Survey of Cultural Practices Used in Viburnum Production[1]

Arjina Shrestha[2], Janet C. Cole[3], and Mark E. Payton[4]
Department of Horticulture and Landscape Architecture, 358 Ag Hall
Oklahoma State University, Stillwater, OK 74078

Abstract

A survey of commercial nursery growers was conducted to identify cultural practices used in viburnum production. Viburnums composed less than 25% of the production inventory for most nurseries surveyed. Nurseries reported that viburnums are mostly spring planted and produced in containers in bark-based container substrates. Most are irrigated once a day during dry months with sprinklers using water from wells and ponds. Altering some production practices may increase plant growth and quality and improve irrigation efficiency.

Index words: nursery production, irrigation.

Species used in this study: Korean spice viburnum (*Viburnum carlesii* Hemsl.); arrowwood viburnum (*V. dentatum* L.); Mohican viburnum (*V. lantana* L. 'Mohican'); winterthur smooth viburnum (*V. nudum* L. 'Winterthur'); fragrant viburnum (*V.* × *juddii* Rehd.); leatherleaf viburnum (*V. rhytidophyllum* Hemsl.); Burkwood viburnum (*V.* × *burkwoodii* Burkw. and Skipw. Ex Anon.); spring bouquet viburnum (*V. tinus* L. 'Compactum'); eastern snowball (*V. opulus* L.); pink dawn viburnum (*V.* × *bodnantense* Stearn.); cardinal candy viburnum (*V. dilatatum* Thunb.); summer snowflake doublefile viburnum (*V. plicatum* f. *tomentosum* (Thunb.) Rehd.); C. A. Hildebrant's viburnum (*V. wrightii* Miq.); southern blackhaw viburnum (*V. rufidulum* Raf.).

Significance to the Nursery Industry

Viburnums are popular landscape plants that are considered relatively adaptable and low-maintenance compared to most woody plants. The nursery industry has many production options available including use of various container sizes, substrates, or irrigation methods. The cultural practices used for viburnum production may influence production efficiency and viburnum plant growth and quality. Surveys are useful in identifying frequently or infrequently used cultural practices during crop production. Nursery producers should consider fall potting in addition to the traditional spring potting. Organic amendments like sphagnum peat, coir or municipal compost should be incorporated into container substrate to optimize water use. Alternative water sources such as recycled or reclaimed water and highly efficient irrigation methods such as capillary mats and cyclic irrigation that could improve water and nutrient management should also be considered. These changes in crop management practices may increase plant quality during production while minimizing production costs and reducing environmental impacts.

Introduction

Viburnums are remarkably adaptable plants compared to most woody shrubs and are valued as tough and trouble-free flowering shrubs. They have few debilitating pests and diseases. They can be grown in full sun or shade (13). Viburnum species vary in soil moisture requirements. Many species thrive in moist soil while some are drought tolerant (16, 33).

Viburnums are produced in many nurseries throughout the United States. Over three million viburnums are sold annually in the U.S. with a wholesale value of over $22 million (38). Nursery crop production requires a large amount of manual labor and careful management. Each nursery may grow just a few to a few hundred plant species. Each species must be managed based on its cultural requirements (1).

The nursery industry has more production options available today than in the past. Production practices adopted by nurseries may influence nursery productivity and input efficiency. Irrigation is one of the most critical cultural practices in nursery crop production. Water available for irrigation is rapidly declining due to population growth, industrialization, and urban development. The goal of nursery growers is to produce quality plants and maxize profit by efficient and effective use of resources while reducing environmental impacts.

Various studies have reported the effect of different container substrates on plant growth and water savings. Guérin et al. (18) noted a strong relationship between viburnum height and substrate physical parameters. The tallest plants occurred in substrates with the greatest water content and availability. Arnold and McDonald (3) showed that shoot growth of *Rosa* × '*Radrazz*' L. was better in bark based substrate [pine bark:peat moss:sand (4:1:1 by vol)] than in peat-based substrate (Sungro SB 400). Research conducted on *Acer rubrum* L. using substrate containing combinations of pine bark and peat, pine bark and coir, or 100% pine bark resulted in a 17 and 12% increase in height in the pine bark/peat mix compared to the pine bark/coir mix and 100% pine bark, respectively. The peat or coir increased available water and possibly increased nutrient holding capacity to generate more growth in the species tested (14).

