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Ornamental Plants - - 1982: A Summary of Research

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CONTENTS

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ON THE COVER: Elton M. Smith, professor of horticulture, displays plants grown in a standard rigid plastic container (left) and a flexible poly bag (right). Current research results indicate several advantages of this newly introduced poly bag container when compared to rigid containers (see page 5).

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Growth of *Taxus cuspidata* 'Thayeri' Produced in Containers

ELTON M. SMITH and SHARON A. TREASTER[1]

ABSTRACT

The objective of this study was to evaluate the growth of *Taxus cuspidata* 'Thayeri', produced in containers, as influenced by light, media, and fertilizer treatments. Shoot length and dry weight of plants during the second and third year evaluation were significantly higher under shade and soluble fertilizer treatments. Growth the third season was greater under the ½ oz/sq ft fertilizer rate. Foliar nitrogen levels were higher in plants produced in hardwood bark-sand than soil-peat-perlite. The pH of the media decreased with increasing rates of fertilizer.

INTRODUCTION

Taxus have historically been produced in the field by commercial nurserymen. However, in recent years there has been increasing interest in producing them in containers. Unlike most other woody landscape plants, the transition from field production to container production has not been economically feasible with *Taxus* because growth has been less than satisfactory in containers. In recent years, however, improved sources of media such as hardwood bark and different types of fertilizer have become available for container production. With these advances and the continued need to produce satisfactory *Taxus* in containers, this study was undertaken.

The specific objective was to evaluate the growth of container grown *Taxus* as influenced by light, media, and fertilizer treatments. Although several research papers have been presented relative to nutrition of *Taxus* (1, 2, 3, 4), the light studies deal principally with their effects on cold hardiness (5, 7).

MATERIALS AND METHODS

The cultivar selected for this study was *Taxus cuspidata* 'Thayeri', a relatively fast growing selection. Two-year old cuttings were potted in April 1978 into 2-gallon rigid poly containers. The final set of data was evaluated in October 1980 following three additional growing seasons.

The light treatments consisted of full sun and 50% shade under lath, except during the period of November-April when they were all overwintered in a quonset house covered with single layer white polyethylene.

The media consisted of either soil-peat-sand (1-1-1), a commercially used nursery mix at that time, and hardwood bark (100%). The plants were fertilized after potting with either a slow release formulation of Osmocote 18-6-12 (8-9 month formulation) or a soluble fertilizer marketed as Peters 20-20-20. The rates of fertilizer were computed to apply the equivalent of 0, ¼, ½ and 1 oz of actual nitrogen/sq ft.

The three longest shoots from each of the 10 plants in each treatment were harvested in October 1979 and October 1980, measured, and weighed. The means were separated and analyzed using Duncan's multiple range test at the 5% level. At the completion of the study, soil pH was measured along with foliar nitrogen and plant width.

RESULTS AND DISCUSSION

Mean shoot lengths in 1979 (Table 1) and 1980 (Table 2) were higher in plants produced in the shade than in sun by an average of 2 to 3 inches/shoot. Despite the improved drainage in the hardwood bark media, the *Taxus* shoot growth was significantly higher in the soil-peat-sand media. The most effective fertilizer treatment for mean shoot growth was the soluble fertilizer at the ¼ and ½ oz rates.

In general, the mean shoot dry weight was highest

TABLE 1.—Shoot Growth of Container Grown Taxus cuspidata **'Thayeri' Produced Under Various Light, Media, and Fertilizer Treatments in 1979.**

Treatment	Mean Shoot Length (inches)	Mean Shoot Dry Weight (grams)
Light		
Shade	13.31 a*	6.9 a
Sun	10.41 b	4.8 b
Media		
Soil-Peat-Sand	12.3 a	5.9 a
Hardwood bark	11.4 b	5.8 a
Fertilizer Method		
Soluble	14.4 a	7.5 a
Slow release	11.7 b	5.4 b
Fertilizer Rate		
1 oz N/sq ft	12.2 b	6.4 a
½ oz N/sq ft	13.4 a	6.5 a
¼ oz N/sq ft	13.5 a	6.5 a
0 N/sq ft	4.8 c	2.2 b

*Letters followed by dissimilar letters are significantly different according to Duncan's multiple range test at the 5% level.

[1]Professor and Technician, Dept. of Horticulture, The Ohio State University and Ohio Agricultural Research and Development Center.

TABLE 2.—Shoot Growth of Container Grown Taxus cuspidata **'Thayeri' Produced Under Various Light, Media, and Fertilizer Treatments in 1980.**

Treatment	Mean Shoot Length (inches)	Mean Shoot Dry Weight (grams)
Light		
Shade	15.4 a*	3.6 a
Sun	13.8 b	3.1 b
Media		
Soil-Peat-Sand	15.1 a	3.6 a
Hardwood bark	14.0 b	3.1 b
Fertilizer Method		
Soluble	17.3 a	4.2 a
Slow release	14.0 b	3.2 b
Fertilizer Rate		
1 oz N/sq ft	14.3 b	3.4 b
½ oz N/sq ft	16.3 a	4.0 a
¼ oz N/sq ft	16.3 a	3.7 ab
0	8.0 c	1.3 c

*Letters followed by dissimilar letters are significantly different according to Duncan's multiple range test at the 5% level.

in the plants in the same treatments as those producing optimum shoot length. The only exception was that in 1980 there were no differences in dry weight of growth between the three fertilizer treatments.

Generally, the foliar nitrogen level was higher in plants produced in the hardwood bark media and in the 1 oz and ½ oz fertilizer treatments (Table 3). The recommended level of nitrogen for *Taxus* is between 1.50% and 3.50% dry weight (6) and all but the non-fertilized and the ¼ oz shade-grown plants in soil-peat-sand were in that range.

At the conclusion of the study, the average pH of the unfertilized hardwood media was 7.2 and the soil-peat-sand 6.8 (Table 4). At increasing rates of fertilizer, the media pH decreased in both media. No attempts were made to control media pH during the study. However, the results of this 3-year study suggest that both media and fertilizer rate influence the pH.

TABLE 4.—The pH of Container Grown Taxus cuspidata **'Thayeri' Produced Under Various Media and Fertilizer Treatments.**

Treatment	pH — Fertilizer Rate: 1 oz	½ oz	¼ oz	0
Hardwood Bark	4.9	5.8	6.5	7.2
Soil-Peat-Sand	5.4	6.3	6.1	6.8

The plants were measured for width at the end of the third year and ranged between 14.5 and 15.9 inches. Almost all plants would be sold commercially as 12 to 15-inch plants, with a few in the 15 to 18-inch size. Without question, the darkest green foliage color was obtained in plants grown in shade, although this was not evaluated in this study.

SUMMARY

As a result of this research, nurserymen thinking of growing *Taxus* in containers would be advised to produce plants in shade, with a soluble fertilizer program at a rate equivalent to ½ oz of N/sq ft/yr.

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TABLE 3.—Nitrogen Levels of Taxus cuspidata **'Thayeri' Produced Under Various Light, Media, and Fertilizer Treatments Following Three Growing Seasons.**

Media	Treatments: Fertilizer	Rate/sq ft	Percent Nitrogen: Shade	Sun
Hardwood Bark	Soluble	1	2.20	2.27
Hardwood Bark	Soluble	½	2.54	1.88
Hardwood Bark	Soluble	¼	1.93	2.08
Hardwood Bark	Slow Release	1	2.81	2.82
Hardwood Bark	Slow Release	½	2.32	3.50
Hardwood Bark	Slow Release	¼	2.46	1.77
Hardwood Bark	Check	0	1.51	1.25
Soil-Peat-Sand	Soluble	1	1.92	1.94
Soil-Peat-Sand	Soluble	½	2.42	2.20
Soil-Peat-Sand	Soluble	¼	2.75	1.67
Soil-Peat-Sand	Slow Release	1	1.88	1.57
Soil-Peat-Sand	Slow Release	½	1.90	1.76
Soil-Peat-Sand	Slow Release	¼	1.31	1.74
Soil-Peat-Sand	Check	0	0.92	1.01

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A Comparison of Plant Growth in Poly Bags Produced on Capillary Irrigation

ELTON M. SMITH and SHARON A. TREASTER[1]

ABSTRACT

Growth of eight species of landscape plants produced in poly bag and rigid containers on capillary irrigation beds was compared. Plant growth in all three poly bags was superior to standard rigid containers with three species, while growth of the remaining five species was equal in poly pots to rigid containers. One brand of poly bag container weakened at the seam by the end of the growing season and is considered unacceptable for commercial nursery use.

INTRODUCTION

The standard container used in the U. S. for container grown nursery stock is made of rigid plastic, although some metal and a few composition containers are also used. However, in England, New Zealand, and Australia, containers made of poly bags are used extensively.

The major advantage of poly bags when compared to other types of containers is reduced cost. In addition, poly bags due to their flexibility can be spaced closer together, increasing efficiency of irrigation, fertilizer, and pesticide applications. Since the poly bag is not tapered, the base is wider resulting in greater stability and less time needed to re-set plants that have blown over. Additional advantages include reduced storage space, lower transportation charges, and fewer disposal problems.

Lack of readily available adapters for U. S. potting machines and retailer acceptance are the reasons poly bags are not extensively used in this country.

Research in the U. S. has shown that increases in plant growth in poly bags can be up to 15% greater than plants produced in rigid containers (1), while others have shown growth to be equal to or superior than that in rigid containers (3).

[1]Professor and Technician, Dept. of Horticulture, The Ohio State University and Ohio Agricultural Research and Development Center.

Another container production method common in Europe but not in the U. S. is capillary irrigation. Although initial establishment cost of capillary irrigation is higher than some other irrigation systems (2, 6), there are several advantages, including less water consumption, less water run-off, reduced potential for foliar diseases, and reduced operational costs. In addition, the more uniform media moisture content results in improved plant growth compared to other irrigation methods (4, 5).

The purpose of this research project was to compare the growth of several landscape plant species produced in several poly bag containers and rigid containers on capillary irrigation beds.

MATERIALS AND METHODS

Eight cultivars and species of landscape crops were planted into 1 gallon containers on May 9, 1980, into a pine bark mix distributed as Metro Mix 500. The plants included were: *Cotoneaster apiculata*—Cranberry Cotoneaster, *Cotoneaster dammeri* 'Royal Beauty'—Royal Beauty Cotoneaster, *Hedera helix*—English Ivy, *Juniperus horizontalis* 'Wiltoni'—Blue Rug Juniper, *Syringa vulgaris*—Common Lilac, *Thuja occidentalis* 'Techny'—Techny Arborvitae, *Viburnum rhytodopyhlloides* 'Willowwood'—Willowwood Viburnum, and *Weigela florida* 'Newport Red'—Newport Red Weigela.

The container treatments included the rigid Zarntainer No. 300 and black poly bags sold as Menne Pots (Menne Nursery Corp., North Tonawanda, N. Y.), Sure Grow pots (Cellu-Pak Converter of Virginia, Inc., Chalfont, Pa.), and a poly bag with a black inside and white outside, Max Gro (Co-Poly-Ex, Elgin, Ill.).

The plants were placed on Pellon capillary mats kept moist by irrigation through Chapin twin wall irrigation tubes controlled by a time clock and a so-

TABLE 1.—Growth of Landscape Plants Produced in Poly Bag Containers on Capillary Matting.

Plant	Rigid	Menne	Sure Gro	Max Gro
	Plant Growth (inches)			
	Container Type			
Royal Beauty Cotoneaster	14.7 c*	16.7 ab	17.3 a	16.0 b
Techny Arborvitae	11.7 a	11.8 a	12.1 a	12.0 a
Newport Red Weigela	23.4 ab	22.2 b	24.8 a	24.8 a
Blue Rug Juniper	13.7 b	14.7 a	14.4 ab	14.7 a
Common Lilac	16.3 a	18.1 a	17.2 a	17.7 a
Willowwood Viburnum	35.7 a	37.7 a	37.9 a	36.9 a
Cranberry Cotoneaster	23.9 b	27.5 ab	29.2 a	29.2 a
English Ivy	44.8 a	44.7 a	49.6 a	48.9 a

*Values for a given plant with the same letter are not significantly different at the 5% level according to Duncan's multiple range test.

lenoid valve. The experiment was conducted in a commercial nursery in central Ohio with plants placed on the mat May 28 and maintained under nursery conditions with routine spraying and pruning. The pruning tended to reduce the growth differences between treatments. A randomized block design was used with three 10-plant replications.

