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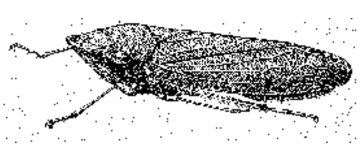

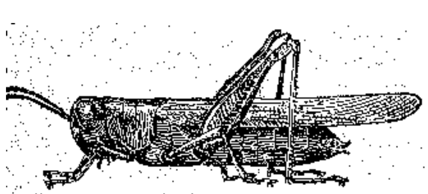

Pest Management in the United States Greenhouse and Nursery Industry: II. Disease Control

Ronald K. Jones[1], Ann R. Chase[2], Melvin P. Garber[3], William G. Hudson[4], Jeffrey G. Norcini[5], and Kane Bondari[6]

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Summary. A national survey of the commercial ornamental industry was conducted to determine the current status of pest control including chemical and nonchemical disease control practices. The fungicides thiophanate methyl, chlorothalonil, mancozeb, and metalaxyl were used in the greatest quantity and by the largest percentage of growers. Metalaxyl was used in greenhouse and field operations by the highest percentage of growers, primarily to control root diseases but many growers reported using metalaxyl to control foliar disease. Overall, more fungicides were used in the field for foliar diseases, whereas almost equal amounts of fungicides were used for foliar and root diseases in the greenhouse.

[1]*Associate professor and extension plant pathologist, North Carolina State University, 2422 Gardner Hall, Raleigh, NC 27695-7616.*

[2]*Emeritus professor of plant pathology, Central Florida Research and Education Center, University of Florida, Apopka, FL 32703.*

[3]*Associate professor and extension horticulturist, University of Georgia, P.O. Box 1209, Tifton, GA 31793.*

[4]*Associate professor and extension entomologist, University of Georgia, P.O. Box 1209, Tifton, GA 31793.*

[5]*Associate professor, University of Florida Research and Education Center, Route 4, Box 4092, Monticello, FL 32344-9304.*

[6]*Professor, Department of Statistical and Computer Service, Coastal Plain Experiment Station, Tifton GA 31793.*

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Disease control methods have changed periodically over the years according to sociological and scientific developments. In the early 1900s, the ornamentals industry used many disease control methods based on cultural controls such as use of pathogen-free planting material (Murashige, 1974; Priapi, 1993), environmental manipulation, and a few inorganic pesticides such as sulfur and copper used alone or in combination with lime to control diseases. During the 1960s, many new organic fungicides became available, which revolutionized disease control in the ornamentals industry. These fungicides were highly effective, active against a relatively narrow range of pathogens with low injury to crop plants, and easier to apply than previously available products. The use of these newer fungicides allowed higher-quality, less-expensive plants to be distributed throughout the world.

During the past 10 years, improved environmental management techniques (Cuny, 1995) such as humidity control (Bartok, 1990; Onofrey, 1994),and light and temperature controls, especially with computerized systems (Pritchard and Flynn, 1993), have altered further the balance of pest control methods in the ornamental industry. Fungicide use patterns have continued to change during the past 5 to 10 years. Decreased, threatened or lost availability of standard industry chemicals such as methyl bromide (Whitten, 1994) dodemorph acetate and benomyl sometimes have forced a shift to less effective products or to nonchemical methods of pest control. New earth-friendly (Robb, 1994) products, such as silicon for *Pythium* control (Lawson, 1994), bicarbonates for powdery mildew control (Horst et al., 1992), horticultural oils (Steward, 1993), biorational (Triact) ,and biological (SoilGard) products (W.R. Grace & Co., Grace BioControl, Columbia, Md.) currently are being researched and are labeled for use in the United States. At the same time, the industry has been confronted with pest resistance to some of the most commonly used products (Pommer and Lorenz, 1982; Roberts, 1994). Environmental regulations and USEPA Worker Protection Standards, such as reentry restrictions, have complicated further the use of pesticides on ornamentals. Finally, a dramatic shift in public opinion regarding