Bilderback and Lorscheider (7) showed that at low irrigation volumes or under conditions of irrigation conservation, use of a wetting agent in the substrate enhanced plant growth. Cyclic irrigation (changing the volume of water applied and the frequency of application) can also increase available water and reduce runoff and resulting fertilizer loss from the

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[2]Graduate Research Assistant.

[3]Regents Professor. To whom reprint requests should be addressed. janet.cole@okstate.edu.

[4]Professor, Statistics Department, Oklahoma State University, Stillwater, OK 74078.

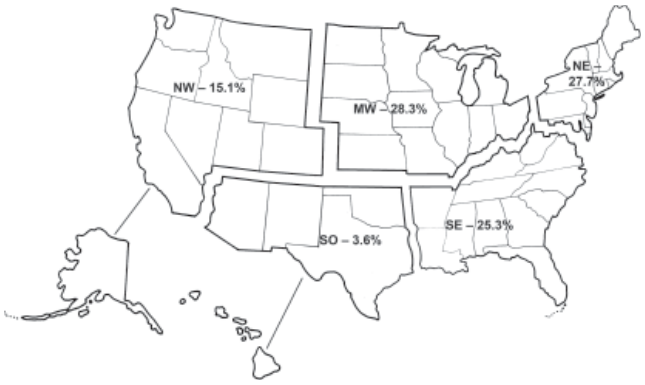

Fig. 1. Percentage of nursery respondents in each U.S. region growing viburnums. NW = northwest, MW = midwest, NE = northeast, SO = south, SE = southeast.

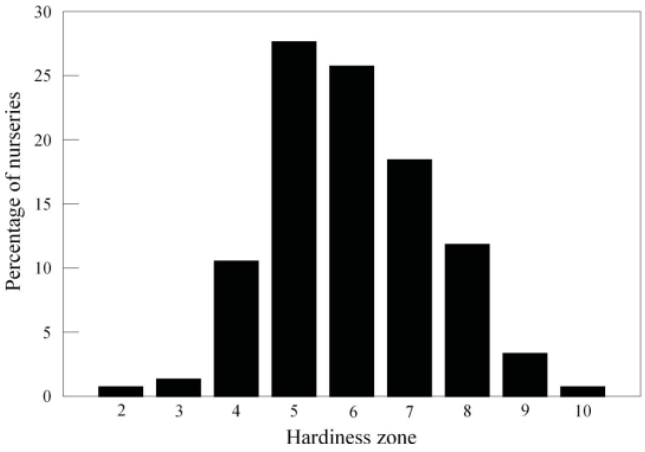

Fig. 2. Distribution of U.U.S. nursery respondents growing viburnums based on USDA cold hardiness zone.

nursery with equal or increased plant growth (14). Longer stems and greater plant fresh weight with more flowers and longer life span occurred in *Chrysanthemum indicum* L. irrigated four times per week compared to those irrigated twice per week (9). Water quality can vary from source to source (42). Water quality not only affects plant growth, but also influences fertilizer, pesticide, and growth regulator effectiveness (1).

It is important to optimize nursery cultural practices for increased production efficiency of the nursery. Therefore, the objective of this research was to identify cultural practices used in commercial production of viburnum species.

Materials and Methods

A list of production nurseries was obtained from the American Nursery and Landscape Association. Based on the name and information from websites, nurseries that obviously did not grow viburnums were eliminated from the list, leaving a mailing list of 459 nurseries. On January 14, 2009, the survey was mailed to each nursery along with a letter describing the project and a postage-paid envelope in which to return the completed survey. About six weeks after the first mailing, follow-up letters and surveys were mailed to nurseries that had not responded. Relationships among the responses to various questions were assessed by constructing two-way contingency tables using PROC FREQ in SAS (PC SAS version 9; SAS Institute, Cary, NC).