Plant height or width was measured August 30, 1980. Means were separated by Duncan's multiple range test.

RESULTS AND DISCUSSION

The growing season from June through August 1980 was favorable with ample rainfall, and the plants were not irrigated from overhead after the initial watering to initiate capillary action with the mat.

As shown in Table 1, plant growth was significantly greater in poly bag containers in three species, including Royal Beauty Cotoneaster, Cranberry Cotoneaster, and Blue Rug Juniper. In nearly all other treatments, plant growth in poly bag containers was equivalent to growth in rigid cans.

Plant growth was very similar between the various bag containers with two exceptions. Growth of weigela in the Menne Pot was less than in other treatments and growth of Royal Beauty Cotoneaster in the Max Gro containers was less than in other containers.

The physical characteristics including color, thickness, and dimensions of the Menne and Sure Gro containers were similar and, in fact, difficult to differentiate. There were no limiting factors to handling or storage properties of either of these containers. Both of these containers would be suitable for commercial nursery use in Ohio. The Max Gro containers with the white outside color and black inside had a vertical seam and in many instances by late in the growing season the seams often weakened and the pots split along the seam. Continued splitting occurred when plants were moved for winter storage. This fault is serious enough to caution commercial growers relative to their use, although the company is developing an improved container that should correct this drawback.

SUMMARY

Although neither capillary mat irrigation nor poly bag pots are in general nursery use in the U. S., it would appear from this evaluation that plant growth is very satisfactory and commercial trials should be undertaken with poly bag containers on capillary irrigation.

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Sodium Chloride Phytotoxicity to Sugar Maple

ELTON M. SMITH and SHARON A. TREASTER[1]

ABSTRACT

Sodium chloride was applied over a 3-year period under 10-year-old Sugar Maple trees isolated from highways to correlate foliar injury with known rates of application to the soil surface. Increasing foliar necrosis and defoliation were detected with increasing rates and time. The most severe phytotoxicity was observed at foliar sodium levels of 82-452 ppm, which corresponded to sodium chloride treatments of 8-20 lb/100 sq ft.

INTRODUCTION

Sugar Maple, *Acer saccharum,* is an excellent landscape tree for planting in Ohio. However, the usefulness of Sugar Maple planted along streets is limited due to its habit of developing leaf necrosis beginning in early to mid-summer and continuing throughout summer and autumn. In many instances, the condition is related to stress from lack of adequate soil moisture. However, in certain situations de-icing salts may be a significant contributor to the necrosis and early leaf defoliation. Sugar Maple has been reported to be intolerant to salt (5).

Sodium chloride (NaCl), the most commonly used salt for de-icing streets, may affect plant growth by: 1) increasing osmotic pressure differences and causing desiccation, 2) accumulating specific ions in toxic concentrations within plant tissues, and 3) altering mineral nutritional balances (3). High salt concentrations are manifested in Sugar Maple as marginal necrosis, small or pale green leaves, premature defoliation, and terminal twig dieback which leads to tree decline (6). Not everyone agrees that winter applications of roadside salt contribute to Sugar Maple damage (2), even though most evidence supports this claim (1, 3, 4, 5, 6).

Salt damage symptoms of Sugar Maple have been correlated with foliar sodium levels of 100 ppm in Minnesota (5), from 327-732 ppm in New Hampshire (4), and 600 ppm from a 3,000 lb/A treatment in Virginia (1).

The majority of the salt research reported above with Sugar Maple has been conducted by evaluating declining trees along highways following severe winter damage. The objective of this research project with healthy trees isolated away from highway salt application was to determine the degree of foliage injury with known rates of sodium chloride application to the soil surface over a 3-year period.

MATERIALS AND METHODS

Sodium chloride, the most commonly used salt form for de-icing highways, was applied at six rates to 10-year old *Acer saccharum* (Sugar Maple) trees at the USDA Laboratory in Delaware, Ohio. Sodium chloride was applied at the following rates:

0 lb/100 sq ft or 0 lb/acre
2 lb/100 sq ft or 880 lb/acre
4 lb/100 sq ft or 1760 lb/acre
8 lb/100 sq ft or 3520 lb/acre
12 lb/100 sq ft or 5280 lb/acre
16 lb/100 sq ft or 7040 lb/acre
20 lb/100 sq ft or 8800 lb/acre

Salt was applied with a rotary spreader over a circular area representing 100 sq ft beneath each tree. A completely random design with three two-tree replications was utilized. Salt was applied Feb. 9, 1977, March 16, 1978, and March 3, 1979. Trees were evaluated Sept. 2, 1977, Sept. 6, 1978, and August 22, 1979. Trees were visually scored for percentage of tree canopy showing some degree of necrosis. Foliage sodium levels were determined only for the August 22, 1979, evaluation.

RESULTS AND DISCUSSION

The first symptoms expressed with NaCl induced damage were yellowish and smaller than normal leaves. The most common symptom was marginal browning or necrosis beginning at the leaf edge and tip, with irregular necrotic spots developing between the veins. In the high treatment rates, the necrotic spots were dark to almost blackish brown. Defoliation was noted in the highest treatment rates.

In order to visually evaluate the treatments, the percentage of the tree canopy with foliage exhibiting marginal necrosis was estimated (Table 1). Leaf damage occurred all 3 years and increased with increasing NaCl rate. More severe necrosis was noted the second and third years, particularly in the 16 and 20 lb/100 sq ft treatments. Defoliation occurred the second and third years in the 20 lb treatment. Branch tip dieback was severe on one tree in 1979. The 20 lb NaCl/100 sq ft rate, equivalent to nearly 4.5 tons of salt/A, is more than double the amount found damaging in the Virginia studies.

There was no significant difference in foliar sodium content between the control, 2, and 4 lb treat-

[1]Professor and Technician, Dept. of Horticulture, The Ohio State University and Ohio Agricultural Research and Development Center.

TABLE 1.—Incidence of Marginal Necrosis of Sugar Maple from NaCl Treatments Over a 3-Year Period.

NaCl Treatment (lb/100 sq ft)	Year	No Injury	Canopy Phytotoxicity Percent of Tree with Marginal Necrosis* 0-33%	33-67%	67-100%†
	77	6	0	0	0
0	78	6	0	0	0
	79	6	0	0	0
	77	4	2	0	0
2	78	3	3	0	0
	79	5	1	0	0
	77	2	4	0	0
4	78	1	5	0	0
	79	4	2	0	0
	77	1	5	0	0
8	78	2	4	0	0
	79	2	3	1	0
	77	2	4	0	0
12	78	0	5	1	0
	79	1	3	2	0
	77	1	5	0	0
16	78	1	3	2	0
	79	1	1	4	0
	77	1	5	0	0
20	78	1	2	2	1
	79	1	2	1	2

*Figures represent actual numbers of trees showing symptoms.
†Some defoliation present.

ments (Table 1). However, when the treatment rate was increased to 8 and 12 lb or 3,520 and 5,280 lb/A, the sodium levels in the foliage were 82 and 100 ppm. Increasing the rate to 7,040 and 8,800 lb/A resulted in levels of 415 and 452 ppm sodium in the foliage. Levels of 100 ppm sodium and above have been correlated to plant injury by other investigators (1, 4, 5), but in this study plant injury was evident in all treatments, with foliar phytotoxicity occurring at 82 ppm and increasing in severity to 452 ppm.

TABLE 2.—Average Foliar Sodium Levels of *Acer saccharum* **Following 3 Years of Annual NaCl Application.**

Treatment (lb/100 sq ft)	Sodium Content (ppm)
0	15.12 a*
2	13.18 a
4	17.44 a
8	82.14 b
12	100.61 b
16	415.24 c
20	452.45 c

*Mean separation by Duncan's multiple range test, 5% level.

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Effects of Fertilizer in the Propagation Medium and Extended Photoperiod on Rooting of *Acer rubrum* 'Red Sunset'

STEVEN M. STILL and BRYCE H. LANE[1]

ABSTRACT

Terminal unbranched *Acer rubrum* L. 'Red Sunset' cuttings were taken on June 16, July 23, and August 28, 1980. Plants were treated with either a 4-hour extended or natural photoperiod. Fertilizer treatments consisted of a slow release fertilizer (18-6-12, 5.4 kg/m^3) amended medium, a 20-20-20 (200 ppm N) liquid fertilizer applied to the medium, or a control medium containing no fertilizer. Cuttings had higher rooting percentages when propagated in June or July under an extended photoperiod, regardless of fertility. Data indicate that supplemental lighting affects rooting response, while the presence of fertilizer in the rooting medium affects root volume provided supplemental lighting is applied.

INTRODUCTION

Budding *Acer rubrum* cultivars onto seedling understock of the same species has recently come under review due to higher than normal percentage of graft incompatibility problems. Schwab (9) reported losses of 50% the first year after budding and an additional 10 to 20% during the second growing season. Losses continue to occur in subsequent years at decreasing rates. These losses necessitate that an alternative vegetative propagation method be developed.

Acer rubrum softwood cuttings have been successfully rooted and various cutting dates have been attempted (1, 8, 9). Several nurseries in Oregon are propagating red maple by softwood cuttings. However, the cost of these plants for midwestern nurseries is still high. If *Acer rubrum* cultivars could successfully be propagated by softwood cuttings and quickly grown to field size in the Midwest, graft incompatibility and subsequent high cost of West Coast liner production might be eliminated. Consequently, it is important to develop a propagation-production program for *Acer rubrum* in the Midwest.

Supplemental lighting (6, 7, 8, 13) applied to softwood cuttings and nutrients applied to the propagation medium (4, 5, 10, 15) are two possible methods for increasing rooting of *Acer rubrum* cuttings. Nutrient mist has reduced nutrient loss from the plants and increased rooting percentage and root quality (3, 13, 15). However, nutrient mist encourages surface algae growth which may reduce aeration and drainage (2). To overcome possible algae problems and still obtain increased root growth from added nutrients, additions of Osmocote or other slow release fertilizers have been researched (3, 4, 5, 11, 12, 18). Since there is little research on the effects of fertilizer application on propagation of deciduous shade tree cuttings, it is important to determine this response on cuttings of red maple.

Extended photoperiods have promoted rooting of many woody plants (6, 7, 8, 13). Long days during rooting decreased the time to root initiation and/or increased the volume of root system development.

The objectives of this study were to determine: 1) the optimum time to take *Acer rubrum* 'Red Sunset' cuttings, 2) the effect(s) of fertilizers applied to the medium during rooting, and 3) the effect of supplemental lighting on rooting.

MATERIALS AND METHODS

Terminal cuttings were taken from 6 cm caliper nursery grown trees on June 16, July 23, and August 28, 1980. The terminal bud and first node of each cutting were removed, the base was wounded on two sides below each axillary bud, and the basal 4 cm was dipped in a 6,000 ppm idolebutyric acid (IBA) (50% water/50% ethyl alcohol) solution for 5 sec. Each cutting was stuck in a separate 0.3 liter container filled with 3:1 (by vol.) perlite/peat rooting medium. Overhead mist was set up to give 6 sec mist every 3 min from 8:00 a.m. to 7:30 p.m. One-half of the cuttings received natural light and the remaining plants received 4 hours (10:00 p.m. to 2:00 a.m.) of 75 watt supplementary incandescent light. Incandescent bulbs were placed 1 m apart and 1 m above the propagation bench to give a light intensity of approximately 20 foot candles (215 lux) at cutting height.

Within a photoperiod treatment, cuttings were rooted in one of the following media: 1) slow release fertilizer [Osmocote 18-6-12 (9 month formulation)] incorporated in the medium at a rate of 5.4 kg/m^3 1 week before cuttings were stuck; 2) liquid fertilizer [Peter's 20-20-20 (200 ppm N)] applied to the medium after rooting began, then applied at 3-day intervals; 3) no fertilizer (control medium). A randomized complete block design was used, with seven

[1]Associate Professor and Research Associate, Dept. of Horticulture, The Ohio State University and Ohio Agricultural Research and Development Center. Mr. Lane is now an Instructor of Horticulture, North Carolina State University, Raleigh.

five-plant replications. After a 5-week rooting period, cuttings were harvested and percent rooting, root dry weights, percent bud break, and shoot length were recorded.

