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LILAC...YEAR-ROUND CUT FLOWER?...DUAL-PURPOSE PLANT?

Lilac as a Forced, Cut flower

History

The forcing of lilac has been an important industry in Europe for over 200 years. An excellent review of literature on this subject including methods and materials is presented by McKelvey (1928) and by Berg (1981)

In 1774, the white lilac industry began in France with the forcing of *Syringa persica* and `Rouge de Marly' in caves and cellars; when forced in the dark, these lilacs produced white flowers. According to Carriere and Andre (Review of Horticulture, 1886, page 458; 1890, page 506) there was but one month in the year, mid-July to mid-August, when forced white lilacs were not sold in Paris. As demand for forced white lilac increased in the major cities of Europe, large production areas centered around such cities as Boskoop and Aalsmeer in Holland and Hamburg and Berlin in Germany in addition to Paris, France.

In the early years of the Cooperative Aalsmeer Auction (CAA), almost 50% of the product consisted of lilacs. Because of the increase of many other cut flowers, the percentage of lilacs has now decreased to 1.5% of total cut flower sales through the CAA. However, the total production of cut, flowering lilac branches since World War II by CAV growers has remained essentially constant at 7-8 million branches per year. Demand and selling price increased following development in 1973 of a flower preservative that increased vase life from 3 days up to 10 days; increased selling price has resulted in an increase in production. (Berg, 1981).

Production of lilac as a cut flower has been rather stable for a number of reasons: it is a unique product with little competition (substitution) from other cut flower crops; there is little production of cut lilac outside of The Netherlands; the long cultivation period provides little opportunity for opportunistic growers; and, production is labor intensive with labor being approximately 50% of the total production costs.

To lower production costs by reducing the time the lilac plants are held in the forcing greenhouse, the possibility of cutting lilac branches at the tight flower bud stage of development then opening the flower buds by holding the cut branches in a solution of sucrose and antimicrobial chemicals has been investigated (See section on "Flowering of Lilac on Cut Branches").

In the United States, demand for forced lilac flowers, primarily obtained from plants imported from Europe and then forced in the U.S., increased until Quarantine 37 went into effect on June 1, 1919. Recently the use and demand is once again increasing and is being primarily supplied by imported, cut-flower lilac.

Recent economic significance

In 1983, the Dutch flower auctions supplied 12 million flowering lilac branches to florists throughout the world. "Lilacs are increasingly popular each year, with demand the highest for white lilacs, but the blue varieties are gaining attention," say the Dutch. "The white variety 'Madame Florent Stepman' and the lavender-blue 'Hugo Koster' are at the top of the list ... demand for flowering cut foliage increased 15 percent over the previous year." (SFN, 1984). The San Francisco Wholesale Ornamental Crops Report for Wednesday, April 4, 1984, reported the demand on the San Francisco Wholesale for cut lilac was steady, offerings of indoor grown cut lilac from Holland were light, and purple lilac was selling at $8.75/bunch of 10 stems (87.5 ¢each). On the same market report the highest wholesale price reported for a tea rose was 36¢. To put this into perspective, however, it should be noted that the Dutch grower's net profit per stem is approximately 2 cents (Berg, 1981); the rose grower's net profit per stem is also approximately 2 cents.

In 1980, 221,000 stems of flowering lilac were imported from The Netherlands into the United States, primarily from mid-October through mid-May. In 1982, the total number of stems of flowering lilac imported into the United States increased to 516,000. There was a 2.3-fold increase in the import of flowering lilac from 1980 to 1982. Of the 516,000 stems imported in 1982, 4,000 stems came from Colombia, South America; 7,000 stems came from South Africa; and, 505,000 stems came from The Netherlands. Other countries from which we have imported cut flowering lilacs in the past include Costa Rica and Israel. Compilation of statistics for 1983 import of lilac flowers into the U.S. has not yet been completed by the Federal-State Market News Service. (California Ornamental Crops Report, 1981, 1982).