Results and Discussion

Of 459 surveys mailed, 205 (44.7%) were completed and returned. Of those 205 surveys returned, 169 (82.4%) respondents indicated that they grow viburnums. Only surveys from nurseries that grow viburnums were included in data analyses. Viburnums were grown in nurseries in most regions of the United States with the smallest proportion of nurseries located in the southern U.S. (Fig 1). Most of the nurseries growing viburnums were located in USDA cold hardiness zones 4 to 8 (94.2%), with zones 5 and 6 having the greatest percentage of growers at 27.6 and 25.7%, respectively (Fig. 2). Viburnums composed less than 25% of the production inventory for 99% of nurseries surveyed. Among the viburnum species listed in the survey, more than half of nurseries grew Korean spice viburnum, arrowwood viburnum, Mohican viburnum, fragrant viburnum, or Burkwood viburnum (Table 1). Spring was the most common planting time for all viburnum species included in the survey (Table 2), followed by fall. Summer and winter were the least common times to plant, likely due to hot and cold temperatures, respectively, that lead to slower rooting and growth.

Nurseries were asked about the production system in which they grew viburnums. A higher percentage of nurseries grew most viburnum species in above-ground containers than in-ground with or without containers or any other system (Table 3). More nurseries grew their field-grown viburnums in sandy loam soil than in any other soil type (Fig. 3). Container-grown viburnums were mostly grown in bark-based substrate with 40% of nurseries using 100% bark (composted or milled pine bark, hardwood bark, or fir bark), among which 60% of nurseries used 100% composted pine bark. Most nurseries (57.3%) use composted pine bark as one of the container substrate components (Fig. 4). Other components that growers listed as being included in container substrates were Douglas fir bark, leaf compost, sawdust, rice hulls, soil, clay, pumice, and perlite. More nurseries used #3 or #5 (2) pots than smaller or larger pots for growing viburnums (Fig. 5). Growers also reported using #SP4, #2, #3.5, #4, and #7 containers. Most viburnums were propagated vegetatively rather than by seed (Table 4).

Table 1. Percentage of U.S. nursery respondents growing different viburnum species.

Viburnum species	Percentage of nurseries
Korean spice	58.0
Arrowwood	61.5
Mohican	52.7
Winterthur smooth	33.1
Fragrant	54.4
Leatherleaf	40.8
Burkwood	52.1
Spring bouquet	18.9
Eastern Snowball	49.7
Pink dawn	10.7
Cardinal candy	23.1
Summer snowflake doublefile	47.3
C. A. Hildebrant's	3.6
Southern blackhaw	8.3

Table 2. Percentage of nursery respondents that plant various viburnum species in summer, fall, spring, or winter.

Viburnum species	Planting season	Percentage of nurseries
Korean spice	Summer	20.6
	Fall	22.7
	Spring	85.6
	Winter	2.1
Arrowwood	Summer	16.5
	Fall	25.2
	Spring	80.6
	Winter	3.9
Mohican	Summer	14.9
	Fall	21.8
	Spring	89.7
	Winter	2.3
Winterthur smooth	Summer	8.9
	Fall	16.1
	Spring	80.4
	Winter	5.4
Fragrant	Summer	18.5
	Fall	21.7
	Spring	87.0
	Winter	2.2
Leatherleaf	Summer	13.2
	Fall	25.0
	Spring	82.4
	Winter	4.4
Burkwood	Summer	15.1
	Fall	16.3
	Spring	88.4
	Winter	1.2
Eastern Snowball	Summer	16.9
	Fall	30.1
	Spring	77.1
	Winter	7.2
Cardinal candy	Summer	7.7
	Fall	15.4
	Spring	84.6
	Winter	7.7
Summer snowflake doublefile	Summer	15.0
	Fall	15.0
	Spring	85.0
	Winter	10.0

Table 3. Percentage of nursery respondents reporting growing various viburnum species in the field with no root restriction, above ground in containers, in-ground in containers, or in other production systems.