RESULTS AND DISCUSSION

Extended photoperiod alone had a positive effect on rooting for cuttings taken June 16 (Table 1, Fig. 1). Both the control and slow release fertilizer treatments rooted significantly better under an extended photoperiod than those treatments under natural light. There were no differences among fertility treatments within each photoperiod regime.

June 16 cuttings rooted in the slow release fertilizer or control medium under an extended photoperiod had a significantly greater mean root dry weight than cuttings rooted in the same amended medium but under natural light (Table 1, Fig. 1). In addition, cuttings rooted in slow release fertilizer amended medium had significantly greater root weights than cuttings in the control medium under the same photoperiod. The increased root volume might be due to earlier rooting. Cuttings receiving slow release fertilizer in addition to a long photoperiod would have longer periods of time for growth, with a continuous supply of nutrients available as well. Within the extended photoperiod regime, cuttings rooted in slow release fertilizer treated medium had a significantly greater mean root dry weight than cuttings receiving different fertility treatments (Table 1). However, within the natural light regime, there were no significant differences due to fertility treatment.

Many of the cuttings taken on June 16 had new shoots before removal from the propagation area. Cuttings that received the slow release fertilizer and rooted under the extended photoperiod treatments had a significantly greater mean percent of new vegetative shoots than any of the other fertility-photoperiod treatments (Table 1). Within the natural light regime, fertility had no effect on percent vegetative shoot growth. The combination of slow release fertilizer and supplemental light appears to be important in order to achieve optimal shoot growth for June cuttings.

Average new shoot length in the cutting bench followed the same trends as the percentage of new shoots. Cuttings receiving a treatment combination

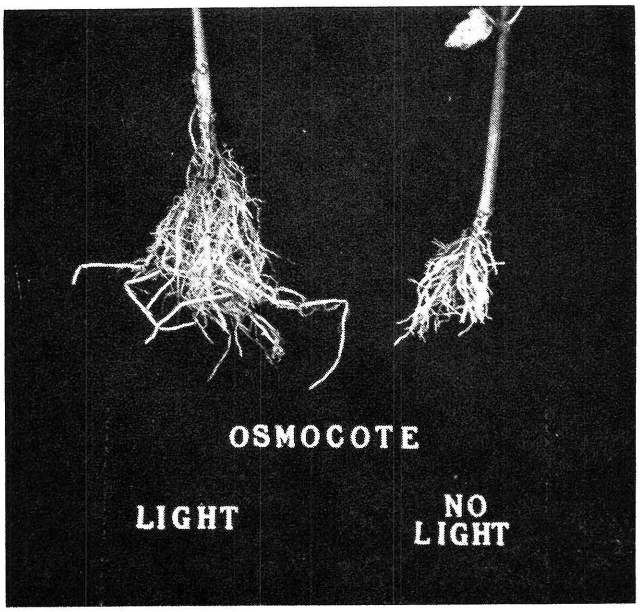

FIG. 1.—June rooted *Acer rubrum* **'Red Sunset' cuttings in a slow release fertilizer amended medium, under an extended photoperiod (light), or under a natural photoperiod (no light) after 5 weeks in propagation bench.**

TABLE 1.—Effects of Fertility-Photoperiod Treatments on Mean Rooting Percent, Root Dry Weight, Percent New Shoots, and Shoot Length of *Acer rubrum* **'Red Sunset' Cuttings Propagated June 16, July 23, and August 28, 1980.**

Treatment	June 16 Rooting (%)	June 16 Root Wt. (g)	June 16 New Shoot (%)	June 16 Shoot Length (mm)	July 23† Rooting (%)	July 23† Root Wt. (g)	August 28† Rooting (%)	August 28† Root Wt. (g)
Extended Photoperiod 4 hours light (10 p.m.-2 a.m.)								
Slow release fertilizer	91.4 a*	2.93 a	51.4 a	20.57 a	91.4 a	1.82 a	54.2 a	0.46 a
Liquid fertilizer	82.8 ab	1.84 bc	20.0 b	3.57 b	88.4 a	1.23 bc	60.0 a	0.38 a
Control	94.3 a	1.90 b	11.4 b	5.40 b	82.8 ab	0.89 bcd	48.4 a	0.31 ab
Natural Photoperiod								
Slow release fertilizer	60.0 c	1.49 bc	20.0 b	5.20 b	57.2 c	1.32 b	25.7 b	0.27 ab
Liquid fertilizer	74.3 bc	1.13 bc	8.6 b	1.30 b	74.2 abc	0.80 abc	20.0 b	0.13 b
Control	57.1 c	0.93 c	5.7 b	1.14 b	65.6 bc	0.62 d	25.7 b	0.11 b

*Mean separation in columns by Duncan's multiple range test, 5 % level. Values with the same letters are not significantly different.
†No shoot growth was observed for cuttings taken on July 23 or August 28.

TABLE 2.—Effects of Cutting Date on Mean Rooting Percent and Root Dry Weight for Fertility-Photoperiod Treatments on Cuttings of Acer rubrum **'Red Sunset'.**

	Extended Photoperiod			Natural Photoperiod		
Cutting Date	Slow Release Fertilizer	Liquid Fertilizer	Control	Slow Release Fertilizer	Liquid Fertilizer	Control
June 16						
Percent Rooting	91.4 a*	82.8 a	94.3 a	60.0 a	74.3 a	57.1 a
Root Dry Wt. (g)	2.93 a	1.84 a	1.90 a	1.49 a	1.13 a	0.93 a
July 23						
Percent Rooting	91.4 a	88.4 a	82.8 a	57.2 a	74.2 a	65.6 a
Root Dry Wt.	1.82 b	1.24 a	0.89 b	1.32 a	0.80 a	0.62 ab
August 28						
Percent Rooting	54.2 b	60.0 b	48.4 b	25.7 b	20.0 a	25.7 a
Root Dry Wt. (g)	0.46 c	0.38 b	0.31 b	0.27 b	0.13 b	0.11 b

*Mean separation in columns by Duncan's multiple range test, 5 % level.

of slow release fertilizer and supplemental lighting had the longest average shoot growth.

Cuttings taken on July 23 had similar rooting percentages when rooted in the same photoperiod treatment (Table 1). For this date, the cuttings rooted in the slow release fertilizer amended medium and under the extended photoperiod treatment had significantly greater rooting percentages than cuttings rooted in the same fertility but under natural light. However, unlike the first experiment, photoperiod didn't affect rooting of cuttings propagated in the control medium. In general, rooting percentages were not affected by either cutting date, but root weights were higher for cuttings taken in June when treated with an extended photoperiod or an extended photoperiod plus slow release fertilizer incorporation (Table 2). No new shoots occurred on cuttings from the July cutting date.

Results of the August 28 cutting date were similar to the first two sampling periods. There were no differences due to fertility within photoperiods, but cuttings that received an extended photoperiod had significantly greater rooting percentages than cuttings rooted under natural light at corresponding fertility levels (Table 1). The use of an extended photoperiod treatment in late August significantly increased rooting percent, but increased fertility in the rooting medium was not beneficial. In general, rooting percentages for all six treatments were significantly less than percentages observed for the first two cutting dates (Table 2). The lower rooting percentages can be explained by the late cutting date. Shoots of stock plants had hardened substantially and terminal buds were formed. These conditions will often lower the rooting percentage.

Except for control plants rooted in both photoperiods, August cuttings showed significantly lower root weights than the previous two cutting dates (Table 2).

SUMMARY

These data indicate that to maximize rooting percentages and stimulate the most root and shoot growth while plants are still under mist, propagation of *Acer rubrum* 'Red Sunset' cuttings should be done in June under an extended photoperiod in a rooting medium amended with slow release fertilizer.

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Comparisons of Growth for Chrysanthemums and Poinsettias Produced in Prototypes of a New Container and Four Potting Media

RICHARD P. VENTANOVETZ and JOHN C. PETERSON[1]

ABSTRACT

Growth of 'Bright Golden Anne' chrysanthemum and 'Annette Hegg Dark Red' poinsettia was compared among plants grown in 16.5 cm conventional plastic pots and prototypes of a new plastic pot (U. S. patent No. 4,173,097). Plants were grown in pots of each type containing 2:1:1 (soil:peat:perlite), 1:1:1 (soil:peat:perlite), Paygro 522, and Metro Mix 500 or 350. At anthesis, flower or bract diameter, inflorescence number, leaf area, shoot fresh and dry weight, root dry weight, and plant height were measured.

Findings showed all parameters except inflorescence number and root dry weight were significantly greater for plants grown in conventional pots. Potting media significantly influenced leaf area, shoot fresh and dry weight, and root dry weight for both plant species. Media also influenced flower diameter and plant height of chrysanthemum.

Findings differed when chrysanthemum plants were grown on a subirrigation capillary mat system. In this case, plants grown in conventional pots had a smaller number of flowers than plants grown in the new pot. There were no significant differences for other parameters measured when subirrigation was used. Differences between pots in previously mentioned studies may have been the result of water stress.

INTRODUCTION

Oxygen is essential for growth and the proper functioning of plant roots (1, 2, 3, 4). An important feature of any potting medium is that it have sufficient pore space to permit oxygen diffusion to roots (2). Since air diffusion takes place more readily nearer to the walls of a pot, root growth tends to predominate in this region (4). Fewer roots are found in interior regions of the potting medium mass within conventional growing containers.

A new growing container (U. S. patent No. 4,173,097) was designed to facilitate increased drainage and oxygen exchange within interior regions of the potting medium mass. The newly designed pot has four protusions which extend upward from the bottom of the pot. These protrusions extend into the lower one-half of the medium contained within the pot. The exterior shape and size of the new pots is similar to a conventional 16.5 cm round plastic pot.

The objective of this study was to compare growth of plants produced in prototypes of the new pot and conventional pots using four different potting media.

MATERIALS AND METHODS

Three experiments were conducted, one in which 'Annette Hegg Dark Red' poinsettia was studied and two experiments in which 'Bright Golden Anne' chrysanthemums were used.

A 2 x 4 factorial design was utilized. In each experiment, two pots and four media were examined.

The potting media used in the poinsettia study included 1:1:1 (soil:peat:perlite), 2:1:1 (soil:peat: perlite), Paygro 522 (hardwood bark:peat:styro-

[1]Graduate Research Associate and Assistant Professor, Dept. of Horticulture, The Ohio State University and Ohio Agricultural Research and Development Center.

foam), and Metro Mix 500 (peat:sand:vermiculite: processed and compost pinebark). In both chrysanthemum experiments, Metro Mix 350 (peat:vermiculite:sand:processed bark) was substituted for Metro Mix 500.

The poinsettia study commenced on Sept. 25, 1980, and terminated Jan. 17, 1981. One cutting was planted in each pot and a typical production program was followed for the production of pinched multibranched poinsettias.

The first chrysanthemum study began on Oct. 17, 1980, and data were collected on Jan. 6, 1981. The second chrysanthemum study was started on April 16, 1981, and data were recorded on July 6, 1981. In both chrysanthemum studies, five cuttings were planted in each pot and a typical 10-week tall variety production schedule was followed. The second chrysanthemum experiment differed from the first in the methods used for providing water and fertilizer. Water was supplied overhead to the soil surface in the first experiment. In the second study, water was supplied by subirrigation with a capillary mat system and plants were fertilized overhead with 300 ppm of 15-15-15 once every 5 days.

Data were collected at anthesis. Measurements included bract or flower diameter, inflorescence number, leaf area, height, shoot fresh and dry weight, and root dry weight.

RESULTS AND DISCUSSION

In this research, potting media had the greatest impact upon growth and development. Data for the poinsettia experiment (Table 1) indicate that growth (height, leaf area, shoot fresh and dry weight, and root dry weight) in Paygro 522 and Metro Mix 500 was very similar. Overall, growth was greater for these potting media than the 1:1:1 or 2:1:1 media. In the first chrysanthemum experiment (Table 3), growth parameters were the greatest for Paygro 522 medium. The smallest values were obtained from plants grown in 1:1:1 medium, with intermediate values for Metro Mix 350 and 2:1:1 media.

Growth data between pots for both the poinsettia (Table 2) and first chrysanthemum (Table 4) experiment were similar. All parameters measured, except inflorescence number and root dry weight, were greater for plants of both species grown in conventional pots. There were no inflorescence number and root dry weight differences between pots.