Lilac as a dual-purpose plant

"Container-grown lilacs are ideal Easter plants, for which date they can be allowed to come along slowly in a 55-degree house from one month before Easter on." (Bahr, 1945)

In reality, like the lilac plants forced for cut flowers, lilac plants could be forced as a container-grown, flowering plant year-round. Show plants in pots should be forced in full light to have the foliage well developed; when the temperature is higher than 76°F, frequent syringing is necessary. When the first flowers expand, the temperature is lowered to 60 to 66º, and when the panicles are about half open the plants are transferred to a cool greenhouse. Hardening-off is essential to ensure good keeping qualities of the flowers.

After forcing, the plant is in the early growth stages of its annual cycle and will not have acquired cold-hardiness; it must be protected from frost and not outplanted into the landscape until spring, or it may be exposed to sequential temperature conditions to induce cold-hardiness and thereafter be stored outdoors.

The most desirable plant habit and production schedule requiring the least amount of time in the greenhouse may possibly be achieved by grafting (see Figure 1 and section regarding propagation).

Standard lilacs (small tree-like forms) can be produced by budding onto properly grown stock of the common lilac (*Syringa vulgaris*) (McKelvey, 1928).

Lilac gray - the color for 1985 is expected to be a "hot" item in two to three years

According to the Color Marketing Group, lilac gray will be a new color for 1985 and is expected to be a "hot" item for two to three years ... Designers indicate that the trends will be toward modern utilitarianism, but with a glamorous look...-something different, but still have a feeling for the "natural". (Carpentar, 1984). It should be safe to conclude that the design and color trends indicate an increased demand for lilacs as a cut flower or as a flowering, container-grown plant.

Species & cultivars

The lilacs include about 28 species of deciduous shrubs or small trees native to Asia and southeastern Europe. The lilacs are deciduous with the exception of *Syringa sempervirens*, which is evergreen. Species and varieties are distinguished from each other by differences in height, time of blooming, and a variety of flower colors and characteristic's as well as by more subtle taxonomic characteristics.

Time of Bloom: Horticulturists divide *Syringa* species into four groups according to their season of bloom. Group One bloom about May 10 in USDA hardiness zone 6 (the farther north, the later the flowering) and includes: *S. affinis, S. oblata S. X hyacinthiflora (S. oblata X S. vulgaris).* Group Two bloom about 10 days after plants in Group One*: S. vulgaris, S* X *chinensis, S* X *persica, S. laciniata, S. pubescens, S. microphylla, S. patula, S. potaninii, S. meyeri, S. julianae.* Group Three bloom on or about June 5 in USDA Zone 6: *S.* X *josiflexa*, *S.* X *henryi,* S. *villosa*, *S. josikaea, S. reflexa, S*. X *swegiflexa, S. emodi, S. komarowii, S. sweginzowii, S. tometella, S wolfii, S. yunnanensis*. Group Four blooms around June 15 in USDA Zone 6: *S. pekinensis, S. reticulata; S. japonica* is the latest, blooming in the North in the beginning of July. (Bailey, 1915. Hillstrom, 1982).

The *Syringa persica* as well as the hybrid *S. chinensis* and its forms were probably the first lilacs used for forcing, but they were largely abandoned when the vogue of the forced white lilac began for they apparently retained more color when forced than was thought desirable. The plants used in the beginning of the forced white lilac industry (approximately 1850's) for forced white lilac were generally dark-flowered forms of *Syringa vulgaris* (*S. vulgaris var. purpurea* and *S. vulgaris* Charles X.). (McKelvey,1928).

Today in The Netherlands varieties of *S. vulgaris* are forced for cut flowers, and the variety 'Madame Florent Stepman' (creamy-yellow in bud, opening white) accounts for 90% of all

varieties forced; 'Marie Legraye' (white, creamy-yellow inbud) accounts for 4%; the remainder is comprised of colored varieties such as 'Charles X.' (light purple). (Berg, 1981).