Viburnum species	Root conditions	Percentage of nurseries
Korean spice	field	45.4
	above ground	74.2
	in-ground	6.2
	other	1.0
Arrowwood	field	49.0
	above ground	74.5
	in-ground	7.8
	other	2.0
Mohican	field	43.7
	above ground	72.4
	in-ground	9.2
	other	—
Winterthur smooth	field	30.4
	above ground	69.6
	in-ground	7.1
	other	—
Fragrant	field	43.8
	above ground	69.7
	in-ground	10.1
	other	1.1
Leatherleaf	field	44.1
	above ground	69.1
	in-ground	8.8
	other	—
Burkwood	field	34.5
	above ground	73.6
	in-ground	8.1
	other	1.2
Eastern Snowball	field	30.5
	above ground	75.6
	in-ground	7.3
	other	—
Cardinal candy	field	33.3
	above ground	64.1
	in-ground	5.1
	other	—
Summer snowflake doublefile	field	30.8
	above ground	75.6
	in-ground	10.3
	other	—

A higher percentage of nurseries were irrigated using water from a well (58.8%) or pond (44.9%) than from other water sources (Fig. 6). Eighty-five percent of nurseries used sprinkler irrigation for irrigating viburnums (Fig. 7). Seventy-two percent of nurseries said that the irrigation frequency differs for different viburnum species; however, once a day was the most common irrigation frequency for viburnums during the dry months of the year (Table 5). During wet months, most viburnums were irrigated as needed, with no regular schedule (Table 5). Ninety-six percent of the nurseries did not use wetting agents or hydrogels in the potting substrate for viburnums. Fifty percent of the nurseries reported that they had observed water stress problems during viburnum production (Table 6). More nurseries experienced slow growth of plants due to water stress than stem dieback, susceptibility to diseases, lower yield, or loss of sale.

Viburnums had medium market demand according to 66% of nurseries and low market demand according to 25% of nurseries. Thirty-three percent of nurseries reported that the market demand of viburnums differed among species. More nurseries responded that Korean spice viburnum and fragrant viburnum had higher market demand than the other viburnum species (Table 7). More than half of nurseries reported

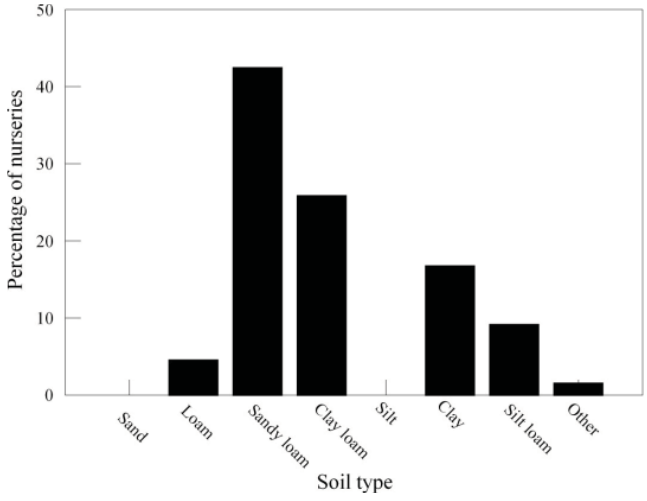

Fig. 3. Percentage of responding nurseries that listed various soil types used in viburnum field production.

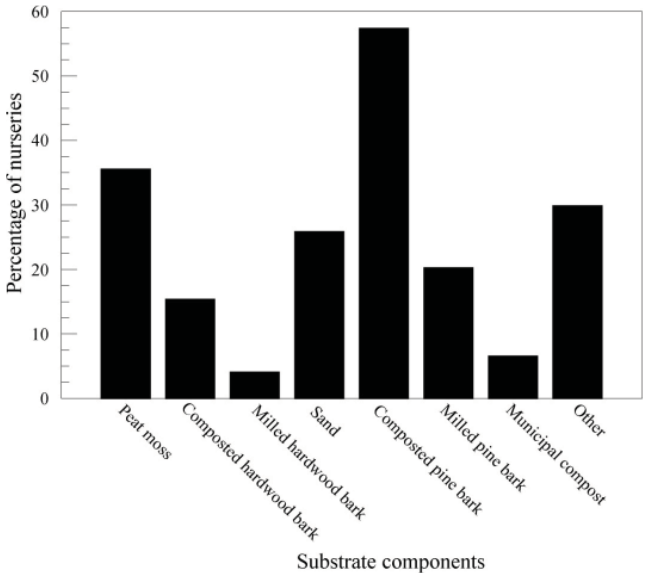

Fig. 4. Percentage of responding nurseries that use various container substrate components in viburnum production.