Lack of inflorescence number differences indicates that pot type did not influence flower bud initiation and development. Similarities in root growth,

TABLE 1.—Effects of Potting Media on Growth of Poinsettia cv. 'Annette Hegg Dark Red'.*

Medium	Height	Bract Diameter	Inflorescence Number	Leaf Area	Shoot Fresh Weight	Shoot Dry Weight	Root Dry Weight
2:1:1	25.5 a	25.4 a	6.1 a	1809 c	137 b	20.5 b	8.6 ab
1:1:1	27.5 ab	25.6 a	6.1 a	1982 bc	150 b	24.5 a	8.1 b
Metro Mix 500	28.8 ab	26.3 a	6.1 a	2264 ab	167 a	27.5 a	7.4 b
Paygro 522	29.3 a	25.9 a	5.9 b	2361 a	168 a	27.9 a	10.1 a

*Mean separation by column, Duncan's multiple range test, 5 % level.

TABLE 2.—Effects of Pot Type on Growth of Poinsettia cv. 'Annette Hegg Dark Red'.*

Pot Type	Height	Bract Diameter	Inflorescence Number	Leaf Area	Shoot Fresh Weight	Shoot Dry Weight	Root Dry Weight
Prototype	26.5 b	25.2 b	6.1 a	1952 b	146 b	23.2 b	8.4 a
Conventional	29.0 a	26.4 a	6.1 a	2247 a	165 a	27.0 a	8.7 a

*Mean separation by column, Duncan's multiple range test, 5 % level.

TABLE 3.—Effects of Potting Media on Growth of Chrysanthemum cv. 'Bright Golden Anne'.*

Medium	Height	Flower Diameter	Inflorescence Number	Leaf Area	Shoot Fresh Weight	Shoot Dry Weight	Root Dry Weight
2:1:1	26.1 c	11.2 a	14.2 a	2794 b	239 b	20.5 c	33.2 b
1:1:1	27.9 bc	10.5 b	14.3 a	2281 c	228 b	22.0 b	15.5 c
Metro Mix 350	29.7 ab	10.9 a	13.9 a	2835 b	239 b	22.6 ab	14.0 c
Paygro 522	29.9 a	10.6 b	14.0 a	3170 a	292 a	23.8 a	63.0 a

*Mean separation by column, Duncan's multiple range test, 5 % level.

TABLE 4.—Effects of Pot Type on Growth of Chrysanthemum cv. 'Bright Golden Anne'.*

Pot Type	Height	Flower Diameter	Inflorescence Number	Leaf Area	Shoot Fresh Weight	Shoot Dry Weight	Root Dry Weight
Prototype	28.1 a	10.7 b	14.2 a	2875 a	238 b	21.6 b	27.2 a
Conventional	28.7 a	11.0 a	14.0 a	2665 a	261 a	22.8 a	35.6 a

*Mean separation by column, Duncan's multiple range test, 5% level.

TABLE 5.—Effects of Potting Media on Growth of Chrysanthemum cv. 'Bright Golden Anne' Grown on Capillary Mats.

Medium	Height	Flower Diameter	Inflorescence Number	Leaf Area	Shoot Fresh Weight	Shoot Dry Weight
2:1:1	32.8 bc	11.2 a	15.7 a	3162 bc	377.8 a	57.2 a
1:1:1	33.6 ab	11.0 a	15.8 a	3326 b	375.4 a	55.9 a
Metro Mix 350	35.3 a	11.7 a	15.7 a	3782 a	430.4 a	65.3 a
Paygro 522	31.3 c	11.8 a	15.8 a	2924 c	364.6 a	52.9 a

*Mean separation by column, Duncan's multiple range test, 5% level.

TABLE 6.—Effects of Pot Type on Growth of Chrysanthemum cv. 'Bright Golden Anne' Grown on Capillary Mats.

Pot Type	Height	Flower Diameter	Inflorescence Number	Leaf Area	Shoot Fresh Weight	Shoot Dry Weight
Prototype	33.0 a	11.6 a	16.2 a	3168 a	390 a	61.4 a
Conventional	33.5 a	11.2 a	15.3 b	3434 a	382 a	54.1 a

*Mean separation by column, Duncan's multiple range test, 5% level.

based upon root dry weight values, seem meaningful since the new pots contained 20% less soil than conventional pots. The upward protrusions in the bottom of new pots accounted for potting medium volume differences. The lack of root dry weight differences between pots, despite potting medium volume differences, suggests root growth was enhanced by the new pot design.

The fact that parameter measurements for the shoots and flowers of the plant were smaller for plants grown in the new pot is very important, since sales of floral crops are directly related to the size and quality of flowers, stems, and leaves.

Since the new pots contained less potting medium than conventional pots and as a result held less water, plants growing in the new pot may have been exposed to water stress conditions more often than plants growing in conventional pots. No conscious effort was made in either previous experiment to compensate for differences in water holding capacity of each pot.

In an effort to compare plant growth in both pots under conditions where moisture availability was not a factor, a second chrysanthemum experiment was conducted.

All treatments and procedures were the same as in the first experiment except for watering and fertilization techniques as previously described.

Again, as in the previous experiment, potting media had the greatest influence upon growth and development (Table 5). Differences for flower diameter, shoot fresh weight, and shoot dry weight were not statistically different, owing to what seemed to be great variability among plants. Plant height and leaf area were significantly different among potting media.

Considering the height and leaf area differences, the apparent trends for flower diameter, and shoot fresh weight and shoot dry weight, the greatest growth was obtained in the Metro Mix 350. Parameters for Paygro 522, 2:1:1, and 1:1:1 were somewhat similar. These findings were different compared to the previous chrysanthemum experiment.

Growth in the conventional pot was not significantly greater as was previously seen. As suspected, water stress may have been a problem but in spite of measures to compensate for this, plant growth in the new pot was not enhanced dramatically. No differences were found among plant growth parameters for both pot types, except for inflorescence number. Conventional pots had approximately one less flower per pot.

SUMMARY

Results of all experiments indicate that with respect to growth and development, there are no significant advantages of producing poinsettia and chrysanthemum plants in the new pot, as compared to a conventional pot of similar diameter. Consideration might posssibly be given to the fact that 20% less soil is contained in the new pot. This may be an important cost consideration for some floral crop producers. Also, other potential advantages of the new pot such as postharvest and root disease suppression characteristics should be evaluated.

Finally, it is most important to note that potting media had a very significant impact upon the growth and development of both crops studied. From a practical point of view, this emphasizes the need for a floral crop producer to carefully select the meduim used for the production of crops. Efforts should undoubtedly be made to characterize the physical and chemical properties of potting media which optimize floral crop growth, development, and quality.

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Effects of pH Upon Nutrient Availability in a Commercial Soilless Root Medium Utilized for Floral Crop Production

JOHN C. PETERSON[1]

ABSTRACT

Availability of ten plant nutrients in a high organic commercial soilless medium (W. R. Grace Metro Mix 300) was quantified at seven pH levels. Results indicate the optimum pH range for nutrient availability, a range of compromise for nutrients which become more or less available as pH is altered, was 5.2 to 5.5. This range is a whole pH unit or more lower than the optimum pH characterized for mineral field soil. Findings suggest that cultural recommendations and production techniques based upon the relationship between pH and nutrient availability in mineral field soil may need to be modified for production of floral crops in this and other organic root media.

INTRODUCTION

The composition of root media utilized for floral crop production has changed dramatically in recent years. Production techniques have shifted from the use of mineral field soil to organic media composed primarily of peatmoss, pinebark, and/or hardwood bark. In short, there has been a shift from soil to soilless media (1, 3, 5, 7, 9, 12, 13, 15, 19).

Despite significant modifications in root media composition, many of the fundamental concepts of soil chemistry used to develop cultural recommendations and production techniques continue to be based upon research conducted with mineral field soil. One concept in particular relates to the influences of pH upon availability of plant nutrients in root media.

pH is the negative log of the hydrogen ion concentration. It quantitatively describes the acidity or basicity of a substance. The pH scale covers a range from 1 to 14, with 1 representing a neutral value. The portion of the range from 7 to 1 represents an increasing acidity, and from 7 to 14 indicates an increasing alkalinity (2, 4, 10).

Research has demonstrated that pH greatly influences the availability of elements in root media. As pH changes, some elements become more available while others become less available (4, 10, 18, 21).

The optimum pH range for soil has generally been accepted as 6.5 to 6.8. Consequently, floral crop production efforts are usually directed towards establishing and maintaining root medium pH in this range (7, 11, 12, 16, 17).

This optimum pH range was identified from research conducted with mineral field soil (1, 2). As seen in Figure 1, pH values from 6.5 to 6.8 are a range between which a compromise in availability was evident for those elements which become more available with increasing pH and those that increase in availability with decreasing pH (18).

It is interesting to note that research has also been conducted in which investigators evaluated nutrient availability in an organic field soil (14). The organic field soil used by researchers for this study is often referred to as a muck peat and is comprised of highly decomposed organic matter. The findings of this work are represented in Figure 2 and indicate that the optimum pH range for this organic field soil, a compromise region for those elements available at higher pH values and those more available at lower pH values, is about 5.5 to 5.8. This range is 1 full pH unit lower than that identified for a mineral field soil.

This information has stimulated questions about the optimum pH range for producing floral crops in soilless media, composed principally of organic substances and containing no mineral field soil.

In an effort to explore the relationship between pH and nutrient availability in a soilless medium, typical of that used for producing floral crops, the following research was conducted.

MATERIALS AND METHODS

A widely used commercial soilless potting medium, Metro Mix 300 (a product of the W. R. Grace Co.), was supplied by the manufacturer. This medium contains spagnum peat moss, vermiculite, perlite, granite sand, and composted pine bark (exact proportion of components is proprietary information not available for publication). This medium was specially prepared so as not to contain any of the normally incorporated nutrient additives.

First, this medium was amended with potassium nitrate (770 g/m^3), ammonium nitrate (367 g/m^3), pulverized treble phosphate (0-44-0, 770 g/m^3) and Peters soluble trace element mix (72 g/m^3). Care

[1]Assistant Professor, Dept. of Horticulture, The Ohio State University and Ohio Agricultural Research and Development Center.

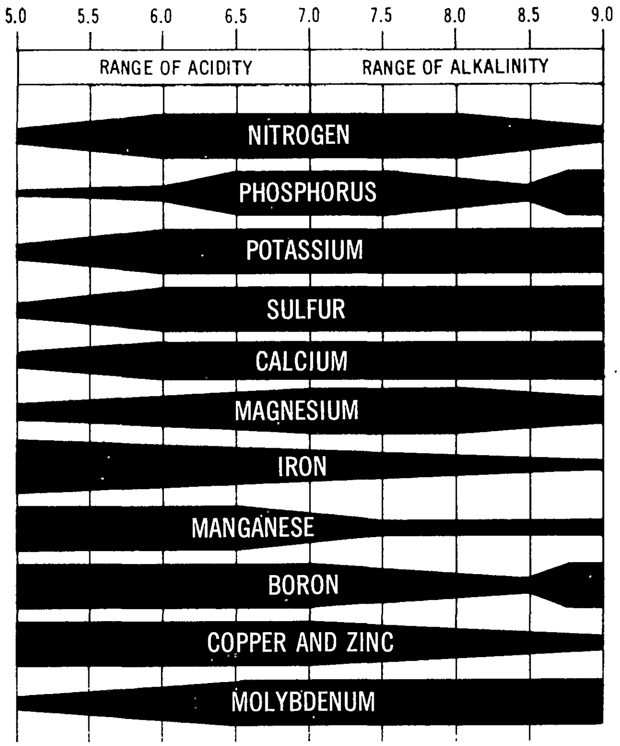

FIG. 1.—Availability of plant nutrients at different pH levels for a mineral soil (18).