Table 1. ***Estimated fungicide use in the United States.***

Fungicide	Respondents No.	Respondents %[z]	Amount (lb) Estimated total active ingredient[y]	Amount (lb) %
Thiophanate methyl	316	45	470926	31
Chlorothalonil	225	32	285170	19
Mancozeb	197	28	194106	13
Metalaxyl	330	47	102150	7
Captan	159	23	86315	6
Fosetyl Al	187	27	74362	5
Iprodione	165	24	70119	5
Copper	157	22	66469	4
Propiconazole	59	8	36070	2
PCNB	84	12	34478	2
Triforine	78	11	29413	2
Etridiazole	90	13	28842	2
Vinclozolin	87	12	17879	1
Triadimefon	133	19	4714	<1
Ferbam	28	4	4670	<1
Fenarimol	47	7	2913	<1
Triflumizole	14	2	611	<1
Ziram	8	1	518	<1
Other[x]	64	9	19363	1
Total	2431		1533524	100

[z]*Determined by dividing number of users for each chemical by number of respondents from the respective region.*
[y]*Use for respondents expanded to total estimated use using USDA total sales for greenhouse/nursery industry; ratio of respondent sales to USDA sales used to estimate total use.*
[x]*Includes Agribrom, AMCL, benomyl, dinocap, dodemorph, dodine, myclobutranil, oxycarbofuran, phaltan, piperalic acid, steptomycin, and sulfur.*

pesticide use has forced all segments of the agricultural industry to rethink the emphasis placed on chemical disease control (Blaine, 1993; Klassen, 1992; Pardo, 1995).

As scientists and educators, we have been waiting expectantly for commercial ornamental producers to rediscover methods of disease control based in nonchemical methodology (Onofrey, 1994). Recently, monthly columns in grower magazines have been filled with articles extolling the benefits of integrated approaches to disease control (Barnes, 1993, 1994), and annual grower meetings sponsored throughout the United States by the Society of American Florists have focused on integrated pest management (IPM). The need for pathogen-free planting stock has been gaining followers (Priapi, 1993), as have the benefits of a well-ventilated greenhouse for pest and pathogen control (Kelly, 1994). Screening greenhouses to exclude insects, particularly virus vectors, has been gaining acceptance (J.R. Baker, personal communication).

The results of a national survey are presented herein to provide information for targeting

Table 2. ***Type of diseases controlled by fungicides in the United States greenhouse and nursery industry.***

Fungicide/bactericide	Field use: Foliar disease No. respondents	Field use: Foliar disease Amount a.i.	Field use: Root disease No. respondents	Field use: Root disease Amount a.i.	Greenhouse use: Foliar disease No. respondents	Greenhouse use: Foliar disease Amount a.i.	Greenhouse use: Root disease No. respondents	Greenhouse use: Root disease Amount a.i.
Thiophanate methyl	131	52499	45	9912	142	36429	147	28249
Chlorothalonil	145	62053	10	1765	113	12209	12	321
Mancozeb	109	40520	5	97	72	7911	2	2
Metalaxyl	40	1667	158	13922	51	2334	202	12783
Captan	85	3366	25	302	55	753	45	16630
Fosetyl al	62	3175	102	11653	54	2235	69	2308
Iprodione	63	7582	21	2158	116	10901	54	7432
Copper	106	15310	8	17	66	1175	5	60
Propiconazole	20	9759	4	87	11	380	2	1
PCNB	10	563	28	6391	8	26	51	2336
Triforine	49	4755	5	28	35	2925	4	14
Etridiazole	5	15	12	23	18	146	81	1490
Vinclozolin	29	740	1	1	69	4815	4	45
Triadimefon	73	716	5	34	74	627	7	4
Ferbam	19	1336	2	153	5	11	3	1
Fenarimol	22	671	1	1	28	144	2	1
Triflumazole	---	---	1	4	2	3	9	118
Ziram	4	78	1	35	1	18	2	4

