KEN 761-07 Faculty *of* Agriculture, Nagoya University Chikusa, NAGOYA 464
Faculty *of* Gen. Ed., Tokyo, University *of* Agriculture and Technology, FUCHU - TOKYO 183 Japan International Research Center *of* Agricultural Sciences, TSUKUBA 305 IBARAKI Kihara Inst. for Biological Res., Yokohama City Univ., YOKOHAMA~SHI
Kimio ITO, Vegetable Breeding Nagano, Chushin Agricultural, Shiojiri - NAGANO 399-64
Laboratory of Vegetable and Ornamental Horticulture, Faculty *of* Agriculture - Kyoto University, KYOTO 606 Morioka Branch, V.O.C.R.S., MORIOKA 020-01
Nationallnst. *of* Agrobiological Resources, YATABE IBARAKI
National Research Inst. *of* Veget. Ornamental, Plants and Tea, Lab. *of* Breeding Soian. Vegetables, ANO AGE-GUN MIE 514-23
Nihon Horticultural Production Institute, 207 Kamishiki, MATSUDO-SHI CHIBA-KEN 271 ~
NIPPON DEL MONTE Corp., Research and Development, NUMATA, GUMMA 378 OHTA Yasuo, TSUKUBA - SHI 305
SAKATA SEED Corp., Kakegawa Breeding Station, Dr. K. Miyoshi, KAKEGAWA - SHIZUOKA 436-01 ~
Sakata Seed Corp., Plant Biotechnology Center, Toshio Shiga, SODEGAURA, CHIBA, 299-02 ~
Shizuoka Agricultural Experimental Station, SHIZUOKA
The Nippon Shinyaku, Institute for Botanical Research, Oyake Sakanotsuji-cho 39, KYOTO 607 YUKURA Yasuo 46.7 3-Chome, TOKYO

JORDAN

Department *of* Agricultural and Scientific Research and Extension, AMMAN
Ministry *of* Agriculture, National Centre for Agricultural Research and Technology Transfer, BAQA'A 19381

KENYA , National Horticultural Research Station, THIKA

Department of Crop Science, University *of* Nairobi, NAIROBI

KIRIBATI

Agricultural Division, P.O.Box 267, TARAWA

KOREA DEMOCRATIC REPUBLIC

Pilot Greenhose Farm, PYONGYANG
Pyongyang Vegetable Research Center, PYONGYANG

KOREA, **REPUBLIC OF**

Choong Ang Seed Co. Ltd., Dr II-Woong Yu, CHEONAN CITY - CHOONG NAM 330-170
Department *of* Agricultural Biology, College *of* Agriculture and Life Sciences, Seoul National University, SUWON 441- 744
Department *of* Horticulture, College *of* Agriculture Seoul National University, SUWEON 170
Dept. of Horticulture, College of Agriculture, Kyungpook National University, TAEGU 702-701 Div. *of* Vegetable Breeding, Horticultural Experiment Station, SUWON 441-440 Horticultural Experiment Station, PUSAN 57111
HUNGNONG Seed Co., Joongbu Breeding Research Station, SEOUL
NONG-WOO SEEDS, Plant Breeding Research Institute, 387-2 Sasa-2Ri, HWASONG 445-820 OSAN, Breeding Institute,
Choong-Ang Seeds Co. Ltd., HWASUNG KYOUNGGI445-810 SEOUL SEED International Co. Ltd., Chongill *BID* 736-17 Yeoksam-dong, SEOUL

KUWAIT

Agricultural Experimental Station, c/o Ministry *of* Public Works, SAFAT

LEBANON Plant Breeding Dept., Agricultural Research Inst., TRIPOLI ..
Faculty *of* Agricultural and Food Sciences, BEIRUT .
Institut de Recherche Agronomique du Liban (IRAL)

LESOTHO

Lesotho Agricultural College, MASERU 100

LIBERIA

CARl, Central Agricultural Research Institute, GBARNGA-BONG COUNTY CARl, Central Agricultural Research Institute, MONROVIA, SUAKOKO

LIBYA
Agricultural Research Station, TRIPOLI nI:~ National Bureau for Agricultural Consultations and Studies, TRIPOLI

MADAGASCAR
Centre National de la Recherche Appliquee au Development Rural, ANTANANARIVO (101)

