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The Virginia Commercial Greenhouse Industry—Current Practices and Future Needs Assessment

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SUMMARY. This report summarizes responses to a survey of Virginia's commercial greenhouse industry, conducted in 2000–01. The survey included questions about interests and needs of growers to assist Virginia Tech Horticulture faculty and staff in planning educational and research programming. Respondents were asked about current cultural practices, future plans for automation and technology, and impact of issues facing the

greenhouse industry such as regulations and labor. The 273 responses were categorized based on the amount of heated greenhouse space: small, medium, large, or other (including part-time). Following analysis of the responses, focus groups were conducted across Virginia to further discuss issues raised in the survey.

While the United States Department of Agriculture (USDA) regularly evaluates and reports floriculture crop numbers, growing area, and receipts (USDA, 2002), our survey included smaller and part-time growers in these quantitative areas. We also followed Panter's (1994) survey of the Colorado commercial greenhouse industry in asking questions about specific issues and programming needs. The main objectives of the survey were twofold: to define the size and scope of the industry and to identify needs and interests to help plan research and educational programming. A previous report described the production spaces, grower experience and education, employees, crops grown, and target markets (Scoggins et al., 2003). This report addresses the second objective to determine current cultural practices and future educational interests as well

as perceptions of primary issues facing the industry.

Materials and methods

A survey consisting of 33 questions asking for 242 pieces of information was developed and distributed to 980 potential greenhouse businesses (Scoggins et al., 2003). The survey instrument was administered, along with follow-up mailings, according to the method described in Dillman (1978). Of potential respondents, 274 usable responses were analyzed, for a response rate of 63%. A brief follow-up questionnaire was sent to further categorize businesses with no outside (non-family) employees to determine whether they were part-time or full-time and truly commercial in nature.

Respondents were categorized based on heated greenhouse space; either small [$<10,000$ ft² (<929.0 m²)], medium [$10,001$ to $29,999$ ft² (929.1 to $2,786.9$ m²)], large [$>30,000$ ft² (>2787.0 m²)], or other (part-time, hobby, or could not be categorized). We hypothesized that the size of the greenhouse operation in terms of controlled space would influence many aspects of the survey responses such as potential markets, interests, and issues. Frequencies were calculated using SPSS (Chicago, Ill.). Data were subjected to a one-way analysis of variance. If there were significant differences among variables, the Waller-Duncan mean separation procedure was applied.

Results and discussion

Knowledge of geographical distribution of clientele is important in program planning and apportionment of educational resources in any state. Respondents were widely dispersed across the state (Fig. 1). Major concentrations of greenhouse operations were in the Shenandoah Valley

Fig. 1. Statewide distribution of respondents to a 2000–01 survey of Virginia greenhouse growers.

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(Rockingham County had the most greenhouse operations with eleven) and east into Albemarle, Orange, and Culpeper counties; the central part of the state including Richmond and surrounding counties, the Tidewater area including the cities of Suffolk, Chesapeake, and Virginia Beach, and the Eastern Shore peninsula. Also, this concentration of greenhouses in the central and eastern area falls within the Chesapeake Bay Watershed; there are associated potential implications. The Maryland Department of Agricul-

ture already requires greenhouse and nursery operations to file mandatory nutrient management plans with the state. Training Virginia growers in this circumstance would require additional programming efforts.

CHARACTERIZATION OF CULTURAL PRACTICES. There is little documentation of actual growing practices; most is anecdotal or individual business profiles in industry magazines. In order to tailor programs suitable to the background of the growers, growers were asked to describe some of their cultural practices,

especially those that might impact areas of water, nutrient, pest, and disease management. Questions were asked in a yes or no format, with the option of not applicable. On average, these questions were answered by 95% of respondents. Cultural practices commonly used included controlled-release fertilizers, horizontal airflow fans, and rotation of insecticide chemistries. Responses to 7 of the 11 questions varied with the size of greenhouse operation (Table 1).

Respondents were asked to in-

Table 1. Cultural practices of greenhouse growers in the state of Virginia, as reported in a 2000–01 survey. Respondents were asked “Do you...”, then the following practices. Potential responses were yes, no, or not applicable (NA). Greenhouse operations are categorized as small [$<10,000$ ft² (929.0 m²)], medium [10,001 to 29,999 ft² (929.1 to 2,786.9 m²)], large [$>30,000$ ft² (2787.0 m²)], or other (part-time, hobby, or could not be categorized).