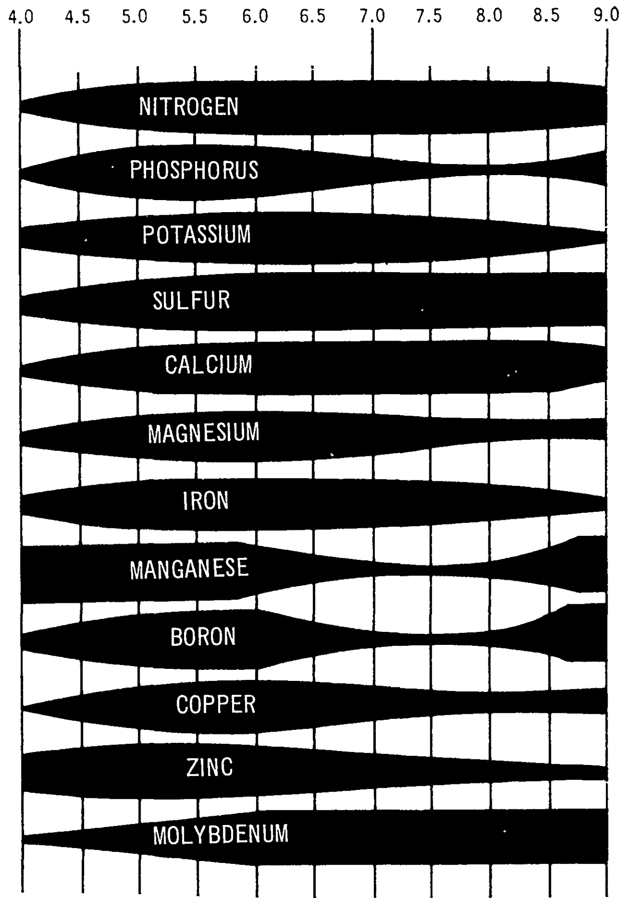

FIG. 2.—Availability of plant nutrients at different pH levels for an organic field soil (14).

was taken to assure uniform distribution of amendments within the medium.

Next, the medium was divided into seven treatment batches and amended with iron sulfate [$FeSO_4$] or calcium hydroxide [$Ca(OH)_2$] at one of the following rates: 1) $FeSO_4$, 10.84 kg/m^3; 2) $Ca(OH)_2$, 2.81 kg/m^3; 3) $Ca(OH)_2$, 4.46 kg/m^3; 4) $Ca(OH)_2$, 6.70 kg/m^3; 5) $Ca(OH)_2$, 8.91 kg/m^3; 6) $Ca(OH)_2$, 17.82 kg/m^3; or 7) $Ca(OH)_2$, 35.64 kg/m^3.

Medium from each treatment batch was then placed in 15.2 cm plastic pots, saturated with distilled water with no leaching permitted, then placed in flats with the exposed surface covered with plastic film to minimize evaporative moisture loss and incubated at 21° C (70° F).

After 4 weeks, five pots from each treatment batch were removed and the medium in each pot analyzed for pH, soluble salts, nitrate nitrogen, phosphorus, potassium, calcium, magnesium, iron, manganese, boron, zinc, and copper.

Analysis samples were prepared using the saturated soil extract method (1). Measurements of pH were made on the medium/distilled water mixture and the extracted solution was analyzed with a conductivity meter, nitrate electrode, and inductively coupled plasma spectrograph to quantify the other parameters measured.

RESULTS AND DISCUSSION

Amendment with iron sulfate or calcium hydroxide enabled us to examine nutrient availability over a pH range from 4.32 to 7.83 (Table 1). Results indicate that availability of most nutrients was altered as pH increased from 4.32 to 7.83 (Fig. 3). Phosphorus, iron, manganese, boron, zinc, and copper all show a trend of decreasing availability associated with increasing pH. Calcium and magnesium increased in availability with increasing pH. Nitrate nitrogen and potassium availability appeared to be relatively unaffected by pH differences.

Despite the fact that there was some variability in soluble salt values, which may cause some slight aberrations in Figure 3, an important perspective was evident. The optimum pH range for nutrient availability in Metro Mix 300 appears to be 5.2 to 5.5. This is a whole pH unit or more lower than the optimum for a mineral field soil.

Optimum pH range differences between mineral field soil and the soilless medium examined in this research may be the result of differences in cation exchange reactions.

TABLE 1.—Conductivity Values and Concentrations of Various Elements in Saturated Soil Extract Solutions Obtained from Samples of Metro Mix 300 Soilless Medium Amended with Iron Sulfate or Calcium Hydroxide to Establish a Range of pH's.

Treatment	pH	Conductivity millimhos/cm Soluble Salts	Plant Nutrients (ppm) NO$_3$-N	P	K	Ca	Mg	Mn	Fe	B	Zn	Cu
1	4.32	5.35	556	76	340	154	125	4.10	0.66	0.80	0.67	0.09
2	4.80	4.70	544	69	375	257	164	2.70	0.61	0.92	0.61	0.09
3	5.17	5.19	607	75	414	300	324	0.84	0.57	0.93	0.44	0.10
4	5.58	4.51	567	55	367	299	135	0.39	0.42	0.70	0.21	0.06
5	6.03	3.94	484	34	332	263	308	0.20	0.52	0.52	0.21	0.07
6	6.45	4.30	549	7	349	354	720	0.06	0.23	0.29	0.18	0.07
7	7.83	4.34	619	2	347	422	753	0.01	0.15	0.17	0.07	0.07

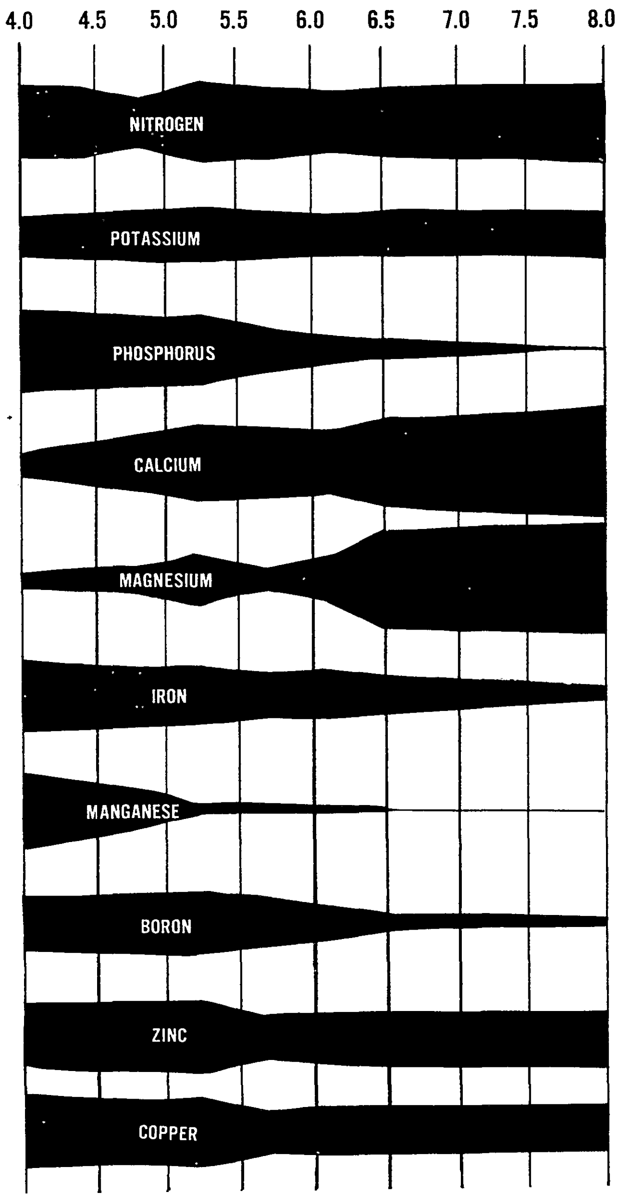

FIG. 3.—Availability of plant nutrients at different pH levels for W. R. Grace Metro Mix 300.

Two types of negative charges are responsible for the retention of exchangeable cations in soil: 1) a permanent charge due to ion substitution and mineral structures, and 2) a pH-dependent charge which varies with changes in pH (10). In mineral soils these negatively charged sites result from exposed oxygen and hydroxyl groups on the edges of clay particles (4, 8, 20). In contrast, the major source of negative charge sites on organic colloids are carboxylic and phenolic sites (4, 8, 20). In mineral soils a large portion of cation exchange is due to permanent charges, but organic colloids are wholly pH dependent (10). These differences in basic chemistry probably account for the different optimum pH ranges for mineral field soil and the high organic soilless medium studied in this research.

The findings of this research are very similar to the research conducted with an organic field soil (14) and provide evidence for modifying perspectives and fertility programs for the production of floral crops in organic soilless media. Results suggest that growers should be striving to maintain a medium pH of approximately 5.5 rather than 6.5 when growing crops in soilless media.

Results as they relate to availability of one element in particular, phosphorus, seem extremely significant. Above a pH of 5.2, availability of this element decreased dramatically. Between a pH of approximately 5.2 and 6.5, availability was reduced more than tenfold. Since phosphorus is a major plant nutrient required in relatively large quantities for plant growth, these findings are very meaningful.

Overall, these results indicate that perspectives relating to pH may need to be modified. All factors which affect root media pH should be assessed. Liming procedures should be evaluated and adjusted where appropriate and influences of alkaline fertilizers as well as high pH, highly buffered water should be carefully examined.

Ramifications of these research findings are no doubt much more complex and broad reaching than this study alone can reveal. Questions remain to be answered concerning optimum pH values for media consisting of a mixture of field soil and organic components. The effect of root media pH on plant growth also may need to be carefully re-assessed.

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An Evaluation of Pre-emergence Herbicides on Tulip and Narcissus[1]

ELTON M. SMITH and SHARON A. TREASTER[2]

ABSTRACT

The purpose of this study was to determine which pre-emergence herbicides would result in satisfactory weed control without causing significant injury on tulip and narcissus. Although several herbicides controlled annual weed growth well into summer from late fall treatment, only Dacthal was determined to be safe to use with tulips while narcissus was tolerant to both Dacthal and Casoron. Kerb and Surflan caused undesirable initial stunting of narcissus but the plants recovered and these herbicides should be further evaluated for this bulb species.

INTRODUCTION

In recent years the application of pre-emergence herbicides has become a common practice in the landscape by both commercial grounds maintenance personnel and home gardeners alike. Since proper application dictates that the herbicides should be applied in autumn or early spring before weed seed germination, the applicator may not know that there may be hardy bulbs in the area.

Very few herbicides are labeled for use on hardy bulbs, especially tulips and daffodils or narcissus (1). Thus, a need exists to determine what additional herbicides can be expected to control weeds without injury to bulb plantings.

MATERIALS AND METHODS

The bulbs in the study included the Darwin hybrid tulip 'Apeldorn's Elite' and the miniature narcissus 'Campernelli Flore Pleno' which were planted in the OSU field nursery Dec. 3, 1980. The herbicides and rates included: napropamide or Devrinol 4.0 lb ai/A (active ingredient/acre), DCPA or Dacthal 12.0 lb ai/A, simazine or Princep 1.5 lb ai/A, dichlobenil or Casoron 6.0 lb ai/A, pronamide or Kerb 2.0 lb ai/A, oxadiazon or Ronstar 4.0 lb ai/A, oxyfluorfen or Goal 4.0 lb ai/A, and oryzalin or Surflan 2.0 lb ai/A. The herbicides were applied Dec. 3, 1980, in 90 sq ft plots in three replications.

Sprayable herbicides were applied with a 3-gallon pump type compression tank sprayer and granular materials were applied with a hand held rotary spreader.

The soil composition was Brookston clay loam with a pH of 6.5 and an organic matter content of 2.0%.

Phytotoxicity was evaluated in May soon after all bulbs had emerged from the soil but prior to blooming. Weed control evaluations were conducted at approximately 1-month intervals throughout the summer. The predominant annual weed species in the study included yellow foxtail, giant crabgrass, smartweed, wild lettuce, pigweed, and purslane.

[1]The authors express sincere thanks to the following companies for assistance with the study: Park Seed Co., Diamond Shamrock, Stauffer, Rhone Poulenc and Rohm and Haas.

[2]Professor and Technician, Dept. of Horticulture, The Ohio State University and Ohio Agricultural Research and Development Center.

RESULTS AND DISCUSSION

An insufficient number of weeds had emerged to differentiate between treatments at the initial evaluation period in May; thus the first observation of weed control was conducted in mid-June. At that time, Devrinol, Casoron, Ronstar, Goal, and Surflan resulted in acceptable annual grass and broadleaf weed control (Table 1). However, Dacthal, Princep, and Kerb did not yield values of 7 or higher which are considered satisfactory. In early July and early August, only Ronstar, Goal, and Surflan were controlling weeds at a satisfactory point.