MALAWI
Bunda College of Agriculture, University of Malawi, LILONGWE Bvumbwe Agricultural Research Station, LIMBE
The Officer-in-Charge, Chitedze Agricultural Research Station, LILONGWE The Principal Natural Resources College, LILONGWE

MALAYSIA
Dept. of Agronomy and Horticulture, University of Agriculture Malaysia, SERDANG - SELANGOR Dept. of Genetics & Cellular Biology, University of Malaya, KUALA LUMPUR 22-11 MARDI, KUALA LUMPUR
MARDI, Research Station JALAN KEBUN, SERDANG-SELANGOR MARDI, Tanah Rata 39007, Cameron Highlands - PAHANG

MALI
Institut d'Economie Rurale, Ministere de I'Agriculture, BAMAKO
MALTA
Department of Science, University of Malta, University Campus, MSIDA
MARTINIQUE , I.R.A.T.-C.I.R.A.D., FORT DE FRANCE

MAURITANIA
Centre Nat. de Recherche Agronomique et de D~veloppement de I'Agriculture, Ministere de I'Agriculture, Dept. de I'Horticulture, NOUAKCHOn

MAURITIUS
Ministry of Agriculture and Natural Resources, Agricultural Service, PORT LOUIS

MEXICO
Centro de Botanica, Colegio de Postgraduados, 56230 CHAPINGO-Estado de Mexico
Centro de Investigaciones Agricolas del Nord, INIA-SARH, 3300 CD. DELICIAS - CHIH. Experimental Station Celaya, INIFAP, CELAYA-GTO 38000
Genetic Center, College of Postgraduate, 56230 MONTECILLO
IBPGR, Oficina para Latinoamerica, c/o CIMMYT, MEXICO 06600 D.F.
Instituto Nacional de Investigaciones Forestales y Agropecuarias (INIFAP), Dr. Juan Hernandez Hernandez, 93400 PAPANTLA-VERACRUZ
Instituto Nacional de Investigaciones Forestales, Agricolas y Pecuarias (INIFAP), MEXICO CITY Instituto Nacional de. Investigaciones Agricolas, Apartado Postal C-1, TAMPICO Jose A. Laborde, CELAYA-GTO. 38040
Library, C.I.F.A.P., Campo Exper. del Sur de Tamaulipas Apartado Postal C-1, TAMPICO

MOROCCO
Complexe Horticole, Institut Agronomique et Veterinaire, Hassan I" AGADIR
Direction de la Production Vegetate, Ministere de I'Agrlculture et de la Reforme Agranre, RABAT
Division de la Documentation et de I'lnformation, Direction de /a Pianification et des Affaires Economiq., RABAT - DiVision de Recherches et Experimentations Foresters, Bibliotheque, RABAT - AGDAL
Ecole Nationale d'Agriculture, MEKNES
Ecole Nationale Forestiere des Ingenieurs, SALE Institut de Technoiogie Horticole, MEKNES
Institut National de la Recherche Agronomique, INRA, RABAT Societe du Developpement Agricole (SODEA), RABAT

MOZAMBIQUE
Facultad de Agricultura, Universidade Eduardo Mondlane, MAPUTO

MYANMAR
Institute of Agriculture, University of Yangon, University Estate, YANGON

NEPAL
National Agricultural Research and Servic Centre, Department of Agricultural Development Ministry of Agriculture, KATHMANDU
NEW ZELAND
J. WATTlE CANNERIES Ltd, HASTINGS
The Librarian (serials), Massey University, PALMERSTON NORTH
NICARAGUA
Istituto Superior Ciencias Agropecuarias, REGEN, MANAGUA
NIGER
Institut National de la Recherche Agronomique au Niger, (INRAN), NIAMEY