For production of forced lilac as a flowering, dualpurpose, container-grown plant, Dr. Bob Tick nor (Oregon State University, North Willamette Experiment Station) has used *Syringa meyeri* 'Palabin' (see accompanying report by Ticknor). This specie was initially chosen because of its relatively dwarf size and precocious blooming: the plant flowers freely at an early age. Flowers are generally produced when young plants are less than two feet in height, a characteristic that is highly unusual among lilacs. The plant grows slowly, withstands pruning well, and can be kept as low as three feet. It may also be grafted on a standard about four feet high with the crown kept trimmed to a spherical shape. The cold hardiness of this species is often misrepresented as being hardy only to USDA Hardiness Zone 5 or 6; however, in USDA Hardiness Zone 3B (average minimum temperature of -35°F) it has grown to six or seven feet (Kvaalen, 1982). Ticknor is now also evaluating a number of varieties of S. vulgaris to determine their suitability for forcing as a dual-purpose, container-grown, flowering plant.

Growth and development of lilac ...and its control

For forcing, it is necessary that flower buds be present, their rest be broken, and sufficient nutrients and water be available to the flower.

Flower Initiation

By the time the flowers of a lilac are over and the elongation of the new growth of the flowering branches is nearly complete, the next season's flower buds, although not fully mature, are formed (McKelvey, 1928). The initiation of flower buds starts about the 21st of June, beginning with the first forceable cultivar 'Marie Legraye', somewhat later on 'Madame Stepman' (which forces slightly later than does 'Marie Legraye'), and latest on the late forcing 'Ludwig Spath'. Flower bud initiation is generally complete by the end of August. (Sijtsema, 1962).

When the upper leaf pair has unfolded (May-June), the bushes should be disturbed to induce them to form flower buds.

In May-June, root pruning or spraying with Alar (590 grams per 100 liters of water), a plant growth retardant, enhances the formation of flower buds. Application of Alar is sometimes followed by root pruning. The action required is dependent upon the variety. 'Legraye', for example, is not sprayed with Alar nor are the roots pruned because it readily sets flower buds. "Blue" lilacs are generally not treated with growth regulators, but are root pruned. (Berg, 1981)

An application of chlormequat chloride (CCC), a plant growth regulator, in June to improve flower bud set may be substituted for the older practice of root pruning. CCC at 0.25% was applied to shrubs of 'Madame Florent Stepman' in late June. CCC improved flower bud set in all cases. (Bauer & Paul, 1975)

After June, when the new growth is almost complete, only enough water is given to prevent wilting. When the flower buds have been formed, more water is given until they have reached

their full size. Then in the fall it is essential to keep the plant rather dry so that the wood may ripen thoroughly and early (Bailey, 1915).

Flower Bud Development, Dormancy, & Forcing

In the late 1800's, Lemoine (McKelvey, 1928) discussed the rest period of lilac and described "three divisions during the rest period: initial rest, complete rest, and final rest. In initial rest the faculty of development diminishes more and more; in winterrest, it no longer exists; in final rest, it returns by slow degrees.

Sijtsema (1962) and others have reported factors affecting summerrest (initial rest) and winterrest (complete rest).

Summerrest (initial rest):

"To ripen the wood and flower buds, plants required for winter forcing are root-pruned about the beginning of August, lifted and potted in September, and plunged outdoors until required for forcing." (Chittenden, 1951).

In August the buds of 'Madame Stepman' are in summerrest. Defoliation breaks the summerrest. About the middle of August the flower bud development has progressed so far that a branch is able to flower after defoliation. (Sijstema, 1962).

M. C. Renault in 1902 also stated that lilac may be made to flower in autumn by removing the leaves in August and watering daily (McKelvey, 1928).

Defoliation may be induced by placing the lilac plants in the dark in August/September. The early-defoliated plants do not progress into winterrest (Berg 1980).