Table 3. *Fungicide use for different types of disease control.*

	Active ingredient (%)			
	Field use		Greenhouse use	
Fungicide/bactericide	Foliar	Root	Foliar	Root
Thiophanate methyl	41.6[z]	7.6	19.4	31.4
Chlorothalonil	81.3	2.3	16.0	0.4
Mancozeb	82.5	0.8	16.6	0.1
Metalaxyl	5.5	45.3	7.6	41.6
Captan	16.0	1.4	3.6	79.0
Fosetyl al	16.4	60.2	11.5	11.9
Copper	93.3	0.1	6.2	0.4
Propiconazole	95.5	0.8	3.7	---
PCNB	6.0	68.6	0.3	25.1
Triforine	61.9	---	37.9	0.2
Etridiazole	5.7	13.1	7.5	73.7
Vinclozolin	27.0	7.7	38.8	26.5
Triadimefon	51.8	2.5	45.4	0.3
Ferbam	89.0	10.2	0.7	0.1
Fenarimol	82.2	0.1	17.6	0.1
Triflumizole	---	3.2	2.4	94.4
Ziram	62.8	30.9	3.3	3.0

[z]*Calculated by amount active ingredient for different site/total amount active ingredient for each fungicide/bactericide.*

new products and services for the ornamentals industry as well as to evaluate the degree of knowledge, use, and efficacy of the full range of disease control methods currently available. Future research, extension, and allied industry efforts might use this type of information to serve the ornamentals industry more effectively.

This survey was conducted and data analyzed as detailed previously (Garber et al., 1996).

Results and discussion

Fungicide use patterns. The number of respondents reporting use of various fungicides/bactericides is given in Table 1 in descending order of active ingredient, with at least 1% of the respondents reporting its use. The most frequently used fungicide was metalaxyl (Subdue) with a total of 47% of respondents reporting its use. The next most commonly applied fungicides were thiophanate-methyl (45%) and chlorothalonil (32%). Fungicides (in addition to metalaxyl) used for control of pythiaceous fungi included fosetyl aluminum (27%) and etridiazole (13%), for a total of 87% of the respondents using at least one fungicide product for control of pythiaceous fungi. About 22% of the respondents reported use of a copper compound and about 28% used some formulation of maneb/mancozeb. The balance between broad-spectrum and other fungicides was about equal when considering a narrow-spectrum fungicide is one that gives good control of only one or two major groups of plant pathogens. The most significant factor influencing this balance was the use of fungicides specific for pythiaceous fungi ,which are considered a nonbroad-spectrum group. In general, a preference for broad-spectrum products such as thiophanate methyl, chlorothalonil, copper, or mancozeb prevailed.

The volume of fungicide/bactericide differed from the reported frequency, since use rates differ dramatically (Table 1). Highest-volume products of the total reported were thiophanate methyl at 470,926 lb (214,058 kg) (31%), chlorothalonil at 285,170 lb (129,623 kg) (19%), and mancozeb at 194,106 lb (88,230 kg) (13%). Metalaxyl, used at very low rates, accounted for only 102,150 lb (46,432 kg) (7%) of the total volume of active ingredients reported, even though it was used by the highest percentage of growers. Iprodione, captan, and fosetyl al each accounted for about 5% of the total volume of fungicides used. Respondents were asked to report use of each fungicide/bactericide according to treatment site and type of disease targeted for control (Table 2). In general, fewer respondents applied products for control of root diseases in the field than any other type. Greenhouse producers applied more fungicides for root disease control. This may be related to a greater ability to affect the root environment and to the generally higher crop value and production costs, which can bear this expense. While most fungicides are used appropriately, inconsistencies with the label and the potential benefits of the fungicide can be found. A significant number of respondents reported using etridiazole and metalaxyl for foliar disease control, which is inconsistent with label instructions and potential beneficial use. Educational efforts should continue to stress the need for consistency in fungicide use according to labeled directions and known activity.