NIGERIA
Dept. of Agronomy, Inst. for Agricultural Research, Ahmadu Bello University, SAMARU - ZARIA
Dept of Crop Science, University of Nigeria, NSUKKA
National Horticultural Research Inst, Idi-lshin Jericho Reservation Area, IBADAN
NORWAY
Dept of Vegetable Crops, the Agricultural University of Norway, 1432 AA8-NLH I¥;
PAKISTAN
Pakistan Agricultural Research Council, ISLAMABAD
Vegetable Research Institute, FAISALABAD 38950
PAPUA NEW GUINEA
Department of Agriculture and Livestock, Headquarters, Sprint Garden Road, KONEDOBU
Department of Agriculture, Food Management Branch, Food Processing Preservat. Unit, LAE, MOROBE PROIVINCE
PERU
Dept. de Ciencias Agropecuarias, Universidad Nacional de San Agustin, AREQUIPA
Dept de Horticultura, Universidad Nacional Agraria, LA MOLINA-LIMA
Experiment Station LA MOLINA, LA MOLINA -LIMA HOLLE Miguel, LIMA 18
Instituto Nacional de Investigaci6n, Promoci6n Agropecuaria (INIPA), Sinchi Roca 2727 - Lince, LIMA 14
Julio A. QUEA, T ACNA
PHILIPPINES
College of Agriculture, Inst of Plant Breeding, Univ. of the Philippines at Los Banos, LAGUNA 3720 EAST-WEST SEED Company Inc., MAKATI (Manila)
POLAND
Academy of Agriculture, Inst of Genetics and Plant Breeding, 60-625 POZNAN Department of Plant Genetics, Breeding and Biotechnology, 02766 WARSAWA
Dept of Genetics and Plant Breeding, University of Agriculture, 60-198 POZNAN
Dept of Genetics, A. Mickiewicz University, 60-594 POZNAN
Inst of Plant Genetics, Polish Academy of Sciences, 60-479 POZNAN
POlAN Krakowska Hodowta, I Nasiennictwo Ogrodnicze, 30-130 KRAKOW Research Institute of Vegetable Crops, 96-100 SKIERNIEWICE
PORTUGAL
I.N.IA, Estacao Agronomica Nacional, OEIRAS
PUERTO RICO
Univ. de Puerto Rico, Rec. de Mayaguez, Colegio de Ciencias Agricolas, Estacion Exp. Agr. Subest de Isabela, ISABELA 00662
University of Puerto Rico, College of Agricultural Sciences, MAY AGUEZ 00708
ROMANIA
Research Inst for Vegetable and Flower Growth, 8268 VIORA JUD. GIURGIU
RUSSIA
All-Russian Research Institute of Vegetable Breeding and Seed Production, 143080 MOSKOV REGION
Boishoy Haritoniewsky, MOSKVA 8-78

Dept. of International Book Exchange, Central Scientific Agricultural Library, 107804 GSP-MOSCOW B-139 Majkop Research Station of Vavilov Institute of Plant Industry, 352772 MAJKOP REGION - SUNTUK N.I.Vavilon All Union, Inst. of Plant Industry, 190000 S. PIETROBOURG
Research Inst. on Vegetable Crop Breeding and Seed Production, 143080 ODINTSOV district

RWANDA
Institut des Sciencies Agronomiques du Rwanda (ISAR), BUTARE

SAMOA
Department of Agriculture, Ministry of Agriculture, APIA

SAO TOME AND PRINCIPE
Ministerio da Agricultura, Estacao Experimental, SAD TOME

SAUDI ARABIA
Department of Horticulture, Ministry of Agriculture, RIYADH

SENEGAL
Centre pour Ie Development de "Horticulture (ISRA), DAKAR
CORAF, Vegetable Research Network Attn. Alain Mbaye, DAKAR

SEYCHELLES
Direction Generale de la Production Agricole, Ministere de "Agriculture, GRAND'ANSE, MAHE Grand'Anse Experimental Centre GRAND'ANSE, MAHE

SLOVAK REPUBLIC

Research and Breeding Inst. for Vegetable and Special Plants, 94701 HURBANOVO Research and Breeding Institute for Vegetable and Special Plants, 94001 NOVE ZEMKY Research Breeding Station, Novofruct s.e., 94043 NOVE ZAMKY Slachttitelska Stanica, CRALOVA PRI SENCI
Vyskumnya slaschtitelsky ustav zeleniny-VRBANOVO, 93041 KVETOSLAVOV

SLOVENIA
Agricultural Institute of Slovenia, Dr. Mihaela Cerne, 61109 LJUBLJANA

SOLOMON ISLANDS
Dodo Creek Research Station, HONIARA

SOUTH AFRICA
Division of Plant and Seed Control, PRETORIA 0001

SPAIN
C.S.I.C., Estacion Experimental La Mayora, ALGARROBO-COSTA MALAGACentro de Investigaciones Agrarias, 26080 LOGRONO Clause Iberica S.A., PATERNA (Valencia)