Effect of photoperiod on forcing in August:

Harancourt (1903) reported that continuous photoperiodic lighting (application of electric lighting of low eighteen candle-power intensity) starting at or a little before sunset until sunrise throughout the forcing period reduced the time of flowering from 25 days with natural daylength to 15 days with continuous light. The lilacs, dug in the autumn after leaf fall and planted in the greenhouse, were given a good watering which was not repeated. The temperature was kept at 59°F the first day, 63°F the second day, and 68°F for the rest of the period. Under this regime of uninterrupted light and a maximum temperature of 68°F the lilacs were forced into bloom in fifteen days.

Legraye and Stepman can be induced to flower after 4 weeks dark storage; high temperature (110°F) is required during forcing and plants must be misted regularly (misted at 20 minute intervals) to prevent drying of the flower buds. When the buds have "loosened", the day temperature can be lowered to 86°F (second week of forcing), to 70°F the third week of forcing and to 59°F the fourth week; the night temperature throughout the forcing period is 59°F. (Berg, 1981). Later in the season, the day temperature during the first week of forcing can be lower:

November = 100°F; December = 90ºF; January = 80°F; February = 70°F; March = 60°F. The duration of the forcing period also becomes shorter later in the season. (Berg, 1981).

High forcing temperatures which induce very rapid growth may inhibit pigment formation in the flowers; below a temperature of 60°F the flowers begin to color, whereas, if forced in a higher temperature in the full light they are white. To obtain color in the forced Marly Lilac, the plants must be kept at approximately 54ºF; the process takes twice as long as that for producing white lilac. (McKelvey, 1928). Bailey (1915) stated that the shade of color developed depends on the time when full light is given and also on the temperature.

In September, defoliation followed by a light warm water treatment is necessary for good flowering. Cold (30-36°F), if given to defoliated branches during this stage of development, has almost no effect on the summerrest. (Sijtsema, 1962).

The plunging of lilac plants, all but the pots, into a hot water bath (96-104°F for 10 hours) was reported in 1890 to aid in forcing lilac (McKelvey, 1928).

Transition from summerrest to winterrest:

From the end of August ‘til the middle of October the summerrest gradually changes into the winterrest. During the transitional period cold temperatures deepen the winterrest; this process goes on more quickly at 30°F than at 36°F and not at all or with little effect at 40-46°F.

Winterrest (complete rest):

Winterrest is caused by factors located in the buds and is dependent on the temperature in September and October. During the deepest winterrest, warm water is not able to break the rest sufficiently without injuring the buds. Good flowering is not possible again before the second week of November.

Maintaining plants in winterrest: Lilacs to be used in forcing are frequently retarded: when in a dormant condition (winterrest) they are placed into cold storage, kept there through the following summer, or over their normal growing period, and taken the following autumn or winter into the forcing house as needed. As early as 1830, use of this method was reported (McKelvey, 1928). Retardation is still used today, not only with lilacs, but with many other plants as well.

Early bud break is a major problem in marketing woody plants after cold storage. Once plants are removed from cold storage, plant activity resumes and bud break occurs on many species within a few days: the new growth is susceptible to damage and desiccation during shipping. Bud break and shoot elongation of *Syringa* was not inhibited by spray applications of abscisic acid (ABA) during winterrest. However, immersion application of ABA at either 200 or 400 ppm was effective in delaying terminal and lateral bud break about 4 days beyond the control (Cohen and Kelley, 1974).

Breaking winterrest (final rest):

Winterrest is broken by the natural cold by the end of November. Breaking the winterrest of 'Madame Stepman' requires 3-4 weeks at 30°F about the middle of September, 4 weeks about the middle of October, or 3-4 weeks at the end of October. If the temperature rises from 30 to 46°F or higher, breaking of winterrest goes on more slowly Gibberellic acid does not break winterrest of *Syringa*. (Sijtsema, 1962).