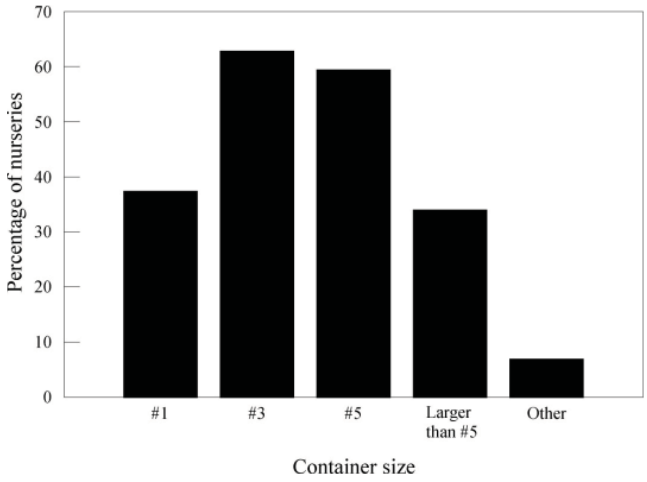

Fig. 5. Percentage of nursery respondents growing viburnums in various container sizes.

that arrowwood, Mohican, winterthur smooth, Burkwood, spring bouquet, cardinal candy, and summer snowflake doublefile viburnum had a medium market demand.

Seventy-eight percent of the nurseries reported annual production costs of more than $100,000 (Fig. 8A), while 96% of the nurseries reported that their irrigation cost was less than 25% of their production cost. Ninety percent of the nurseries had more than $100,000 in annual gross sales from their nursery in 2008, or the most recently completed fiscal year (Table 8B). Most (99%) of the nurseries reported that viburnums contributed less than 25% percent of their gross sales.

Based on the survey results, nurseries may improve cultural practices used in viburnum production to increase plant growth and quality and improve irrigation efficiency. Spring was reported as the most common planting time for all viburnum species included in the survey. Ivy et al. (23) showed that growers can incorporate more fall potting in place of traditional spring potting. Soil temperature and moisture are favorable for rapid root growth which helps plants survive during the first year of transplanting in the landscape (6). Utilizing fall planting leads to subsequent root establishment resulting in larger plants in the spring that often can withstand dryer conditions during the summer than plants planted in the spring. As size of the landscape industry increases, adoption of fall planting may help growers produce a quality plant and meet industry demand throughout the year. Ivy et al. (23) reported that rooted stem cuttings of *V. awabuki* K. Koch., potted in September or October, were larger and had greater N and P content than those potted in March. Viburnums potted in September produced the largest total dry weight compared to those potted in July, October, March or May when fertilized with Wilbro/Polyon 15N–1.8P–7.5K ($15N–4P_2O_5–9K_2O$), whereas plants potted in March were the smallest. Viburnums potted in July, September, and October and grown with Scotts 23N–1.8P–6.6K ($23N–4P_2O_5–8K_2O$) outperformed those potted in March or May. No plants were injured by winter temperatures regardless of potting date throughout the study period.

Viburnums are mostly container-grown which requires larger volumes of water than in-ground production without root restriction. Most nurseries irrigate viburnums using water from wells and ponds. In various parts of the United States, ground water storage and surface water volumes are declining and water shortages are increasing due to competition by agriculture, industrial or domestic users (24, 31, 41). Groundwater is also being contaminated by saltwater intrusion as a result of removing groundwater faster than it is being recharged or infiltration of contaminants from nearby industrial, urban, and agricultural operations (4). Environmental agencies are claiming more surface water to protect endangered flora and fauna along waterways. Excessive irrigation has a direct impact on production costs. Growers using well water incur costs associated with pumping water and growers using municipal surface water sources must pay for the water.

Our survey results showed that 40% of nurseries used 100% bark for container grown viburnums. Total porosity and air space are highest in the 100% bark substrate. However, previous research has shown that plant available water

Table 4. Percentage of nursery respondents that propagate various viburnum species by seed or by vegetative means.