Cultural practice	Yes ^z	No	N/A
Keep “pet” plants (not for commercial use) in your greenhouse	36%	61%	3%
Use controlled-release fertilizer	80%	16%	4%
Use screening to exclude insects from greenhouse	21%	74%	5%
Use horizontal airflow fans in some or all greenhouses	82%	15%	3%

	Cultural practices by size of greenhouse operation (%) ^z											
	Small			Medium			Large			Other		
	Yes	No	NA	Yes	No	NA	Yes	No	NA	Yes	No	NA
Test irrigation water annually	36	59	5	46	50	4	65	35	0	25	55	20
Test growing media during crop cycle	37	58	5	35	61	4	67	33	0	11	68	21
Adjust fertilizer/irrigation practices based on results of the tests	46	46	8	43	53	4	77	18	5	27	50	23
Calibrate fertilizer injector during crop cycle	39	40	21	58	36	6	67	28	5	10	50	40
Rotate insecticide chemistries	76	15	9	88	10	2	98	0	3	70	15	15
Calibrate spray equipment regularly	35	47	18	42	48	10	47	45	8	20	50	30
Sanitize benches/floors/other structures after each crop cycle	66	27	7	78	20	2	72	28	0	57	19	24

^zNumber of respondents ranged from 262 to 266.

^yTopic interest varied depending on size of operation. Number of respondents was small (146), medium (49), large (40), and other (21).

^zNumber of responses; did not vary significantly among questions.

Table 2. Automation of greenhouse functions and technology used by greenhouse growers in the state of Virginia, as reported in a 2000–01 survey.

Automation function	Respondents with automation in place (%) ^z	Respondents planning to add automation within 2 years (%)
Fertilizer application	54	12
Irrigation	52	18
Pot filling	24	10%
Media mixing	23	7
Labeling: Tagging	9	8
Plant transport in greenhouse	8	8
Labeling: Bar coding	5	9
Loading	4	6
Packaging for shipping	<1	2

Technology	Respondents using technology (%) ^z	Respondents planning to add technology within 2 years (%)
Computer-based financial management	59	16
Computerized inventory control	24	21
E-mail	63	11
FAX	77	7
Internet	63	12
Web site for greenhouse business	20	29

^zPercentage does not total 100% as respondents could check more than automation (N = 205) or technology function (N = 230).

dicate which of 11 greenhouse functions they have automated or plan to automate within the next 2 years. Only two functions, fertilizer application and irrigation, are currently automated by more than half of respondents (Table 2). An examination of responses sorted by the size of operation shows that larger greenhouses, as expected, have more automation in place (data not shown).

When asked to indicate which of nine types of irrigation systems they used, many growers indicated more than one system (Table 3). Although close to half of growers reported having automated irrigation, 91% use some hand watering. There was a trend toward larger operations using more automated systems such as ebb and flood benches, boom and drip irrigation. Systems also mentioned were capillary mats and float beds.

EDUCATIONAL INTERESTS. The survey was designed to determine levels of interest in three programming areas: plant production, specific crops, and business management. Respondents were asked to rank their level of interest in the specific topic on a scale from 1 to 4, with 1 = no interest and 4 = great interest. They were also given the opportunity to identify other areas of interest in each area. Responses to most topics varied significantly based on the size of the greenhouse operation.

Among the plant production topics in which interest did not vary by the size of the operation, are fundamental issues that every grower must master: insect and disease management, reduction of pesticide usage, and water quality (Table 4). Interest in more advanced topics such as automation did vary depending on the size of the operation. Other topics suggested by respondents included scheduling, organic techniques, alternative crops, and methods of propagation.

The plant production interests of growers with different mixes of crops (Scoggins et al., 2003) were observed to be somewhat different from the overall levels of interest. Perennial growers had a higher than average interest in plant growth regulators (2.8), field trial reports (2.8), reducing pesticide use (3.2), and water quality (3.0), while food crop producers were more interested in nutrition (3.3), field trial results (2.8), waste water and runoff management (2.4), and ventilation and cooling (3.0). Cut

flower growers showed higher than average interest in field trial reports (3.0). All three of these grower groups showed a higher than average interest in disease control (3.6 for food crops, 3.5 for the others).

Respondents were asked to rank their level of interest in fourteen crops or types of crops on the same scale as previously described (Table 5). Respondents seemed most interested in learning more about crops they already grow—for example cut flower growers ranked their interest in learning about this type of crop at 3.4 while the overall ranking of cutflowers was only 1.9. Interest in learning more about geraniums and poinsettias, the largest-selling bedding plant and potted flowering crop respectively (Jerardo, 2002), varied significantly by size of

greenhouse operation. Large growers were more interested in learning about poinsettias; for other size categories, the level of interest declined with the size of the operation. Both medium and large growers expressed more interest in learning more about geraniums than did smaller growers. Interest in the other eleven crops did not vary significantly by size category.

Respondents were asked to rank their level of interest in 12 different management topics. As with plant production topics, topics in which interest did not vary by the size of the greenhouse operation are the basics that must be handled by all businesses (Table 6). With well over half of the small and medium-sized operations selling directly to the public from their greenhouse (Scoggins et al., 2003) it is

Table 3. Irrigation systems in use by greenhouse growers in the state of Virginia, as reported in a 2000–01 survey.