In 1961, Rupprecht stated that lilac plants were best forced by storage at -2° to -4°C (25-28°F) for 5 weeks followed by treatment in a warm water bath (77°F) for 8 hours. He reported that storage at 38-40°F also broke dormancy, but the forcing time needed was slightly longer. "It was during the first and last stages of rest that the specimens of the lilac 'Charles X.', treated with ether, were brought into growth with a rapidity that was remarkable.. .lilacs that had been etherised in the first week in August flowered regularly during the first fortnight in September." (McKelvey, 1928)

Flowering of lilac on cut branches & postproduction handling of cut lilac flowers

Flower buds on cut branches may be opened by holding the branches at 58-64°F in a solution of antimicrobial substances plus 3% sugar; branches kept in water alone or in antimicrobial substances alone did not flower (Rupprecht, 1961). Marousky (1982) reported that a variety of antimicrobial chemicals were ineffective in opening lilac flowers unless combined with a 24% sucrose solution; with sugar, tight buds opened in 21 weeks when held at 70°F.

Sijtsema (1962) wrote a detailed, 57-page summary on flowering lilac on cut branches. The florets on forced cut branches can be opened, but are somewhat smaller than those on branches forced on the shrubs. Sijtsema states that "Cut branches of the cultivar 'Madame Stepman' can be forced if the lowest 35 cm of the branches are disinfected during 6 hours with 0.02% scabex (contains phenylmercuric chloride) and afterwards the branches are placed in a solution containing: 0.003% $AgNO_3$ and 0.003% streptomycinesulphate as bactericides; 5% concentration of cladox (2,4-dinitrothiocyanobenzene) as fungicide; 0.2% $Ca(NO_3)_2$; 3% sucrose; 0.01% boric acid; 0.02% citric acid, lowered to 0.01% during flowering; and, 0.1% - 0.2% glycerol.

Sijtsema further states that "High concentrations of citric acid (0.08%) or sucrose (4.5 - 6%) further the development of the flower buds, but shorten the keeping quality. However, if the concentrations of these two substances are lowered from 0.08 to 0.02% and from 6% to 3 % respectively within 6 days after the start of the flower bud development, the speed of flower bud development is increased and the keeping quality is not seriously affected. The development is a little better, but slower, at 64°F than at 72-78°F. The racemes on forced cut branches grow out well, but the florets are still somewhat smaller than on branches forced on the shrubs."

Sytsema (1973) tested several commercially available products to prolong the vase life of lilac sprays in the water in which the stems were plunged prior to marketing and in the vase water used after marketing. No chemical used in the plunging water had a significant beneficial effect. But, when used in the vase water, the most beneficial chemicals were Aadural, Aadural M.S. and

Mimosachrysal. Chrysal was less useful, but did improve flower development and prolong life compared with water alone. These contain aluminum salts.

Development of lilac flower buds is inhibited by ethylene (Harkema and Woltering, 1981). Bud development was inhibited when cut sprays of forced lilac were kept in a room with 3 ppm ethylene for 1 day at 70°F and then kept in water in a controlled atmosphere with no extra ethylene.

Handling the plant after forcing

After forcing, the plants are cut back to 2 or 3 buds and maintained in a cool house to start into fresh growth. When all danger of frost is past, they are planted out.

Methods of propagation: 1) Seed, 2) Cutting, 3) Layering, 4) Grafting, and 5) *In Vitro* propagation.

