The dry wt of Japanese holly in 6.0 liter nursery containers with various densities of redroot pigweed resulted in size reductions from the control of about 30% (Fig. 1). Growth reductions were even greater when large crabgrass was the competing species. At a density of 1 large crabgrass plant per container, plant size was reduced 35% from the control and the reduction increased to nearly 60% when the competing crabgrass plants increased to 32 per container. With 1 each of the competing weed species the Japanese holly plants were reduced in size by nearly 50% of the control.

These results emphasize the severe losses in plant size from weed competition in nursery containers.

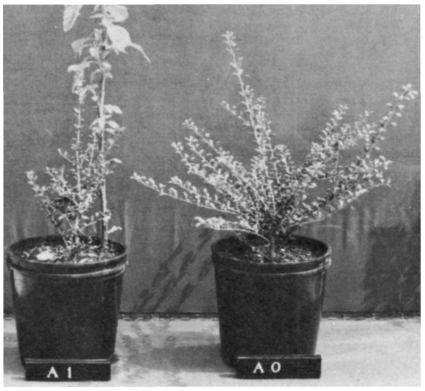

Fig. 1. One-year-old Japanese holly in 6.0 liter nursery containers 100 days after initiation of treatments.
Left: 1 redroot pigweed/container;
Right: weed-free control.

Literature Cited

1. Ahrens, J. F. 1966. Trials with dichlobenil and diphenamid for controlling weeds in container nursery stock. *Proc. No. East Weed Contr. Conf.* 20:232-236.
2. Fretz, T. A. 1972. Performance of herbicides on container grown nursery stock. University of Georgia. Res. Rpt. 120, p. 11.
3. Padgett, J. H., and T. L. Frazier. 1962. The relationship between costs and pricing of woody ornamentals. *Ga. Agr. Expt. Sta. Bul. N. S.* 100. p. 34.

Repressed Growth and Leaf Chlorosis of Japanese Holly Grown in Hardwood Bark[1]

W. C. Morris and D. C. Milbocker[2]
University of Kentucky, Lexington

Abstract. **Suppressed growth and chlorotic leaves of Japanese holly (*Ilex crenata*, Thunb. 'Hetzii') when grown in hardwood bark, were caused by the uptake of excessive amounts of available Mn in bark leachates.**

Until recently (2), hardwood bark has not been recommended as a growing medium. Plants grown in hardwood bark amended soils become nitrogen deficient because of the increased demand for N during decomposition of the bark (1). Supplemental N added to satisfy this demand can easily lead to high soluble salt concn. Even when soluble salt concn were not a problem, plant growth was not comparable to the growth of plants in peat amended soils (5). At the Kentucky Agr. Expt. Sta. new growth of Japanese holly growing in red oak bark (predominantly *Quercus falcata* Michx. and *Q. borealis* Michx. 'Maxima') fortified with N was reduced and chlorotic resembling symptoms of Fe deficiency in Japanese holly described by Tatnall and Dunham (10). Somers and Shive reported (9) that excess Mn produced symptoms similar to Fe deficiency in soybean. Chlorotic leaves developed when the ratio of Fe to Mn in the nutrient solution was lower than 1.5. The objective of this investigation was to determine if the ratio of Fe to Mn was a potential cause of repressed growth and leaf chlorosis.

Rooted cuttings of Japanese holly were planted individually in 24 glazed crocks (7.5 liter) filled with either sharp quartz sand, red oak bark, or equal parts of each and arranged in a completely randomized design. Every other day 5 liters of complete nutrient solution as prepared from Table 1 of Dutt and Bergman (3) were poured over ½ the crocks filled with each medium, while the same formulation without Fe was poured over the other half. The excess liquid from each container drained into individual reservoirs and was reused until replaced after 15 days. The pH of the 15 day old solutions was determined with a Beckman pH meter before replacement with new solutions as a measure of media pH. The length of each shoot and no. of shoots were recorded for each plant at 15, 45, and 75 days after planting.

At 60 days 3 seeds of soybean, *Glycine max* (L.) Merr. 'Hawkeye', were planted in each crock to verify the chlorotic symptoms reported by Somers and Shive (9). The experiment was terminated 2 weeks later, and the Fe and Mn content of a 1g (dry wt) sample of leaf tissue from the entire holly plant was determined with an atomic absorption spectrophotometer using the Perkin-Elmer modification of the method of Jones and Issac (6). The amounts of Fe and Mn were also determined spectrophotometrically in red oak bark samples and in a 24-hr leachate from red oak bark.

Leaves were determined to be chlorotic if they were interveinally yellow-green as compared to the uniform deep green of leaves on plants grown in sand under complete nutrient fertilization.