Viburnum species	Percentage of nurseries	
	Seed propagation	Vegetative propagation
Korean spice	5.6	94.4
Arrowwood	4.5	95.5
Mohican	0.0	100.0
Winterthur smooth	2.6	97.4
Fragrant	0.0	100.0
Leatherleaf	0.0	100.0
Burkwood	3.4	96.6
Eastern snowball	0.0	100.0
Cardinal candy	0.0	100.0
Summer snowflake doublefile	1.8	98.2

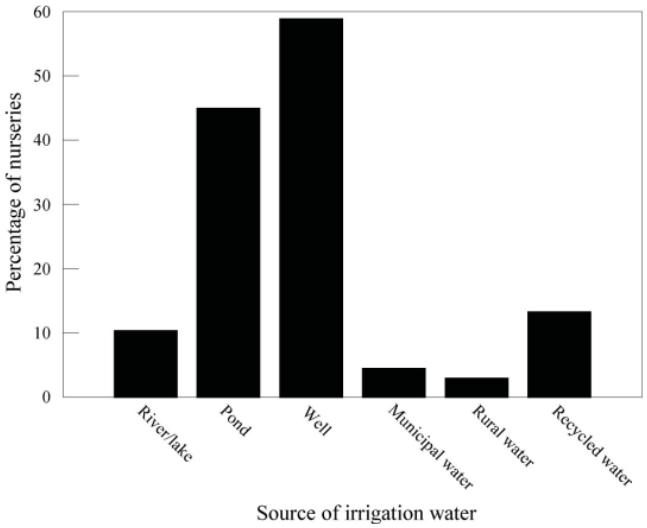

Fig. 6. Percentage of nursery respondents using various water sources to irrigate viburnums during production.

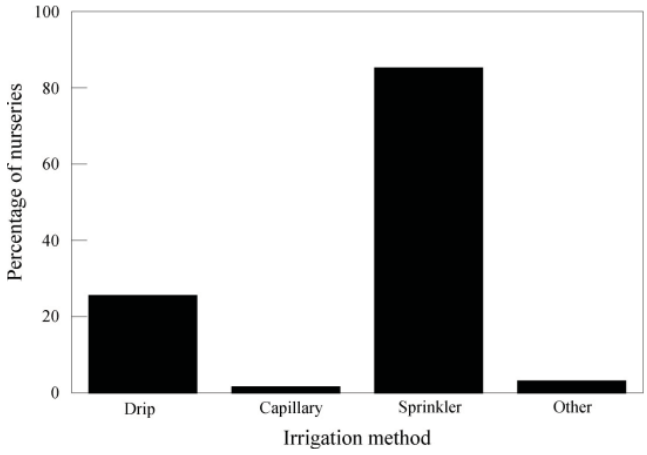

Fig. 7. Percentage of responding nurseries that use various irrigation methods in viburnum production.

and shoot growth can be increased by adding sand or peat compared to 100% pine bark (14, 27). In a study by Caron et al. (10), amount of irrigation water needed to achieve marketable size in *V. odoratissimum* Ker Gawl was reduced by changing peat type from sedge to sphagnum and increasing the percentage of sphagnum peat to 60% on a volume basis, due to reduction in production time. Haydu et al. (20) revealed that changing peat type from sedge to sphagnum can be profitable in the long run. Evans and Iles (15) reported that *V. dentatum* L. grown in coir-based substrates were taller, wider and had greater root fresh mass than plants grown in peat-based substrates.

Only one nursery reported using calcined clay as a component of the container substrate. Several studies have shown that calcined clay can be an alternative to sand in container substrate to increase container capacity, available water, and substrate nutrient retention (11, 35, 36, 37). Pine bark amended with calcined clay can decrease phosphorus leaching (39).

Few nurseries used municipal waste in their container substrate. Composted municipal waste can reduce water usage in open irrigation systems (11). Plants grown with 25% municipal solid waste compost had similar or better growth than plants in 100% pine bark for a wide range of

Table 5. Percentage of nursery respondents reporting irrigation frequency for viburnum species during dry or wet periods.