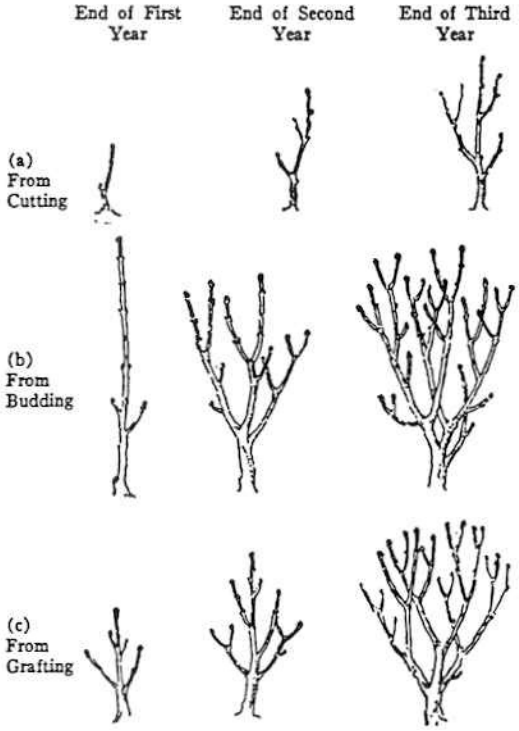

Figure 1. Comparison of plant habit and growth obtained by three different methods of propagation (Wister, 1930).

Plants for forcing are primarily obtained through grafting or budding the desired variety onto a *Syringa vulgaris* rootstock. *S. vulgaris* forms a vigorous, compact rootball. Disadvantages of *using S. tomentella, S. reflexa*, and *S. josikaea* as rootstock include poor rootball formation, less storage of food reserves in roots, crooked branches make grafting/budding more difficult, and flower bud development on grafted/budded branch is poorer. However, to produce a container-grown, flowering lilac for the dual-purpose plant market, it may be desirable to use common privet (*Ligustrum vulgare*) as the rootstock: McKelvey (1928) notes that *S. vulgare* when grafted upon common privet are more dwarf and compact plants and bloom sooner and more profusely than when on their own roots or grafted on stock of their own species.

1. Seed Germination:

Seedling rootstocks may display variability in vigor. Lilac seed capsules (each capsule contains four thin, lozenge-shaped seeds about 1/2 inch long that are bright brown in color when mature)

may be picked in the fall. Lilac seed should be stored dry. Seed will keep with little loss of viability up to 2 years if kept in sacks in a well-aerated place.

Seed without pretreatment may be sown in the fall, or cold-stratified seed may be sown in the early spring. For seedling rootstock, seed is planted in the greenhouse in February or in outdoor groundbeds in March-April. If germinated in the greenhouse, seedlings are transplanted outside in May.

2. Softwood Cuttings:

Although many varieties root easily, others are nearly impossible (McKelvey, 1928).

Bojarczuk (1978) reported "The highest percentage of rooted cuttings with the best root system was obtained from cuttings taken at the beginning of and during full bloom. Cuttings taken from the apical and central part of a young shoot rooted better than those taken from the basal part. NAA at 0.4% gave the best rooting."

Cuttings are an uncertain method of propagation owing to liability of infection with bacterial pathogen, *Pseudomonas syringae*. Softwood basal cuttings are taken when about 2 inches long, around flowering time, treated with 0.2% IBA powder and inserted under mist. Rooting will occur after five to six weeks (Lamb, et al, 1975). Hand (1978) reported that callus formation can be expected after 2 to 3 weeks. He stated "**This is a critical time in controlling the mist as too much will result in a large buildup of callus and little or reduced root development**. Once 60 to 70% of the cuttings have developed the beginnings of a root system, the first stages of hardening off begin."

Edmund Mezitt (1978) stated that, after 40 years of rooting lilac cuttings at Weston Nurseries using various methods including mist systems in poly tents, a simple sub-irrigation method has proven reliable with hard-to-root cultivars. Cuttings are taken at flowering time before the flowers fade, wounded heavily on one side before applying Hormoroot C, then stuck in a three inch deep slit in the cutting pan. The cutting pans (8 ft x 3 ft x 6 inches) are filled with 3/4 inch stone to a depth of 2 inches and the rest with horticultural-grade perlite. The stones are separated from the perlite with a fine mesh plastic screen. A 4-inch perforated drain tile is inserted in each corner of the pan and can be filled with water to uniformly raise the water level in the perlite to the desired height. The pan is filled with water the day before the cuttings are stuck; the perlite is thus saturated and when the water is siphoned out prior to sticking the cuttings, the perlite is compacted. After the cuttings are stuck in the tray, the pan is again flooded until the cuttings are turgid. The pans seldom need to be refilled with water again before the cuttings root. Cuttings begin rooting within a month and most of them are ready for potting in 6 weeks. The rooting percentage is over 90% for all cultivars, except *S. vulgaris* 'Primrose', which has been about 60%.