Growth of Japanese holly was supressed (Fig. 1) and leaves were chlorotic when hardwood bark was used as a growing medium. The omission of Fe from the nutrient solution did not significantly reduce growth or induce leaf chlorosis of sand cultured holly. Either enough accumulated Fe in the plant was mobilized or impurities were sufficient to prevent chlorosis. Soybean seedlings planted with the holly to verify the results of Somers and Shive (9) were chlorotic when grown in bark and green when grown in sand. The H^+ concn was depressed (high pH) in the solns leached through the bark (Fig. 2). According to Mann (8) and Emmert (4), Mn availability in soil is greatly reduced above a pH of 6 while Fe remains relatively more available. Therefore a rise in the pH should tend to improve the Fe-Mn ratio as reported by Somers and Shive (9) and should tend to prevent leaf chlorosis.

The bark and leachate contained ample quantities of Fe and Mn for good growth. However the Fe content was lower in holly grown in bark than in those grown in sand (Table 1). A similar repression in Fe uptake by Mn was also observed in soybean by Somers and Shive (9). The 400 ppm Fe found in bark is twice as much as the 197 ppm Mn which is a ratio favorable for Fe uptake. The leachate contained 86 ppm of Fe and 612 ppm of Mn. This ratio is

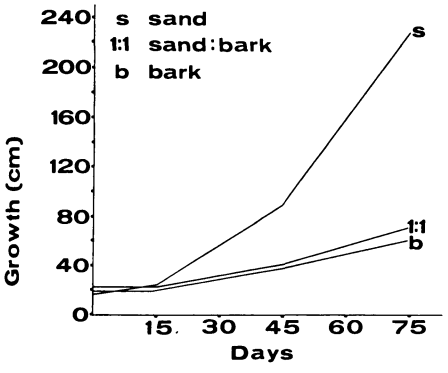

Fig. 1. Cumulative shoot growth of Japanese Holly plants grown in 3 media.

[1]Received for publication March 20, 1972. The investigation reported in this paper (No. 72-10-15) is in connection with a project of the Kentucky Agr. Expt. Sta. and is published with approval of the Director.

[2]Graduate student and Assistant Professor of Horticulture, respectively.

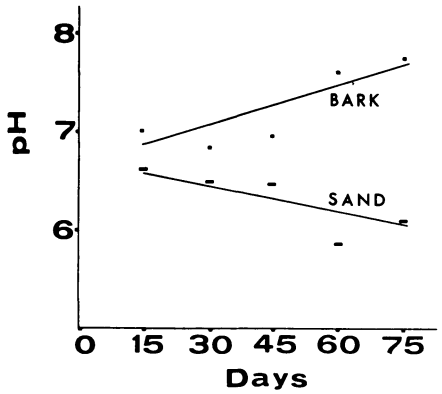

Fig. 2. Changes in pH of 2 media with time as determined by leachate measurements.

definitely adverse for plant growth and could be expected to produce symptoms of Mn toxicity in soybean (9) and in other species (7). Mn uptake is relative to the available Mn in the growing medium (4, 8, 9). The Mn content of leaves was approx twice as high in holly plants grown in bark as in holly plants grown in sand (Table 1). The chlorosis appears to be the symptom of Mn toxicity rather than Fe deficiency. Since repressed growth rates are symptomatic of Mn toxicity (7), the repressed growth rates of holly in bark further support the hypothesis of Mn toxicity.

Table 1. Fe and Mn content of Japanese Holly leaves from plants grown in 2 media and irrigated with 2 nutrient solutions.

Media	Fe content in nutrient solution	Leaf content (ppm) Fe	Mn
Sand	Fe	212	630
	No Fe	207	588
Hardwood bark	Fe	153	992
	No Fe	111	1125
LSD	5%	60	294

High Mn contents were found in the barks of several hardwood species by Haramaki, Nuss and Oliver (personal communication). If Mn uptake of tree species is related to the available Mn in the soil as is reported for herbaceous species (4, 8, 9), trees grown on manganiferous acid soils could be expected to contain large quantities of Mn. This accumulation of Mn should be considered when using hardwood bark as a soil amendment.