Tulip

With the exception of Dacthal, all herbicides injured tulip beyond acceptable tolerance in the May evaluation. Since Dacthal did not adequately control weeds from December treatment, more research needs to be conducted to determine either a more satis-

TABLE 1.—Weed Control During the Growing Season Following December Application.

Treatment	Rate lb ai/A	Evaluation Dates June 12	July 8	August 1
Check		4.7*	3.3	1.7
Devrinol	4.0	7.0	5.0	4.3
Dacthal	12.0	6.7	4.0	2.7
Princep	1.5	6.7	5.7	3.7
Casoron	6.0	7.7	5.3	4.3
Kerb	2.0	6.0	4.7	2.3
Ronstar	4.0	9.0	8.0	7.0
Goal	4.0	9.7	9.0	8.0
Surflan	2.0	8.7	8.0	7.0

*Visual weed control rating—1-10, with values above 7 acceptable and 10 best.

factory application time or increased rates of Dacthal to yield the desirable weed control.

Narcissus

Narcissus was more tolerant of the herbicides utilized in this study than tulips. Dacthal and Casoron were both relatively non-injurious to narcissus, although slight injury was noted in some plots. Kerb and Surflan, although causing moderate injury, should be evaluated in further trials with narcissus. Among Dacthal, Casoron, Kerb, and Surflan, only Casoron and Surflan adequately controlled weeds, with Surflan resulting in the longest duration of weed control. Kerb should be considered for fall application where perennial grasses have invaded the narcissus planting. Kerb is not normally considered an herbicide for spring or summer annual weed control. Perennial weeds not evaluated per se in this study could be controlled with Casoron, along with annual weeds.

Herbicides

In this study Ronstar controlled weeds into August and, as nurserymen have noted in recent years, it is an excellent, long lasting herbicide. Ronstar, however, injures herbaceous plants as they come through the soil surface. Possibly less injury would result if Ronstar was applied in spring after the foliage has emerged from the soil but prior to weed seed germination.

The most effective weed control in this study was achieved with Goal. However, the rates used were higher than the 2.0 lb ai/A now labeled for ornamentals. This higher rate of 4.0 lb ai/A thus caused severe injury and death to both tulip and narcissus. Additional study is necessary at rates of less than 2.0 lb ai/A to determine a more desirable level.

A relatively new herbicide, Devrinol, caused moderate injury to both tulip and narcissus. Weed control was acceptable in June but did not hold into later months.

Princep used at one-half the normal rate for woody plants was still too phytotoxic to both bulb species and did not adequately control annual weeds.

TABLE 2.—Phytotoxicity of Tulip and Narcissus in May Following Herbicide Treatment in December.

Treatment	Rate lb ai/A	Phytotoxicity*	
		Tulip	Narcissus
Check		5.0	5.0
Devrinol	4.0	3.0	3.0
Dacthal	12.0	3.7	4.5
Princep	1.5	2.7	3.0
Casoron	6.0	2.3	4.0
Kerb	2.0	2.3	3.3
Ronstar	4.0	3.0	1.3
Goal	4.0	1.7	1.0
Surflan	2.0	2.7	3.3

*Visual phytotoxicity scale: 5=no injury; 4=slight injury, scattered slight stunting; 3=moderate injury, general stunting, and/or shoot inhibition; 2=severe injury, extensive stunting, and/or shoot inhibition; 1=plants dead.

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An Evaluation of Hot Sauce for Prevention of Mice and Deer Damage in a Commercial Nursery

ELTON M. SMITH and THOMAS M. STOCKDALE[1]

ABSTRACT

In an attempt to prevent field mouse damage and buck deer rub damage to field grown nursery stock, Hot Sauce with anti-desiccant was sprayed on 10 species. No significant reduction in damage from mice feeding or deer rubbing was observed, due to either improper timing of the repellent or ineffective treatment. Flowering cherry was the species most heavily damaged by mice and Red Maple was the most severely injured by deer, although some rubbing was observed in Marshall's Seedless Green Ash, London Planetree, Bradford Callery Pear, and Sweetbay Magnolia.

INTRODUCTION

Damage to nursery stock from mice and deer can be a serious problem to the production nurseryman. Mice chew the bark of trees and shrubs at the soil line and plants which are girdled often die. Damage from deer can come from extensive feeding on the terminal shoots or from limb or trunk breakage and debarking due to the rubbing of antlers against the trees.

Some companies have reported successful control of mice and deer with various wildlife repellents (1). A relatively new product, made from hot peppers and sold for use on nursery and fruit trees to control wildlife, has been recently promoted in the industry (2).

The objective of this research was to control the feeding by mice and antler rubbing by deer in a commercial nursery with a hot pepper based product sold as Hot Sauce. Feeding by deer had not been a problem in the nursery selected for this trial and was not evaluated for that purpose.

MATERIALS AND METHODS

Deer had been causing rub damage in a commercial nursery in central Ohio and the owner asked for assistance in preventing further damage. A new product, supposedly relatively effective against this type of injury, sold as Hot Sauce, Animal Repellent, was claimed to be very effective against deer damage. The composition of the Hot Sauce was 2.5% Capsaicin by weight and 97.5% inert ingredients. Eight ounces were mixed with 2 quarts of Vapor Gard in 100 gallons of water and sprayed at 100 psi from a 250 gallon hydraulic sprayer. The purpose of the Vapor Gard was to aid in sticking the Hot Sauce to the nursery stock and to prolong its effective repellent properties.

The plant materials in the study included *Pinus strobus*—Eastern White Pine, *Picea abies*—Norway Maple, *Prunus subhirtella pendula*—Weeping Flowering Cherry, *Malus* cultivars—flowering crabapples, *Quercus accutissima*—Sawtooth Oak, *Fraxinus pennsylvanica* 'Marshall's Seedless'—Marshall's Seedless Green Ash, *Acer rubrum* 'Red Sunset'—Red Sunset Red Maple, *Platanus occidentalis* 'Bloodgood'—Bloodgood London Planetree, *Pyrus calleryana* 'Bradford'—Bradford Callery Pear, and *Magnolia virginiana*—Sweetbay Magnolia.

Plants were sprayed Nov. 4, 1980, on an overcast day with a temperature of 55° F. Deer rub damage was extensive on Red Maple and noticeable on several other species prior to the Hot Sauce treatment. There were no indications of mice feeding at the time of treatment. The evaluation was conducted Dec. 3, 1980, with both deer rub and mice feeding activity recorded.

RESULTS AND DISCUSSION

As shown in Table 1, there was very little additional deer rubbing damage after treatment in November. With approximately 1,200 trees in the study, only five additional trees were damaged in the untreated plots and just two in the treated plots. This small number of newly injured trees in both treated and check plots was considered too small to be of significance. An October treatment prior to the buck rubbing season would have been a more ideal treatment time.

It is of interest to note, however, that the rubbing damage both prior to and following treatment was most prevalent on Red Maple which were the tallest trees in the nursery with the strongest limbs. Additional trees injured, but to a far lesser extent, were Bradford Callery Pear, Marshall's Seedless Green Ash, Sweetbay Magnolia, and London Planetree. There was very little, if any, damage to flowering crabapples, Sawtooth Oak, flowering cherry, Norway Spruce, and White Pine.

Mouse damage was extensive on flowering cherry, but there were no differences between Hot Sauce

[1]Professor, Dept. of Horticulture, and Professor, Dept. of Fisheries, Wildlife, and Outdoor Recreation, The Ohio State University and the Ohio Agricultural Research and Development Center.

TABLE 1.—An Evaluation of Hot Sauce for Prevention of Mice and Deer Damage in Commercial Nursery Stock.

Plant Species	Treatment	Number of Plants	Number with Mouse Damage	Number with Previous Deer Damage 11/4/80	Number with New Deer Damage 12/3/80
Evergreens					
White Pine	Check	75	0	1	1
2-8'	Hot Sauce	81	0	0	0
Norway Spruce	Check	65	0	0	0
3-4'	Hot Sauce	35	0	0	0
Deciduous					
Flowering Cherry	Check	95	38	0	0
2-4'	Hot Sauce	135	42	0	0
Flowering Crabapple	Check	50	1	0	1
3-6'	Hot Sauce	54	0	1	0
Sawtooth Oak	Check	10	0	0	0
2-3'	Hot Sauce	37	0	0	0
Marshall's Seedless Green Ash	Check	36	2	1	1
6-8'	Hot Sauce	56	1	7	2
Red Maple	Check	36	0	6	2
8-10'	Hot Sauce	61	0	27	0
London Planetree	Check	97	0	5	0
6-8'	Hot Sauce	103	0	0	0
Bradford Callery Pear	Check	37	0	5	0
4-8'	Hot Sauce	61	1	5	0
Sweetbay Magnolia	Check	10	0	3	0
4'	Hot Sauce	35	0	4	0

treated or control plots (Table 1). Only an occasional tree of flowering crabapple, Marshall's Seedless Green Ash, and Bradford Callery Pear were damaged by mice and again there were no differences between treated and untreated trees.

The results of treatment with Hot Sauce were discouraging in this study. However, these results suggest that additional research is warranted with other products or perhaps with higher rates of Hot Sauce. Deer, mouse, and rabbit damage in commercial nurseries can be very severe and effective chemical controls are desperately needed by the industry. Thus, additional research is necessary.

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Test Results of Fungicides for Control of Diseases of Ornamentals

C. C. POWELL[1]

INTRODUCTION

In past years, many of our test results have routinely been published in this research circular (5, 6). Our work has been part of a national USDA-assisted program to research pesticides for use on ornamental crops. Many new disease controlling chemicals have been discovered in recent years (1). More than 300 ornamentals tests with many of these new chemicals have been conducted here at Ohio State University (Table 1). Many pesticide labels have been expanded and several new products are now on the market (3, 4, 8).

All of the tests conducted provide valuable information to check on the safety of the use on the plant type in question. Ornamentals are valuable commodities (2). Any proposed pesticide use must be shown to be completely safe for use on the crop or plants. This data will not be presented here in detail. Table 2 lists the chemicals and woody ornamentals that have been shown to be safe. The rates listed are generally four times what would be the labeled use rate. Spraying was always done to the point of runoff, and at least three sprays were applied at labeled intervals (usually biweekly).

METHODS

Trial 1: Powdery mildew (caused by *Microsphaera alni*) on 'Mollis' azalea (Rhododendron X molle).

Field-grown 'Mollis' azaleas (approximately 2 feet tall) were sprayed biweekly with seven fungicide treatments on August 16, August 31, and Sept. 15, 1978. Two treatments were sprayed on a monthly schedule August 16 and Sept. 15, 1978. Three randomized replications of approximately 16 plants per replication were sprayed for each of the nine treatments. Plants were sprayed to runoff with a 2-gallon CO_2-pressurized sprayer (25 psi). Moderate disease incidence was present in the test plants just prior to initiation of the experiment. Disease ratings were based on infection of upper foliage that occurred after the trial was begun. Disease severity was rated on Sept. 25, 1978.

Trial 2: Scab (caused by *Fusicladium pyracanthe*) on firethorn (*Pyracantha coccinea* 'Lalandei'); first trial.

Plants were grown in 2-gallon containers under standard nursery conditions with overhead irrigation. Treatments were applied on a biweekly schedule on June 7, June 21, July 6, July 19, August 2, and August 16, 1978. A randomized complete block design was used with 4 replications of approximately 45 plants per replication for each of 7 treatments. Plants were sprayed to runoff with a 2-gallon CO_2-pressurized sprayer (25 psi). Disease severity and phytotoxicity were rated on August 24, 1978.

Trial 3: Scab (caused by *Fusicladium pyracanthe*) on firethorn (*Pyracantha coccinea* 'Lalandei'); second trial.

In this trial, a wider variety of chemicals were evaluated on 2-year-old pyracantha shrubs, planted in a hedge row on The Ohio State University campus. The treatments were sprayed with a 2-gallon hand-pump sprayer (20 psi) when the plants blossomed on June 4 and again on June 17. There were two randomly dispersed replications of 8 feet of hedge per treatment. The percent of fruit blackened by scab was estimated on August 5.

Trial 4: Black spot (caused by *Diplocarpon rosae*) on hybrid tea roses (*Rosa dilecta* 'Peace').