3. Layering:

Shoots from well-established stool beds are pegged down firmly when the buds are swelling in spring. Cut a tongue 2 inches long in the section to be covered in the soil. The following spring,

sever the rooted layers from the mother plant and line out. (Lamb, et al., 1975). The lilac can be easily layered but it will take about two years to get satisfactory roots, and it is therefore not commercially attractive when budding and grafting are readily accomplished (Wister, 1930).

4. Budding & Grafting:

Budding is used primarily to produce plants for forcing flowering branches for cutting since it produces a few vigorous, long flowering branches per plant in the shortest time period. For example, in the spring of year 1, seed is sown to produce seedling rootstock; in the summer of the second year, plants are budgrafted in July/August in the field; in March of year 3, the tips of the scion are pinched to promote development of 2-4 branches on the grafted plant (all shoots are removed from the rootstock); in the spring of the fourth year, the plants are pruned, and the roots are pruned in the summer; in the fifth year, plants are pruned in the spring and sprayed with a growth retardant or root pruned depending upon the variety; in the winter of the fifth year, the plants are forced and the first flowering lilac branches are cut and marketed. (Berg, 1981).

If the budgraft of year 2 fails, a cleft or wedge graft may be made onto the rootstock. Old bushes which do not produce enough flowering wood can be rejuvenated by grafting.

Grafting- Grafting may be done either in August or in February.

For August grafting, pot pencil-thick seedlings of *Syringa vulgaris* in spring. Plunge the pots outside until grafting time, when the pots are lifted and all but 2 inches of the stem of the rootstock is cut away. After tying, place the grafts in a cold frame under double glass or in a closed case in the greenhouse. Callusing will take place quickly and, when the callus turns brown, harden off the plants immediately. When the plants are transplanted into beds, they should be planted deeply to encourage scion rooting. (Lamb, et al., 1975)

In February grafting, lift and bench graft the rootstocks using the whip method. After tying and waxing the grafts, heel them into a shaded cold frame or shed. In early spring, plant them out deeply in nursery beds. (Lamb, et al., 1975)

5. In Vitro Propagation *of Syringa vulgaris* 'Vesper' (Hildebrandt and Harney, 1983):

Difficult to root cultivars may be propagated through tissue culture propagation .

Explants of actively growing shoot tips (5- to 10mm-long) of 'Vesper' lilac (*Syringa vulgaris* L.) initiated new shoots in 2-4 weeks on a modified Murashige and Skoog revised medium plus 0.1 mg/liter 6-benzylamino purine (BA) and either 0.125, 0.25 or 0.5 mg/liter indoleacetic acid (IAA). These shoots were transferred for multiplication to the same medium but with 7.5 mg/liter BA and 0.1 mg/liter B-naphthaleneacetic acid (NAA). In 5-6 weeks about 6 shoots, 12-15 mm in length, had been produced per explant. There was no increase in the number of shoots by placing them in either a horizontal or inverted position compared to upright. Although excised shoots would root in vitro, rooting was more successful in vermiculite in a plastic-covered flat. After 3-4 weeks, rooted shoots were potted in 7.5 cm2 pots containing moistened 1 peat: 1 perlite: 1

vermiculite (by volume) and placed in a mist bed for 2-3 weeks, after which the plants were moved to a shade house and gradually exposed to full sunlight.

Microorganisms and insects associated with lilacs

Mycorrhizae - "Lilac roots are rather slender, with many rootlets and upon these no mycorrhizas are found though the roots of adjoining trees and shrubs may have them abundantly." (McKelvey, 1928).

Additional information on production cost analyses and pest-disease management are available by writing to: Jim Green, Hort. Dept., Oregon State University, Corvallis, OR 97331.

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