Literature Cited

1. Allison, F. E. 1965. Decomposition of wood and bark sawdusts in soil, nitrogen requirements and effects on plants. *U. S. Dept. Agr. Tech. Bul.* 1332. 58 p.
2. Anonymous. 1971. Growing media for container grown ornamentals. *Nursery Business.* 17(1):67-68.
3. Dutt, J. O. and E. L. Bergman. 1966. Nutrient solution culture of plants. The Penn. State Univ., College of Agr., Ext. Serv., University Park, Pa. 16 p.
4. Emmert, E. M. 1931. The effect of soil reaction on the growth of tomatoes and lettuce and on the nitrogen, phosphorus and manganese content of the soil and plant. *Univ. Kentucky Agr. Expt. Sta. Bul.* 314. 83 p.
5. Hornsby, A. G. and R. E. Phillips. 1965. Comparative effects of undecomposed wood residues and peat moss on growth of sudan grass. *Univ. of Arkansas Agr. Expt. Sta. Bul.* 696. 31 p.
6. Jones, J. B., Jr. and R. A. Issac. 1969. Comparative elemental analysis of plant tissue by spark emission and atomic absorption spectroscopy. *Agron. J.* 61:393-394.
7. Labanauskas, C. K. Manganese. p. 264-285. *In* Chapman, H. D. (ed). 1966. Diagnostic criteria for plants and soils. Univ. of Cal. Riverside, Cal. 793 p.
8. Mann, H. B. 1930. Availability of manganese and of iron as affected by applications of calcium and magnesium carbonates to the soil. *Soil Sci.* 30:117-141.
9. Somers, I. I. and J. W. Shive. 1942. The iron-manganese relation in plant metabolism. *Plant Physiology* 17:582-602.
10. Tatnall, D. V. and C. W. Dunham. 1963. Nutrient deficiency symptoms in American, Japanese and Chinese hollies. *Proc. Amer. Soc. Hort. Sci.* 78:560-563.

Growth and Flowering Response of Deciduous Azaleas to Growth Retardants[1]

G. F. Ryan
Western Washington Research and Extension Center
Washington State University, Puyallup

Abstract. **The no. of flower buds on 'Gibraltar' Exbury azaleas (*Rhododendron* spp.) was increased by single sprays of succinic acid-2,2-dimethylhydrazide (SADH) at 7,500 to 20,000 ppm, 1-propyl phosphonic acid (PPA) at 1000 ppm, 5-chloro, 2-thenyl, tri-n-butyl-phosphoniumchloride (CTBP) at 1000 and 3000 ppm, and α-cyclopropyl-α-(methoxyphenyl)-5-pyrimidinemethanol (ancymidol) at 250 and 500 ppm. Applications in July reduced plant ht. Early August applications of SADH had less effect on no. of flower buds than early July applications and did not reduce plant ht. Double sprays of (2-chloroethyl)trimethyl ammonium chloride (chlormequat) at 2000 and 4000 ppm did not affect ht or no. of flower buds. A soil drench of 2,4-dichlorobenzyl-tributylphosphonium chloride (CBBP) at 0.5 or 1.0 g per plant increased the no. of flower buds on 'Cecile' and 'Renne' Exbury azaleas.**

Young plants of some cultivars of deciduous azaleas do not produce a commercially acceptable no. of flower buds by their 2nd year of growth. Effects of growth retardants on flower initiation in rhododendrons and evergreen azaleas have been studied extensively since the first reports by Stuart and Cathey (1, 2, 3). This paper reports growth retardant effects on flowering and plant growth of 3 cultivars of deciduous azaleas of the Exbury Strain of Knaphill Hybrids.

Rooted cuttings of 'Gibraltar' were started in the summer of 1967, planted in 3.8 liter cans in May 1968 and sprayed with SADH[2] at 7,500 and 10,000 ppm on July 10. In this and later experiments, the 85% soluble powder formulation of SADH was used, without added surfactant except as indicated later. The no. of flower buds per plant was more than doubled by the SADH applications.

The 2nd experiment was with plants of 'Gibraltar' propagated in 1968 and transplanted in 1970 to 7.6 liter cans in a commercial nursery. Treatments consisted of 3 rates of SADH applied as single sprays on 3 different dates starting July 6 or double sprays July 6 and 22. Double sprays of chlormequat[2] at 2000 and 4000 ppm were also included.

On these older and larger plants, there was a significant but somewhat smaller response than in 1968 (Table 1). The increase in flower buds was due primarily to an increase in the no. of buds per shoot, rather than to more shoots with flower buds. Two applications were not significantly more effective than 1 application (data not shown).

Two weeks difference in timing of a single application in July had no effect on total no. of buds per plant (Table 1). However, early July application increased the % shoots producing flower buds. The % shoots with flower buds was not affected by late July or August applications, except for the highest rate (20,000 ppm) applied July 22. Plant ht was significantly reduced by the early July applications, and the plants had up to 20% more shoots. Plant ht and no. of flower buds were not significantly affected by chlormequat.

Time and rate of application of SADH affected time of flower opening the following spring (Table 2). The August application of 20,000 ppm delayed opening approx 2 weeks, compared with untreated plants. Except

[1]Received for publication May 8, 1972. Paper No. 3857. Project No. 0085, Washington Agricultural Experiment Stations, Pullman, Washington 99163.

[2]Chemicals used in this study were supplied by UniRoyal Chemical Division of UniRoyal, Inc., American Cyanamid Company, Niagara Chemical Division of FMC Corporation, Chemagro Corporation, Eli Lilly and Company, and Mobil Chemical Company.