Biweekly or monthly sprays on 5-year-old field-grown roses were initiated on June 4 and continued on June 17, July 1, 15, 29, and August 12 and 26. They were sprayed to runoff with a 2-gallon hand-pump sprayer (20 psi). In each treatment there were 9-15 randomized plants. Disease severity was rated on a 1-10 scale on Sept. 8.

Trial 5: Leaf spot (caused by *Septoria cornicola*) on yellow twig dogwood (*Cornus sericea*).

Yellow twig dogwoods were planted in two rows on May 22. These plants were sprayed to runoff with 2-gallon hand-pump sprayers (20 psi) on August 8, 21, and Sept. 3. There were three randomly placed plants per treatment. The plants were rated on Sept. 25 for percent leaves spotted or defoliated.

Trial 6: Leaf blight (caused by *Alternaria zinniae*), powdery mildew (caused by *Erysiphe cichoracearum*), and bacterial leaf spot (caused by

[1]Associate Professor, Dept. of Plant Pathology, The Ohio State University and Ohio Agricultural Research and Development Center.

***Xanthomonas nigromaculans* f. sp. *zinnia*) on zinnia (*Zinnia elegans* 'Cactus Flowered Mix').**

Zinnias were planted on June 20. On August 1 they were inoculated with ground up, blighted leaves harvested from an infected planting in 1979. The plants were sprayed to runoff using a 2-gallon hand-pump sprayer (20 psi) on August 8, 21, and Sept. 3. On Sept. 25 the percent of leaves infected with Alternaria leaf blight, bacterial leaf spot, and powdery mildew was estimated. There were four replications of 6 row feet per replication per treatment.

Trial 7: Frogeye leaf spot (caused by *Physallospora obtusa* on Washington hawthorn (*Crataegus phaenopyrum*).

Ten-year-old trees in a Columbus nursery were

TABLE 1.—New, Presently Unregistered Products Used in Fungicide Tests.

Name	Source	Composition
Vangard 10W	CIBA-GEIGY Corp., Greensboro, NC 27409	10% 1-((2(2, 4-Dichlorophenyl) -4-ethyl-1, 3-dioxolan-2-yl) methyl) 1-H-1, 2, 4,-triazole
Ornilan 50W	Mallinckrodt, Inc. St. Louis, MO 63147	50% vinclozolin
Manzate 200 3.8F	DuPont Chemical Corp. Wilmington, DE	3.8 lb per gallon flowable mancozeb
Baycor 25W	Mobay Chemical Corp. Kansas City, MO 64120	B ((1, 1 'biphenyl)-4-yloxy-α-(1, 1-dimethylethyl)-1H-1, 2, 4-triazole -1-ethanol

TABLE 2.—Currently Unlabeled Pesticide Uses on Woody Ornamentals Demonstrated Safe in Tests of 1979 and 1980.

Plant	Pesticide	Rate (oz) per 100 gal
Hydrangea (Mint Supreme)	Chlorothalonil (Daconil 2787, 4F)	136
	Iprodione (Chipco 26019, 50W)	64
	Vinclozolin (Ornilan, 50W)	64
English Ivy (Thorndale)	Chlorothalonil (Daconil 2787, 4F)	136
	Iprodione (Chipco 26019, 50W)	64
	Vinclozolin (Ornilan, 50W)	64
Euonymus (Vegetus)	Chlorothalonil (Daconil 2787, 4F)	136
	Iprodione (Chipco 26019, 50W)	64
	Vinclozolin (Ornilan, 50W)	64
Dogwood (Yellow twig)	Vinclozolin (Ornilan, 50W)	64
	Mancozeb (Manzate 200F)	128
	Vinclozolin (Ornilan, 50W)	64
Ash (Seedling White)	CGA 64251 (Vangard 10W)	24
	Mancozeb (Manzate 200F)	128
	Iprodione (Chipco 26019, 50W)	64
Hawthorn (Paul's Scarlet)	Copper Hydroxide (Kocide 101, 77W)	128
	Mancozeb (Manzate 200, 80WP)	96
	Triforine (Funginex, 6.5EC)	200
	CGA 64251 (Vangard 10W)	24
Crabapples (Seedlings)	Triforine (Funginex, 6.5EC)	1500
	CGA 64251 (Vangard 10W)	24
Rose (Command Performance)	Mancozeb (Manzate 200F)	32
Rose (Peace)	Mancozeb (Manzate 200F)	32
Pyracantha (Lelandi)	Iprodione (Chipco 26019, 50W)	64
	Triforine (Funginex, 6.5EC)	5860
	CGA 64251 (Vangard)	24
	Mancozeb (Manzate 200F)	32
Scotch pine	Iprodione (Chipco 26019)	16
Holly (American)	Chlorothalonil (Daconil 4F)	58

treated in this experiment. Treatments were applied April 12, May 1, and May 15 from bud break through flowering. There were nine treatments with three replications of two trees per replication per treatment. Trees were sprayed to runoff with a 10-gallon power sprayer (centrifugal pump—45 psi). Disease severity was rated on May 29.

RESULTS

Trial 1: Powdery mildew (caused by *Microsphaera alni*) on 'Mollis' azalea (Rhododendron X molle).

All treatments adequately controlled the disease (Table 3). Bayleton 50 WP sprayed monthly may have performed better if rate had been increased to 8 ounces/100 gallons. No phytotoxicity was noted. Benlate is the only treatment currently registered for use on azalea.

TABLE 3.—Control of Powdery Mildew on Mollis Azalea with Two or Three Late Season Sprays.

Treatment and Rate/100 Gallons	Disease Severity*
Bayleton 25 WP 4 oz + Exhalt 800 8 oz	0.0 a †
Bayleton 25 WP 8 oz + Exhalt 800 8 oz	0.0 a
Triforine 18.2 EC 48 oz	0.1 a
Bayleton 50 WP 4 oz + Exhalt 800 8 oz	0.1 a
Triforine 18.2 EC 12 oz	0.2 a
Benlate 50 WP 8 oz + Exhalt 800 8oz	0.2 a
Benlate 50 WP 16 oz + Exhalt 800 8 oz	0.3 ab‡
Bayleton 50 WP 2 oz + Exhalt 800 8 oz	0.3 ab
Bayleton 50 WP 4 oz + Exhalt 800 8 oz	0.6 b ‡
Check	2.1 c

*Disease severity: 0=no disease, 5=100% of upper leaves with at least one powdery mildew colony.

†The small letters indicate Duncan's multiple range groupings of treatments that do not differ significantly at the 0.05 level.

‡These treatments applied monthly.

TABLE 4.—Copper Fungicides and the Control of Scab on Firethorn.

Treatment and Rate/100 Gallons	Disease Severity*	Phytotoxicity†
Kocide 101 77 WP 4 lb + Exhalt 800 8 oz	0.0 a‡	0
Kocide 101 77 WP 1 lb + Exhalt 800 8 oz	0.0 a	0
Citcop 4E 4 qt	0.1 a	0
Citcop 4E 2 qt	0.2 a	0
Agristrep 21.2 WP 4 lb + Exhalt 800 8 oz	2.6 b	1.7
Agristrep 21.2 WP 1 lb + Exhalt 800 8 oz	2.7 b	0.3
Check	3.6 c	0

*Disease severity: 0=no disease, 5=100% of leaves with at least one scab.

†Phytotoxicity: 0=no phytotoxicity, 5=all young foliage with chlorotic leaf tips (plants rated 4 or above were unsalable).

‡The small letters indicate Duncan's multiple range groupings of treatments that do not differ significantly at the 0.05 level.

Trial 2: Scab (caused by *Fusicladium pyracanthe*) on firethorn (*Pyracantha coccinea* 'Lalandei'); first trial.

Although disease was severe in the check plants, excellent control of scab was obtained with both copper fungicides (Table 4). The Kocide-treated plants had a heavy residue apparent at all times with both rates. This should not affect salability, however. Streptomycin was slightly phytotoxic, with 13 out of 180 treated plants being unsalable.

Trial 3: Scab (caused by *Fusicladium pyracanthe*) on firethorn (*Pyracantha coccinea* 'Lalandei'); second trial.

Funginex (at high rate) provided moderate control of the disease (Table 5). Benlate and Vangard (at high rate) were outstanding. Thus, the only chemical providing disease control at "normal" rates in this two-application program continues to be Benlate. No phytotoxicity was noted from any treatment.

Trial 4: Black spot (caused by *Diplocarpon rosae*) on hybrid tea roses (*Rosa dilecta* 'Peace').

Triforine provided the best control, but only when sprayed biweekly (Table 6). The addition of Manzate 200 or Benlate to the triforine did not enhance control on either the biweekly or monthly spray schedules. No phytotoxicity from any treatment was noted in the experiment.

Trial 5: Leaf spot (caused by *Septoria cornicola*) on yellow twig dogwood (*Cornus sericea*).

Although Benlate alone was not included in the test, it seemed to be the only fungicide that provided a high level of control (Table 7). Whenever Benlate was combined with Manzate 200, good control

TABLE 5.—A Two-Application Trial for Control of Scab on Firethorn.

Treatment	Rate/100 Gallons	Disease Severity*
Benlate 50WP + Triton B-1956	16 oz + 4 oz	10% a †
Vangard 10WP + Triton B-1956	24 oz + 4 oz	10% a
Funginex 6.5EC	200 oz	26% a
Vangard 10WP + Triton B-1956	6 oz + 4 oz	33% ab
Manzate 3.8F	32 oz	56% bc
Chipco 26019 50WP + Triton B-1956	4 lb + 4 oz	63% cd
Funginex 6.5EC	50 oz	73% cd
Chipco 26019 50WP + Triton B-1956	1 lb + 4 oz	73% cd
Control		86% d

*Disease rated by percent fruit blackened.

†The small letters indicate Duncan's multiple range groupings that do not differ significantly at the 0.05 level.

TABLE 6.—Control of Black Spot on Rose.

Treatment	Frequency	Rate/100 Gallons	Disease Severity*
Triforine 18.2EC + Manzate 200 80WP	Bi-weekly	16 oz + 1 lb	0.308 a†
Triforine 18.2EC	Bi-weekly	16 oz	0.900 a
Triforine 18.2EC + Benlate 50WP	Bi-weekly	16 oz + 1 lb	1.636 a
Benlate 50WP + Manzate 200 80WP + B-1956	Bi-weekly	1 lb + 1 lb + 4 oz	4.000 b
Triforine 18.2EC + Benlate 50WP	Monthly	16 oz + 1 lb	4.083 b
Manzate 200 3.8F	Bi-weekly	32 oz	4.556 b
Triforine 18.2EC	Monthly	16 oz	4.846 b
Triforine 18.2EC + Manzate 200 80WP	Monthly	16 oz + 1 lb	4.933 b
Benlate 50WP + Manzate 200 80WP + B-1956	Monthly	1 lb + 1 lb + 4 oz	7.222 c
Control			

*Disease rated on a 1-10 scale, with 1=no disease and 10=100% of leaves either defoliated or with blackspot lesions.

†The small letters indicate Duncan's multiple range groupings that do not differ significantly at the 0.05 level.

was achieved. No phytotoxicity was noted from any of the treatments.

Trial 6: Leaf blight (caused by *Alternaria zinniae*), powdery mildew (caused by *Erysiphe cichoracearum*), and bacterial leaf spot (caused by *Xanthomonas nigromaculans* f. sp. *zinnia*) on zinnia (*Zinnia elegans* 'Cactus Flowered Mix').

Alternaria was controlled to some degree by all the treatments (Table 8). Chipco 26019 provided outstanding control. High rates of flowable Manzate were added to approximate the same level of control. Bacterial leaf spot and powdery mildew were also controlled well with Chipco 26019, although mildew severity was not very heavy. No phytotoxicity from any treatment was noted.

Trial 7: Frogeye leaf spot (caused by *Physallospora obtusa* on Washington hawthorn (*Crataegus phaenopyrum*).

There was only a light infestation on the unsprayed trees (Table 9). Vangard controlled the disease, but was slightly phytotoxic. Manzate 200 per-

TABLE 7.—Three Late-Season Sprays to Control Septoria Leaf Spot on Dogwood.