The percent of active ingredient for each chemical product used under various growing conditions is given in Table 3. Some products (propiconazole, benomyl, and copper) are used almost exclusively for a single target such as foliar diseases in the field. One hundred percent of piperalic acid use was reported for foliar disease control in the greenhouse. Etridiazole was used mainly for root disease control in the greenhouse. About the same amount of metalaxyl was used for root disease control in the field as in the greenhouse (Tables 2 and 3). Thiophanate methyl was used primarily for foliar disease control in the field but for root disease control in the greenhouse. Finally, the products with the most broad spectrum were used in roughly equal amounts in the field and greenhouse for root and foliar diseases (e.g., thiophanate-methyl).

A summary of the fungicide use comparing greenhouse vs. field and for foliar disease vs. root disease use reveals that almost 54% of the active ingredient was applied to field-grown ornamentals for foliar diseases (Table 4). Use of fungicides in greenhouses was considerably less, 19% being applied for foliar disease and 17% applied for root diseases. The smallest amount of active ingredient was applied to field-grown ornamentals for control of root diseases. More respondents used fungicides for foliar diseases (field and greenhouse) than for root disease control. The relatively low use rate (active ingredient) of metalaxyl, which is the most widely used fungicide, may account for all of this effect.

Patterns of fungicide use also differed by regions. More captan was used in the northeastern region (Table 5) than any other fungicide whereas thiophanate-methyl was the most widely used

Table 4. *Total disease-control fungicide used for four categories of disease.*

	Amount		Frequency	
Category	Active ingredient (lb)	%[z]	No.	%[y]
Field use				
Foliar	248048	53.8	1100	33.9
Root	47020	10.2	442	13.6
Greenhouse use				
Foliar	87647	19.0	985	30.4
Root	78246	17.0	715	22.1
Total	460962	100.0	3242	100.0

[z]*Amount of active ingredient used in each category divided by total amount of active ingredient for all fungicides.*
[y]*Calculated as the total number of users in each category divided by total users of fungicide; some totals exceed number of respondents in survey due to use of more than one fungicide by some respondents..*

Table 5. *Estimated fungicide use in the northeastern region.*

	Respondents		Amount (lb)	
Fungicides	No.	%[z]	Estimated total active ingredient[y]	%
Captan	32	22	69705	41
Chlorothalonil	33	23	20944	12
Thiophanate methyl	42	29	16123	10
Fosetyl Al	23	16	13717	8
Mancozeb	39	27	10403	6
Metalaxyl	58	41	7948	5
Vinclozolin	13	9	6492	4
PCNB	10	7	6438	4
Etridiazole	17	12	3943	2
Copper	17	12	1988	1
Iprodione	16	11	1397	1
Fenarimol	8	6	883	1
Triadimefon	20	14	821	<1
Ferbam	8	6	353	<1
Triforine	10	7	262	<1
Triflumizole	2	1	304	<1
Propiconazole	5	3	105	<1
Ziram	1	1	27	<1
Other[x]	16	11	6892	4
Total	370		168663	100

[z]*Determined by dividing number of users for each chemical by number of respondents from the respective region.*
[y]*Use for respondents expanded to total estimated use using USDA total sales for greenhouse/nursery industry; ratio of respondents sales to USDA sales used to estimate total use.*
[x]*Includes benomyl, dodemorph, phaltan, piperalic acid and sulfur.*

fungicide in the other three regions. Metalaxyl was used by the greatest percentage of the growers in the northeastern and western regions, whereas thiophanate-methyl was used by the highest percentage of the growers in the southeastern (Table 6) and north-central (Table 7) regions. The greatest total estimated use of fungicide occurred in the southeastern region (Table 6). The lowest amount of fungicide use was reported in the northeastern region (Table 5). The amount of captan used in the northeastern region (Table 5) and thiophanate-methyl used in the north-central region (Table 7) was more than three times that of any other fungicide. In the southeastern (Table 6) and western (Table 8) regions, the amount of fungicides used