Viburnum species	Percentage of nurseries					
	More than once a day	Once a day	Every other day	Twice a week	Once a week	Other
			Irrigation frequency during dry periods			
Korean spice	12.4	35.8	13.6	16.1	13.6	8.6
Arrowwood	19.3	47.7	9.1	4.6	11.4	8.0
Mohican	14.5	47.4	6.6	6.6	15.8	9.2
Winterthur smooth	16.0	48.0	8.0	10.0	8.0	10.0
Fragrant	13.0	36.4	14.3	14.3	15.6	6.5
Leatherleaf	6.8	44.1	17.0	8.5	15.3	8.5
Burkwood	11.1	41.7	9.7	15.3	13.9	8.3
Eastern snowball	12.0	50.7	13.3	8.0	9.3	6.7
Cardinal candy	8.6	40.0	17.1	11.4	14.3	8.6
Summer snowflake doublefile	17.8	43.8	13.7	9.6	11.0	4.1
			Irrigation frequency during wet periods			
Korean spice	2.4	2.4	11.8	18.8	15.3	49.4
Arrowwood	3.4	6.8	21.6	13.6	11.4	43.2
Mohican	2.5	6.4	19.3	18.0	9.0	44.9
Winterthur smooth	1.9	3.9	15.4	15.4	9.6	53.9
Fragrant	2.5	3.8	16.3	15.0	18.8	43.8
Leatherleaf	3.2	1.6	14.3	15.9	14.3	50.8
Burkwood	1.4	1.4	17.6	12.2	21.6	46.0
Eastern snowball	3.9	3.9	16.7	19.2	15.4	41.0
Cardinal candy	—	5.6	16.7	11.1	11.1	55.6
Summer snowflake doublefile	4.2	1.4	18.1	16.7	13.9	45.8

Table 6. Percentage of nursery respondents reporting various water stress symptoms during viburnum production.

Water stress problems	Percentage of nurseries
Slow growth	34.6
Stem dieback	24.1
More susceptible to disease	17.2
Insect damage	—
Reduced quality	—
Lower yield	14.2
Loss of sale	18.4
Other (specify)	5.8

container nursery crops (30). Kiermeier (25) found that *V. lantana* grew more rapidly with higher application rates of composted municipal waste. Viburnum plants produced in substrates with yard compost or raw coir or forest compost/cattle manure were similar in size to those produced in 1:1 peat:pine bark compost and were taller than those produced in mixtures of expanded perlite/composted manure or forest compost and composted bark (18).

Composted pine bark was the primary component of growth substrates in 57.3% of nurseries. However, the future availability of bark for horticultural usage might be limited due to alternative demands (e.g. industrial fuel), reduced timber production (12, 21), and increased importation of logs already debarked (29).

Viburnums are reported to be primarily grown in #3 or #5 containers. Growing plants under different conditions could induce a series of differential characteristics that affect their adaptation to water shortage when transplanted into the landscape. Narciso Pastor et al. (34) reported that *V. tinus* L. grown in #2 containers with coarse pine bark had better development than those grown in #SP5 containers and fine grade pine bark when they were transplanted in the landscape with limited water.

Irrigation efficiency also depends on irrigation method. Viburnums are mostly irrigated by sprinklers. Haydu et al. (20) reported that overhead irrigation required the most water, followed by micro-irrigation, capillary mat and then trays for production of container-grown *V. odoratissimum*. Installation costs were lowest for overhead irrigation and greatest for the tray system followed by micro-irrigation, then capillary mat. Cumulative year profits were greatest

Table 7. Market demand of different viburnum species as perceived by nursery respondents.

	Percentage of nurseries		
Species	High	Medium	Low
Korean spice	63.5	25.7	10.8
Arrowwood	15.8	56.6	27.6
Mohican	1.6	60.9	37.5
Winterthur smooth	7.3	51.2	41.5
Fragrant	55.9	36.8	7.4
Leatherleaf	33.3	41.2	25.5
Burkwood	15.2	57.6	27.3
Spring bouquet	30.4	65.2	4.4
Eastern Snowball	10.2	39.0	50.9
Pink dawn	14.3	21.4	64.3
Cardinal candy	24.2	54.6	21.2
Summer snowflake doublefile	32.7	60.0	7.3
C. A. Hildebrant's	20.0	20.0	60.0
Southern blackhaw	10.0	30.0	60.0