Treatment	Rate/100 Gallons	Disease Severity*
Benomyl 50W + Manzate 200 80W + B-1956	1 lb + 4.8 lb + 4 oz	10 a†
Benomyl 50W + Manzate 200 80W + B-1956	0.5 lb + 1.2 lb + 4 oz	26 a
Manzate 200 3.8F	4 qt	46 b
Manzate 200 80W + B-1956	1.2 lb + 4 oz	80 cde
Chipco 26019 50W + B-1956	1 lb + 4 oz	80 cde
Manzate 200 3.8F	1 qt	83 cde
Daconil 4F	32 oz	86 de
Ornilan 50W + B-1956	1 lb + 4 oz	93 e
Chipco 26019 50W + B-1956	4 lb + 4 oz	93 e
Check		96 e
Ornilan 50W + B-1956	4 lb + 4 oz	100 e

*Plants were rated by the percent of defoliated or spotted leaves.

†The small letters indicate Duncan's multiple range groupings that do not differ significantly at the 0.05 level.

TABLE 8.—Control of Three Diseases of Zinnia with Fungicide Sprays.

Treatment	Rate/100 Gallons	Percent Alternaria*	Percent Leaf Spot*	Percent Powdery Mildew*
Chipco 26019 50WP + B-1956	4 lb + 4 oz	5 a†	13 a	0 a
Chipco 26019 50WP + B-1956	1 lb + 4 oz	5 a	13 a	0 a
Manzate 200 3.8F	4 qt	6 a	15 ab	0 a
Benomyl 50WP + Manzate 100 80WP + B-1956	1 lb + 4.8 lb + 4 oz	10 ab	20 abcd	0 a
Daconil 4F	32 oz	18 abc	28 cd	0 a
Manzate 200 3.8F	1 qt	18 abc	23 abcd	5 ab
Benomyl 50WP + Manzate 200 + B-1956	0.5 lb + 1.2 lb + 4 oz	18 abc	20 abcd	0 a
Manzate 200 80WP + B-1956	1.2 lb + 4 oz	20 abcd	18 abc	3 a
Ornilan 50WP + B-1956	4 lb + 4 oz	24 bcd	20 abcd	10 b
Ornilan 50WP + B-1956	1 lb + 4 oz	30 cd	20 abcd	3 a
Check		35 d	30 d	25 c

*Percent of leaves with lesions or leaf spots.

†Numbers in columns followed by same letter do not differ significantly using Duncan's new multiple range test (p=0.05).

formed well. It is not known why some treatments were worse than the check, but the result was consistent throughout all replications.

DISCUSSION

Several workers have reported that recently developed fungicides have given better disease control than those products previously available (3, 4, 7, 8). Our results were similar in some of the tests. For instance, the Chipco 26019 sprays on zinnias did an outstanding job on control of three quite different pathogens. Such broad spectrum activity is of great use to the ornamentalist who must contend with many different diseases on many crops. It should be noted, however, that Chipco 26019 failed to control leaf spot on dogwood or scab on firethorn in our tests.

The EBDC fungicide mancozeb continues to perform well in many of our tests on ornamentals. Although it is seldom the best treatment in the test, it often provides reasonably good control. Mancozeb did not provide satisfactory control of rose black spot or scab of firethorn in our tests.

Benlate fungicide is a systemic with a spectrum of activity thought by many to be somewhat limited (1). We found Benlate to be fair to good in many of our tests. Benlate as a mildicide continues to perform well. Bayleton also appears quite useful for powdery mildew control. Vangard is a promising new fungicide as well (8), and needs further testing to fully delineate its usefulness in ornamentals disease control.

SUMMARY

Several fungicides were tested on various ornamental plants. Phytotoxicity trials on 12 woody ornamental plant types are reported, with safety demonstrated using four different fungicides. Efficacy trials demonstrating at least one effective control are presented for nine commonly occurring diseases on seven plant types.

TABLE 9.—Control of Frogeye Leaf Spot on Hawthorn with Early Season Sprays.

Treatment and Rate/100 Gallons	Disease Severity*
Vangard 10W 5 oz + Exhalt 800 8 fl oz	0.0 ‡
Manzate 200 80W 6 lb + Exhalt 800 8 fl oz	0.0 a†‡
Vangard 10W 10 oz + Exhalt 800 8 fl oz	0.0 a
Manzate 200 80W 1.5 lb + Exhalt 800 8 fl oz	0.2 ab
Check	0.8 ab
Baycor 25W 64 oz + Exhalt 800 8 fl oz	1.4 b‡
Baycor 25W 16 oz + Exhalt 800 8 fl oz	3.5 c
Kocide 101 77W 1 lb + Exhalt 800 8 fl oz	8.6 d
Kocide 101 77W 4 lb + Exhalt 800 8 fl oz	18.2 e

*Disease severity rated on number of Physallospora lesions per leaf (20 leaves sampled per tree).

†The small letters indicate Duncan's multiple range groupings of treatments that do not differ significantly at the 0.05 level.

‡Slight phytotoxicity expressed as yellow flecking of foliage was noted with these treatments.

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Virus-Indexed Rose Plants: First-Year Performance Results

C. C. POWELL[1]

INTRODUCTION

Rose mosaic virus has been known in this country since 1923 (4). Although it was recognized as being transmissible to healthy roses by budding in 1932 (6), it was not until recently that the identity of at least two of the viruses that cause this disease in roses was proven (2). There are no cultivars known to be immune to the disease (1). Many cultivars are mildly affected, rarely showing the striking yellow lines or mosaic symptoms on the leaves. Although such cultivars are thought to be "mildly affected", they may be severely stunted because of the virus infection. For instance, Pool (3) reported many more blooms are cut from Baccara plants thought to be free of virus.

Control of this disease on roses involves using and propagating only "virus-free" material. It has been demonstrated that high temperature treatment of rose plants would enable propagators to obtain virus-free budding material from previously infected plants (5). Indexing methods were developed so that continued freedom from virus in stock plants could be checked. Thus, it is now possible to produce rose plants from virus-indexed material that are free of rose mosaic viruses. What is the benefit to the home rose grower? Is it advantageous to pay a premium price for virus-free plants?

MATERIALS AND METHODS

In April, we initiated a test to compare virus-indexed material to non-virus indexed material that was identical in every other way. Since there are no known means of spreading these viruses other than by grafting, indexed and non-indexed plants were placed together in the same planting, in a completely randomized block. The plant material was provided by the Jackson & Perkins Co., Medford, Ore. For each cultivar, five indexed and five non-indexed plants were received in March and planted on April 15.

Throughout the summer, normal pesticide sprays had been applied to keep the plants relatively free of insects and disease. The plants were mulched and fertilized at the beginning of the season. Pruning or cutting of flowers was not done.

RESULTS AND DISCUSSION

On Sept. 28, the size of the plants was observed. Because of the irregular growth of the plants, it was not possible to devise a definite procedure for figuring plant size. The approximate height and diameter of spread resulting from the total cane growth were measured, and the plant size computed in cubic feet.

TABLE 1.—Size of Rose Plants After 5 Months of Growth.

	Av Size of Plants in Cubic Feet	
Cultivar	Virus-Indexed	Non-Virus Indexed
Fragrant Cloud	13.0 efg*	1.3 a
First Prize	4.6 abc	5.0 abcd
Bob Hope	1.2 a	1.2 a
Charlotte Armstrong	7.7 abcdef	6.5 abcde
Crimson Glory	11.8 defg	3.7 ab
Chrysler Imperial	8.5 bcdef	1.8 ab
Proud Land	15.8 g	2.0 ab
Kings Ransom	8.3 abcdef	8.6 bcdef
New Yorker	11.3 cdefg	2.8 ab
John F. Kennedy	14.6 fg	3.3 ab
Arlene Francis	4.4 abc	3.1 ab
Queen Elizabeth	14.3 fg	14.1 fg

*The small letters indicate Duncan's multiple range groupings at readings which do not differ significantly at the 0.05 level.

The amount of growth improvement in virus-indexed plants varied among the cultivars in the test (Table 1). Indexed Fragrant Cloud, Crimson Glory, Chrysler Imperial, Proud Land, New Yorker, and John F. Kennedy grew much better than the non-indexed material. The typical rose mosaic leaf sympton was not noted in any plant in the test. These results suggest that virus indexing will improve the performance of roses in Ohio gardens. Further study will be made of these plants regarding winter survivability and growth in the second year.

SUMMARY

The effect of virus indexing on 12 cultivars of hybrid tea roses was evaluated by planting out indexed and non-indexed plants of each cultivar. Although no obvious virus symptoms appeared, all cultivars exhibited more growth among the indexed specimens. Six cultivars from the indexed plants grew to four times greater size as compared to the non-indexed controls.

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[1]Associate Professor, Dept. of Plant Pathology, The Ohio State University and Ohio Agricultural Research and Development Center.

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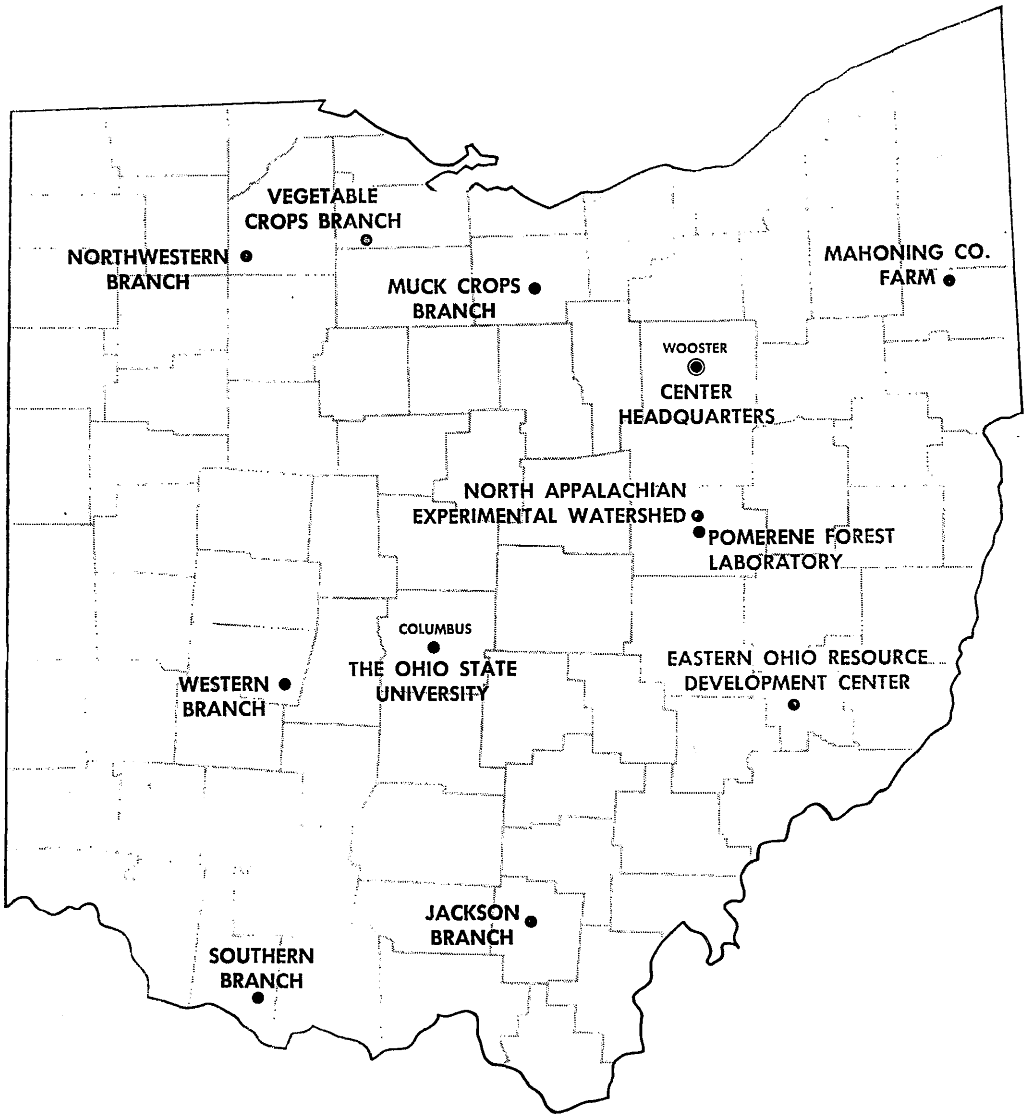

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Vegetable Crops Branch, Fremont, Sandusky County: 105 acres

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