Table 6. *Estimated fungicide use in the southeastern region.*

	Respondents		Amount (lb)	
Fungicide	No.	%[z]	Estimated total active ingredient[y]	%
Thiophanate methyl	111	53	232297	30
Chlorothalonil	82	39	175002	22
Mancozeb	67	32	133017	17
Metalaxyl	107	51	39967	5
Iprodione	40	19	36400	5
Propiconazole	29	14	32425	4
Fosetyl Al	61	29	29085	4
Copper	62	30	24210	3
Etridiazole	22	11	22931	3
Triforine	24	11	17968	2
PCNB	20	10	15177	2
Captan	49	23	7061	1
Propamocarb	3	1	4436	1
Ferbam	12	6	2177	<1
Triadimefon	32	15	1565	<1
Vinclozolin	17	8	1273	<1
Triflumizole	4	2	200	<1
Ziram	1	<1	78	<1
Fenarimol	5	2	18	<1
Other[x]	15	7	2886	<1
Total	763		77822	100

[z]*Determined by dividing number of users for each chemical by number of respondents from the respective region.*
[y]*Use for respondents expanded to total estimated use using USDA total sales for greenhouse/nursery industry; ratio of respondents sales to USDA sales used to estimate total use.*
[x]*Includes Agribrom, AMCL, Benomyl, Dinocap, Dodemorph, piperalic acid, and Steptomycin.*

Table 7. ***Estimated fungicide use in the north-central region.***

	Respondents		Amount (lb)	
Fungicide	No.	%[z]	Estimated total active ingredient[y]	%
Thiophanate methyl	98	46	129104	54
Chlorothalonil	64	30	38998	16
Metalaxyl	81	38	21805	9
Iprodione	44	21	15190	6
Mancozeb	47	22	7009	3
Vinclozolin	26	12	5831	2
Fosetyl Al	43	20	3581	1
Propiconazole	16	7	3400	1
Captan	52	24	2793	1
PCNB	29	14	2534	1
Copper	28	13	2223	1
Etridiazole	40	19	1818	1
Ferbam	6	3	1521	1
Triadimefon	39	18	958	1
Triforine	20	9	674	1
Fenarimol	11	5	453	<1
Triflumizole	3	1	112	<1
Other[x]	14	7	902	1
Total	661		238905	100

[z]*Determined by dividing number of users for each chemical by number of respondents from the respective region.*
[y]*Use for respondents expanded to total estimated use using USDA total sales for greenhouse/nursery industry; ratio of respondent sales to USDA sales used to estimate total use.*
[x]*Includes benomyl, dodemorph, dodine, myclobutranil, oxycarbofuran, and piperalic acid.*

was more evenly distributed among several fungicides. The percent of estimated active ingredient for captan in the northeastern region (Table 5) was 41%, whereas it represents only 1% in the southeastern (Table 6) and north-central (Table 7) regions and 2% in the western (Table 8) regions. Chlorothalonil was the second most heavily used fungicide in all four regions; thiophanate-methyl was the most heavily used fungicide in the southeastern, north-central, and western regions.

Alternatives to chemical disease control. The most-frequently used alternatives to disease control chemicals were monitoring/scouting (92.8%), inspection of incoming stock (90.6%), sanitation (89.1%), irrigation delivery/timing (82.6%), and resistant cultivars (79.5%) (Table 9). Fertility management (71.3%), crop rotation (60.7%), roguing (60.1%), and isolation (54.7%) also were used by at least 50% of the respondents. Media sterilization (48.9%), greenhouse relative humidity control (48%), and culture-indexed starter