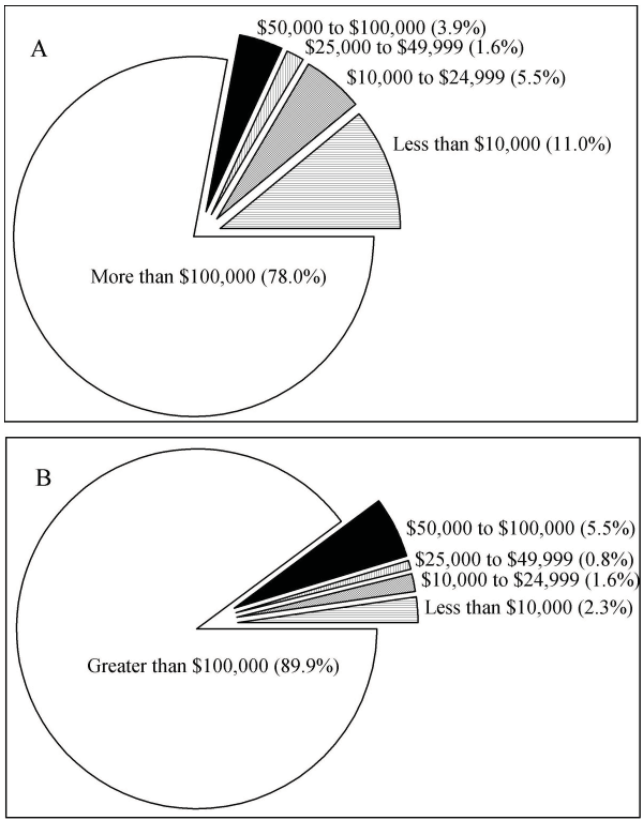

Fig. 8. Annual production cost (A) and gross sales (B) of all crops produced in nurseries responding that they grow viburnums.

with capillary mats, then trays, and overhead. Due to the substantial initial investment, profits were lowest for micro-irrigation. With overhead sprinklers, as little as 25% of the water applied enters containers. When plant spacing is considered a high proportion of water applied by sprinklers falls between containers (5, 19), and thus is unavailable to the plants. Irmak et al. (22) reported that the multi-pot box system (a modification of subirrigation that combines overhead and subirrigation to capture the water falling between containers, making it available when needed by the plants) saved at least 92 and 76% of irrigation water relative to the conventional system (consisting of black containers spaced on 30 cm (12 in) centers) in *V. odoratissimum* in the summer and fall, respectively. Growth indices and shoot and root dry weights were usually higher regardless of season for plants grown in the multi-pot box system.

Runoff water is an important avenue for the movement of agrichemicals from production sites into nearby receiving water bodies (8, 28, 32). However, if properly managed surface runoff can be reused in nursery production (40). This process can save money and also provides an alternative irrigation source. Very few nurseries (13.2%) used recycled water. *Viburnum tinus* 'French White' irrigated with reclaimed wastewater (treated sewage effluent from the wastewater treatment facility) had better plant growth than those irrigated with well water. Reclaimed water increased leaf area, chlorophyll content, and leaf concentration of N, P and K (17). Reuse of treated municipal wastewater, especially when it is low in heavy metals, is beneficial since more water is available for irrigation in areas where scarce summer

rainfall and high evapotranspiration can be problematic. Only 4.4% nurseries reported irrigating viburnums using municipal water.

About 72% of nurseries reported that irrigation frequency differs for different viburnum species. However, most viburnum species were reported to be irrigated mostly once a day during dry months. Irrigating plants based on their actual water use is important to improve irrigation efficiency. According to Kollmann and Grubb (26), in the natural habitat, there was extensive die-back of shoots of *V. opulus* which wilted early and severely in the dry summer of 1989, whereas shoots of *V. lantana* showed little damage. *Viburnum lantana* is most abundant on freely draining soils while *V. opulus* occurs typically on soils that are usually wet for at least part of the year, and its distribution extends to soils that are waterlogged through most of the profile all year. Viburnum species likely differ in their water requirement and drought tolerance. Appropriate selection of viburnum species that require less irrigation water and are more drought tolerant is important in dry arid regions due to limited water availability. Cyclic irrigation has been shown to increase nutrient and water use efficiency without sacrificing plant growth (43).

In conclusion, using more sustainable production techniques that improve irrigation efficiency will reduce production costs, conserve water, and produce higher quality crops. Nursery producers should consider planting time; selection of components of container substrates, use of inorganic and biological amendments in the substrate; alternative irrigation sources; cost and water efficient irrigation methods; irrigation frequency and use of cyclic irrigation that could improve water and nutrient management of viburnums and other ornamental crops.

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