Departamento de Bioquimica y Biologia Molecular, Universidad de Almeria, 04120 LA CANADA DE SAN URBANO Dept. de Biologia Animal y Vegetal, F. Merino de Caceres, Universidad de La Coruna, 15701 LA CORUI'JA Diputacion General de Aragon, Servicio de Investigacion Agraria, Seccion Documentacion y Bibliotheca, 50080 ZARAGOZA
Escuela de Capacitaci6n Agraria, DON BENITO (Badajoz) GIL ORTEGA R., D.G.A. - S.I.A., 50080 ZARAGOZA
Horticulture Department, C.R.I.A., MURCIA
I.N.I.A., Dr.F.Ponz, 28080 MADRID
Instituto Nacionallnvestigaciones Agrarias., Cit. Centro Inv. y Tecn. Biblioteca, 28040 MADRID :-, Plant Protection Department, C.R.I.A., MURCIA
Polytechnical University of Valencia, Biotechnology Department, Dr. F. Nuez, 46020 VALENCIA Polytechnical University of Valencia, Plant Protection Department Pathology, 46020 VALENCIA Semi lias Fit6, BELLPUIG (Lerida)
Semillas Pioneer S.A., J. Riado Abad, 04710 EL EJIDO (ALMERIA) SEMILLAS RAMIRO ARNEDO, CALAHORRA-LOGRONO Sluis & Groot Semi lias, EL EJIDO-ALMERIA

SRI LANKA
Agricultural Research Station, MAHAILLUPPALLAMA

Central Agricultural Research Institute, GANNORUVA, PERADENIYA
Food Technology Section, Ceylon Inst. of Scientific and Industrial Research, COLOMBO Government's Department of Agriculture, PERADENIYA

ST. LUCIA

C.A.R.D.I., CASTRIES

SUDAN

Agricultural Research Corporation, Horticulture Germplasm Unit, WAD MEDANI
Department of Horticulture, Faculty of Agriculture, University of Khartoum, SHAM BAT, KHARTOUM University of Gesira, Faculty of Agricultural Sciences, Dept. of Horticulture, WAD MEDANI

SUISSE

Nestec S.A, CH-1800 VEVEY "

SURINAM

Surinam Agricultural Experiment Station, Cultuurtuinlaan, PARAMARIBO '.

SWAZILAND

Agricultural Research Division, MALKERNS University of Swaziland, KWALUSENI

SYRIA

Faculty of Agriculture, Damascus University, DAMASCUS Faculty of Agriculture, University of Aleppo, ALEPPO

TAIWAN

RO.C. DAIS, T AINAN
Dept. of Horticulture, Nat. Chung Hsing Univ., TAICHUNG 40227 Dept. of Horticulture, Nat. Taiwan University, TAIPEI
Dr. Jan-Fen Wang, The Asian Vegetable and Research Development Center, SHANHUA - TAl NAN
Fengshan Tropical Hort. Exp. Stat., Fengshan - KAOHSIUNG
Information and Documentation, The Asian Vegetable Research and Development Center, SHANHUA TAl NAN 74199
Library, Taiwan Agric. Research Inst., WAN-FENG WU-FENG TAICHUNG
Lowell L. Black, The Asian Vegetable Research and Development Center, SHANHUA, TAINAN 741 National Chiayi, Inst. of Agriculture, CHIAYI
Taiwan Seed Improvement and Propagation Station, TAICHUNG

TANZANIA

Horticultural Training and Research Institute, Tengeru, ARUSHA Sokoine University of Agriculture, OAR ES SALAM

THAILAND

APTA, Phaya Thai Court, BANGKOK 10400
AVRDC, Thailand Outreach Program, Kasetsart University, (Kasetsart) BANGKOK 10903 CHIA TAl Company Limited, BANGKOK 10100
Div. of Horticulture, Dept. of Agriculture, Bagkhen - BANGKOK
EAST-WEST Seed Co. Ltd., Mr. S. J. de Joop, CHIANG MAl 50290 Faculty of Agriculture, Chiang Mai University, CHIANG MAl 50002
Horticulture Research Institute, Headquarters, Dept. of Agriculture, Ministry of Agriculture and Cooperatives, BANGKOK 10900 *r* Thep Watana Seed Co. Ltd., BANGKOK 10500