Table 8. ***Estimated fungicide use in the western region.***

	Respondents		Amount (lb)	
Fungicide	No.	%[z]	Estimated total active ingredient[y]	%
Thiophanate methyl	65	49	93401	27
Chlorothalonil	46	34	50226	14
Mancozeb	44	33	43678	13
Copper	50	37	38047	11
Metalaxyl	84	63	32431	9
Fosetyl Al	60	45	27979	8
Iprodione	65	49	17133	5
Triforine	24	18	10509	3
PCNB	25	19	10329	3
Captan	26	19	6756	2
Vinclozolin	31	23	4284	1
Fenarimol	23	17	1559	1
Triadimefon	42	31	1370	1
Ferbam	2	1	619	<1
Ziram	6	4	413	<1
Propiconazole	9	7	141	<1
Triflumizole	5	4	76	<1
Etridiazole	11	8	151	<1
Other[x]	19	14	8684	2
Total	637		347785	100

[z]*Determined by dividing number of users for each chemical by number of respondents from the respective region.*
[y]*Use for respondents expanded to total estimated use using USDA total sales for greenhouse/nursery industry; ratio of respondent sales to USDA sales used to estimate total use.*
[x]*Includes Agribrom, AMCL, benomyl, dodemorph, myclobutranil, oxycarbofuran, piperalic acid, and sulfur.*

Table 9. ***Experience with and frequency of use of disease control alternatives in the United States greenhouse and nursery industry.***

			Experience (% response)		
Alternative control	**Respondents**	**Used**	**Not effective**	**Effective[z]**	**Effective but impractical**
Fertility management	460	71.3	3.9	95.8	0.2
Irrigation delivery/timing	536	82.6	2.1	96.1	1.9
Pathogen (cultured) indexed starter plants	199	31.8	4.5	93.4	2.0
Greenhouse relative humidity control	299	48.0	2.7	93.9	3.3
Resistant cultivars	519	79.5	1.7	95.0	3.3
Roguing	376	60.1	3.2	93.7	3.2
Media sterilization	314	48.9	4.1	87.9	8.0
Crop rotation	393	60.7	6.9	87.0	6.1
Sanitation	589	89.1	0.7	97.8	1.5
Isolation of incoming stock	346	54.7	10.1	73.5	16.5
Monitoring/scouting	605	92.8	2.1	96.5	1.3
Inspection of incoming stock	595	90.6	3.2	95.1	1.7

[z]*Combined response for somewhat effective and very effective.*

plants (31.8%) also were reported but less commonly used. The general experience with each method was very good, and all methods were reported as effective. Isolation of starter material was reported as effective (73.5%), but a significant percentage of respondents reported it as effective but impractical (16.5%). It is apparent that if an alternative method is used, it is very successful (Table 9). Additional alternatives listed by the respondents for foliar drying and reduction of relative humidity were foliar rinse with a surfactant following watering, horizontal air fans, plant spacing, and aeration. Spot treatment, pH management, pruning, biological control, and control of run-off to prevent standing water also were mentioned by at least one respondent. The use of hydrogenperoxide and chlorination of water also were reported as alternatives to chemical disease control methods, despite the fact that these are chemical products.

Regional use of alternative methods showed a similar response for most methods. The most obvious differences in use were in greenhouse relative humidity management and media sterilization, which were used significantly more in the western region (66.1% and 60.2%, respectively) than in the other regions (41.3% to 47% and 40.8%% to 52.1%, respectively). Fertility management was used a little more frequently in the north-central region than in the other regions. Respondents in the northeastern region reported nearly all methods were effective or very effective ,whereas at least 10% of the respondents in the southeastern and the north-central regions reported media sterilization and isolation were effective but impractical (Table 10). In the western region, more than 21% reported that isolation was effective but impractical, and 10% reported crop rotation as effective but impractical.