System	Respondents reporting use (%) ^z
Hand watering	91
Drip irrigation	47
Overhead impact sprinklers	26
Overhead micro sprinklers	22
Saucers	4
Trough systems	4
Ebb and flood floors	3
Boom sprinklers	3
Ebb and flood benches	2
Other	1

^zPercentage does not total 100% as respondents could check more than one irrigation system ((n = 264).

Table 4. Interest of Virginia greenhouse growers in learning about plant production topics, listed from most interest to least interest. Greenhouse operations are categorized as small [$<10,000$ ft² (929.0 m²)], medium [10,001 to 29,999 ft² (929.1 to 2,786.9 m²)], large [$>30,000$ ft² (2787.0 m²)], or other (part-time, hobby, or could not be categorized).

Topic	Mean level of interest ^z
Insect management	3.5 ^y
Disease management	3.4
Reducing pesticide use	3.1
Water quality	2.9
Reports on field trials	2.7
Ventilation and cooling	2.7

	Mean level of interest by size of greenhouse operation ^x			
	Small	Medium	Large	Other
Automation of greenhouse functions	2.6 b	2.9 ab	3.2 a	1.9 c
Managing wastewater and runoff	2.2 ab	2.6 a	2.5 a	1.8 b
Nutritional management	3.1 a	3.4 a	3.3 a	2.5 b
Plant growth regulators	2.5 ab	2.9 a	3.0 a	2.2 b

^zLevel of interest scale 1 = no interest to 4 = great interest (n = 249).

^yMean number of responses (did not differ significantly between topics).

^xTopic interest varied depending on size of operation [N = 138 (small), 46 (medium), 46 (large), and 19 (other)]. Values within a row differ significantly at $P \leq 0.01$. Mean separation within greenhouse size by Waller-Duncan t test.

Table 5. Interest of Virginia greenhouse growers in learning about various crops, listed from most interest to least interest. Greenhouse operations are categorized as small [$<10,000$ ft² (929.0 m²)], medium [10,001 to 29,999 ft² (929.1 to 2,786.9 m²)], large [$>30,000$ ft² (2787.0 m²)], or other (part-time, hobby, or could not be categorized).

Topic	Mean level of interest ^a
Herbaceous perennials	3.2 ^y
Flowering annuals	3.0
Pansies/cool season crops	2.9
Other flowering potted plants	2.7
Edible herbs	2.7
Potted garden mums	2.5
Vegetable transplants	2.3
Edible crops—vegetables	2.3
Bedding plant plugs	2.2
Aquatic plants	2.1
Bulb crops	2.0
Cut flowers	1.9

	Mean level of interest by size of greenhouse operation ^x			
	Small	Medium	Large	Other
Geraniums	2.3 b	2.6 ab	3.0 a	3.2 a
Poinsettia	1.5 c	1.9 bc	2.3 b	2.9 a

^aLevel of interest scale 1 = no interest to 4 = great interest (n = 229).

^yMean number of responses (did not differ significantly between topics).

^xTopic interest varied depending on size of operation N = 127 (small), 45 (medium), 32 (large), and 15 (other). Values within a row differ significantly at $P \leq 0.01$. Mean separation within greenhouse size by Waller-Duncan *t* test.

Table 6. Interest of Virginia greenhouse growers in learning about management topics, listed from most interest to least interest. Greenhouse operations are categorized as small [$<10,000$ ft² (929.0 m²)], medium [10,001 to 29,999 ft² (929.1 to 2,786.9 m²)], large [$>30,000$ ft² (2787.0 m²)], or other (part-time, hobby, or could not be categorized).

Topic	Mean level of interest ^a
Retail marketing	3.1 ^y
Wholesale marketing	3.0
Pricing	3.0
Environmental regulations	2.9
Computerizing your business	2.8
Basic cost accounting	2.8
Risk management	2.6

	Mean level of interest by size of greenhouse operation ^x			
	Small	Medium	Large	Other
Cost benefit analysis for automation decisions	2.5 b	2.2 b	2.8 a	1.8 c
Labor regulations	2.3 b	2.7 a	2.8 a	2.0 c
Strategies for attracting and keeping good employees	2.5 bc	2.9 b	3.2 a	2.0 c
Providing in-house employee training	2.4 b	2.6 b	3.1 a	1.9 c

^aLevel of interest scale 1 = no interest to 4 = great interest (N = 246).