THE NETHERLANDS

BEL AGRO Handelmaatschappij b.v., 1001 AS AMSTERDAM
Bruinsma Seed b.v., Jurko Leij, 2670 AA NAALDWIJK
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DE RUITER ZONEN, Dr. D. Vreugdenhil, 2691 RA 'S GRAVENZANDE
Enza laden, De Enkhuizer Zaadkandel b.v,. R.Kuijsten, 1600 AA ENKHUIZEN 78
EUCARPIA Secretariat, 6700 AH WAGENINGEN
Gebr. Bakker Zaadteelt Zaadhandel, 1723 LM NOORDSCHARWOUDE
Glasshouse Crops Research and Experiment Station, 2670 AA NAALDWIJK

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Rijk Zwaan Zaadteelt en Zaadhandel B.V., 2678 ZG DE LlER Royal Sluis, 1600 AA ENKHUIZEN
S & G Seeds, J. van Deursen, 2678 LV DE LlER
SAKATA SEED EUROPE B. V., Dr. Y. Kobayashi, 1435 DD RIJSENHOUT Scientia Horticulturae, AMSTERDAM
Sluis en Groot Seeds B. V., 2678 LW DE LlER
Swets & Zeitlinger B.V., Backsets Department, 2160 SZ LlSSE .. Van der Zaden B. V., Beethovenstraat 42, 5102 XB DONGEN

TOGO

Department de l'Agriculture, Ministere de l'Agriculture, YAOUNDE

TRANSNISTRIA MOLDAVIAN REPUBLIK

Inst. of Ecological Genetics of the Academy of Sciences, KISHINEV-277018
Transnistria Institute of Agriculture, Olga O. Timina, 278000 TIRASPOL

TRINIDAD AND TOBAGO

Caribbean Agricultural Research and Development Institute (CARDI), University Campus, ST. AUGUSTINE
GCP/RLA/108/ITA, FAO, Chaguaramas, c/o FAO Representative's Office, PORT OF SPAIN

TUNISIA

Department of Biological Sciences, Faculty of Sciences, Library Research II, 1060 TUNIS ' Ecole Superieure d'Horticulture, CHOTT -MARIEM-SOUSSE
INRAT, Inst. National Recherche Agronomique de Tunisie, 2080 ARIANA INRAT, Laboratoire de Cryptogamie, 2080 ARIANA
Inst. National Agronomique de Tunisie, Lab. Cultures Maraicheres et Florales, 1002- TUNIS BELVEDERE Station d'Appui de la Medjerda, 2010 MANOUBA

TURKEY

Aegean Regional, Agricultural Research Inst., MENEMEN-IZMIR
Ankara University, Faculty of Agriculture, Department of Horticulture, ANKARA-Diskapi Atatork Horticultural Research, Yalova Inst., ISTAMBUL
Department of Horticulture, Fac. Agriculture, Univ. Of Cukurova, 01330 ADANA
Department of Plant Pathology, Fac. Agriculture, Univ. Of Cukurova, 01330 ADANA Ege Universitesi, Ziraat FakOltesi Bitki Koruma B610mO, BORNOVA 35100-IZMIR Uludag Univ., Faculty of Agric., Dept. of Horticulture, BURSA Vegetable Research Institute, 07110 ANTALYA

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Dept. Plant Breeding & Biometry, Cornell University, ITHACA - N.Y. 14853-1902
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USDA, Agr. Mark. Serv., Plant Variety Protection Office, NAL Bldg.-Room 500, BELTSVILLE - Maryland 20705-2351
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VENEZUELA

FUSAGRI, 2122 ARAGUA
Universidad de Oriente, ESTADO MONAGAS

VIETNAM

Vietnam Institute of Agricultural Science and Technology, HANOI

YEMEN

Hits Yemen (Cal Poly), SANA'A Y.A.R.

YUGOSLAVIA

Vegetable Research Institute, Palanka, 11420 SMEDEREVSKA PALANKA VITAMIN, Spice Pepper Breeding Station, 24420 HORGOS

ZAIRE

Institut National pour l'Etude et la Recherche Agronomique (INERA), KISANGANI

ZAMBIA

University of Zambia, LUSAKA

ZIMBABWE ..

Department of Agricultural, Technical and Extension Services (AGRITEX), Ministry of Lands, Agriculture and Rural "/ Resettlement, HARARE
Department of Research and Specialist Services (R & SS), Ministry of Lands, Agriculture and Rural Resettlement, HARARE

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