The effect of firm size on frequency of use of alternatives to disease control chemicals varied. Frequency of use of fertilization management, irri-

Table 10. ***Experience with disease control alternatives in different regions.***

	Experience (% response)											
	Not effective				Effective[z]				Effective but impractical			
Controlalternative	**I[y]**	**II**	**III**	**IV**	**I**	**II**	**III**	**IV**	**I**	**II**	**III**	**IV**
Fertility management	4.1	4.7	3.3	3.8	94.9	95.3	96.7	96.3	1.0	---	---	---
Irrigation delivery/ timing	4.4	1.3	1.3	1.9	94.7	97.4	96.2	96.3	0.9	1.3	2.6	1.9
Pathogen (cultured) indexed starter plants	6.8	2.1	3.1	7.9	93.2	93.7	95.3	92.1	---	4.2	1.5	---
Greenhouse relative humidity control	---	5.8	1.2	3.8	95.3	91.3	95.3	93.5	4.8	2.9	3.5	2.6
Resistant cultivars	1.8	0.7	2.4	2.3	97.3	96.6	93.4	92.0	0.9	2.7	4.2	5.7
Roguing	1.2	2.0	3.7	6.4	93.9	95.1	95.5	89.8	4.9	3.0	0.9	3.8
Media sterilization	6.8	---	---	10.8	87.6	89.4	90.1	83.7	5.5	10.6	10.0	5.4
Crop rotation	6.7	7.5	5.7	8.5	92.1	85.1	87.8	81.7	1.1	7.5	6.5	9.9
Sanitation	---	0.6	0.5	1.8	99.2	96.9	97.8	97.3	0.8	2.4	1.6	0.9
Isolation of incoming stock	9.1	10.7	7.9	14.1	83.3	71.9	75.3	64.8	7.6	17.5	16.8	21.1
Monitoring/ scouting	1.6	1.8	1.6	4.5	97.7	95.2	97.9	95.6	0.8	3.0	0.5	---
Inspection of incoming stock	4.7	1.8	3.2	2.8	94.5	97.0	95.1	93.5	0.8	1.2	1.6	3.7

[z]*Combined response for somewhat effective and very effective.*
[y]*Region of the country as defined in materials and methods: I, northeastern; II, southeastern; III, north-cntral; and IV, western.*

gation management, culture-indexed plants, humidity control, roguing, and isolation increased as firm size increased. In contrast, use of resistant cultivars, rotation, sanitation, scouting and monitoring was about the same for all size firms. Use of media sterilization increased from small to medium firms but was lower for large than medium firms. This may be due to an increased use of prepared, bagged potting media by the largest firms. Experience with alternatives generally was not affected by firm size. As firm size increased, there was an increase in frequency of responses listing the following alternatives as effective but impractical: resistant cultivars, media sterilization, and isolation. Large firms were more likely to report the alternative methods as effective but impractical.

The extensive use of alternative disease control demonstrates a willingness and perceived need by the greenhouse and nursery industry to use alternatives to chemical products. Most alternatives were viewed with a moderate degree of enthusiasm and have met with at least some success. The least used alternative is culture indexing which is the backbone strategy for control of *Xanthomonas* blight on geranium and several serious viral diseases. Due to limited applications on other major ornamentals, the technique has not been used fully. Many plants are produced using tissue culture methods, but their pathogen-free status is not a primary concern and is not rigorously sought by either the ornamental grower or the tissue-culture specialist. Application of this alternative should be expanded if we are to realize optimal disease-control strategies.

More than 90% of the respondents used resistant cultivars of their ornamental plants. The industry may need added emphasis in this area as we encounter increased regulations, decreased chemical pesticide availability, and increased environmental awareness. This is critical for the plant producer and the consumer, who also needs a resistant plant to eliminate the future need for fungicides in the landscape. This would also be a good marketing tool.

The best-used alternatives, scouting and monitoring, are two components of the same methodology and have perhaps come to disease control via insect and mite control. Media sterilization may have lost importance in the past 10 years due to the widespread availability of packaged potting media ,which are relatively free of plant pathogens.

The availability of chemical bactericide and fungicide products changes rapidly as products are lost and others are introduced. Since Du Pont removed ornamentals from the Benlate label in 1991, the sales of thiophanate-methyl for use on ornamentals and turf increased 200% (1991–94). Despite the changes, it is obvious that chemicals are still an integral part of most disease-control programs. It is important to note that most growers are starting to address disease control with an integrated approach, and the days of spraying on a calendar basis are limited for most ornamental producers.

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