^yMean number of responses (did not differ significantly between topics)

^xTopic interest varied depending on size of operation (N = 138 (small), 46 (medium), 38 (large), and 19 (other). Values within a row differ significantly at $P \leq 0.01$. Mean separation within greenhouse size by Waller-Duncan *t* test.

no surprise that retail marketing leads the list. Interest in all four labor-related topics varied significantly by size of the greenhouse operation. Large growers report far more interest in this area since they have more employees to deal with than do smaller operations.

ISSUES OF IMPORTANCE. Along with interest in production topics, one of the primary objectives of the this needs assessment survey was to determine the importance to growers of various issues facing the industry, in terms of impact on their business. Again, respondents

were asked to rank the issue in terms of importance. Marketing topped the list of concerns (Table 7). Three issues, labor availability, new crop development, and pesticide availability, varied significantly by size of greenhouse operation. The issue with greatest difference in importance based on size of the respondent's operation was the availability of competent labor. This is not surprising given that half the respondents have no employees who are not family members, and large growers hire 56% of the year-round employees and 49% of the seasonal workers in the state's greenhouse industry (Scoggins et al., 2003). We realize interest in various issues changes over time—if the survey was readministered in 2003, concerns over state of the economy would probably rank at or near the top. Another important issue for Virginia greenhouse growers was the water shortages and drought of Summer 2002; this was not included in the original list of topics.

AWARENESS AND USE OF RESOURCES.

The position of state greenhouse extension specialist had been frozen or vacant from 1989–99. So we were interested in determining from what resources the growers were accessing information. Other growers and print resources were used by the largest number of respondents (Table 8). The use of computer-based resources was widespread, as almost half were using Internet web sites, and nearly 30% were accessing e-mail newsletters or listserves. With 75% of respondents planning to have Internet access within the next 2 years (Table 2), it is reasonable to expect that these sources of information will increase in importance to greenhouse growers. Sales representatives are an interesting case, in that 88% of respondents from large greenhouse operations report using them as a resource, compared to 65% of medium-sized operations, and far fewer small and part time respondents. It seems reasonable that sales representatives will be more available to those who make large expenditures, and similarly, that those making large expenditures will expend more effort to make sure they are making appropriate purchases.

Floriculture crop production is a cyclical business and timing would certainly impact the attendance at and usefulness of educational programs. Growers were asked to indicate which months they would be most likely to

Industry issues		Respondents' ranking of importance ^z			
		Small	Medium	Large	Other
Marketing					
Financial management					
Compliance with state and federal regulations					
General state of the economy					
Environmental quality concerns					
Crop patenting					
Mean level of interest by size of greenhouse operation ^t					
Availability of competent labor	3.1 b	3.4 ab	3.7 a	2.5 c	
New crop development	3.1 a	3.4 a	3.1 a	2.3 b	
Pesticide availability	3.0 b	3.4 a	3.3 a	2.9 b	

Values within a row differ significantly at $P \leq 0.01$. Mean separation within greenhouse size by Waller-Duncan t test.

Available resources currently used	Respondents using resource (%) ^z
Other growers	85
Books on specific topics	77
Trade journals	70
Local extension agent	61
Sales representatives	50
Publications on specific topics	49
Internet web sites	45
Professional association newsletters	41
Extension fact sheet	37
Extension newsletters	34
Extension specialists	34
E-mail newsletters, listserves	30
CD-ROM (data base)	21
Audio cassettes on specific topics	13
Private consultants	12
Video cassettes on specific topics	10

Month	Proportion (%)
Jan.	73
Feb.	54
March	11
April	3
May	1
June	11
July	39
Aug.	29
Sep t.	15
Oct.	20
Nov.	39
Dec.	32

PROGRAMMING OUTCOME. Information gathered from this study has been critical in planning and executing educational programs across the state of Virginia. Most workshops have been held in the months of January and February, as growers expressed they were much more likely to be able to attend at this time. Program themes included “A Pricing Primer”, “Retailing Greenhouse Crops”, “Perennial Plants Production”, and “Geranium Production”. Virginia Tech also created a “Basic Greenhouse Production

Month	Percentage (%)
Jan.	73
Feb.	54
March	11
April	3
May	1
June	11
July	39
Aug.	29
Sep t.	15
Oct.	20
Nov.	39
Dec.	32

Seminar” with pesticide recertification credit at various locations around the state, to facilitate ease of attendance to greenhouse employees.

To provide more timely information, a grower e-mail discussion list was set up and currently has 75 participants with an average of five to ten postings per week.

The information garnered in the survey has been a tremendous help in understanding the needs of Virginia greenhouse industry. States with a comparable greenhouse grower demographic based on number of growers, gross value of sales by state and growing area under greenhouse cover include Alabama, Connecticut, Indiana, Massachusetts, Tennessee, and Washington (U.S. Dept. Agr., 2002). We feel certain this information will also assist those in other states responsible for delivering educational programming and applied research to a similarly diverse audience.

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