INTERACTION OF 3-INDOLEBUTYRIC ACID AND BENOMYL IN PROMOTING ROOT INITIATION IN STEM CUTTINGS OF WOODY ORNAMENTAL PLANTS[1]

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Abstract. Cuttings from twelve clones of *Ilex*, *Rhododendron*, *Sciadopytis*, *Magnolia* and *Vitis* (woody ornamental plants) were tested for rooting response to combined treatments of benomyl and indolebutyric acid. Response was variable Better rooting was obtained with combined treatments in clones that are normally difficult to root Clones that normally root easily did not show improvement in rooting when benomyl was used with IBA. It is suggested that benomyl may act as a mobilizer in stimulating rooting.

INTRODUCTION

Combinations of auxins and fungicides have been common in plant propagation for many years (4, 9, 10, 12). More recently systemic fungicides have been employed with some success (3, 6). Results have not always been demonstrated to be the results of disease control since in many cases untreated plants showed no evidence of fungal or bacterial invasion. This leads to the conclusion that at least some of the beneficial effect of fungicides in general, and systemic fungicides in particular, may be due to some effect other than fungicidal properties.

The two systemic fungicides most commonly used over the past three years are Benlate (benomyl) and Mertect or TBZ (thiabendazole). The two compounds are very closely related. Benomyl decomposes to benzimidazole carbamic acid methyl ester (BCM). This is thought to be the active ingredient in fungicidal activity. Benomyl breaks down rapidly in water to BCM and in the bean plant it breaks down completely in five days (7). Less is known about TBZ.

A recent study (11) showed that five systemic fungicides commonly used in plant propagation improved rooting of rhododendron cuttings but had no effect on disease control. The response in that study suggested that other genera of plants should be treated with the

[1]Approved for publication by the Director of the Rhode Island Agricultural Experiment Station as Contribution Number 1421.

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more promising systemic fungicides to determine if they also exhibited beneficial additive effects on rooting when systemic fungicides were used with auxins.

MATERIALS AND METHODS

Treatments with auxins and fungicides were applied as talc formulations of 3-indolebutyric acid, with or without benomyl, (methyl 1-(butylcarbomoyl) 2-benzimadazolecarbamate). The numbers of cuttings used in the replicates were determined by available supply but were never less than 25 nor more than 75. All tests were replicated four times and only clonal plant materials were used. The experiments were carried out throughout the year 1970-1971, with cuttings taken at the optimum time for rooting each clone.

Plants included were: *Rhododendron* 'English Roseum', 'Catawbiense Grandiflorum', 'Cunningham's White', 'Lees Dark Purple', *Ilex glabra* 'Leucocarpa', *Ilex opaca, Magnolia conspicua, Sciadopytis verticillata, Juniperus chinensis* 'San Jose', *Vitis labrusca* 'Moore's Early'. There were two clones of *Ilex opaca* and Rhododendron 'Lee's Dark Purple' to make a total of twelve clones in the test. All cuttings were propagated in a rooting medium of equal parts by volume of sphagnum peat moss and coarse grade horticultural perlite in flats on raised beds in a greenhouse. No bottom heat was used but minimum air temperature was 65° F. Mist was electrically controlled to provide six seconds of mist every three minutes. Cuttings were all terminal shoots approximately 4-6 inches long, depending on the clone.

Data were recorded on the basis of percentage of cuttings rooted and on rooting quality. Quality was determined either by counting actual number of roots per cutting or by measuring diameter of rootballs of cuttings with fibrous root systems. A third observation was made of root quality based on the number of primary root connections to the base of the cutting but it was not tabulated in this paper.

RESULTS AND DISCUSSION

When rooting responses were tabulated (Table 1 and 2) it was apparent that addition of benomyl significantly improved rooting quality on some cultivars and in some cases percentages of rooting. This was particularly true of *Ilex opaca, Sciadopytis verticillata* and *Juniperus chinensis* 'San Jose' as well as *Rhododendron* 'Lee's Dark Purple'. In the case of *Ilex* and *Rhododendron,* where two clones were tested, most striking results were obtained with the clone that is more difficult to root. This trend has been observed with other clones not reported in this paper. The reverse can be seen in the clones of *Rhododendron* that are easy to root. They did not exhibit any significant improvement in rooting with the addition of benomyl although there was some increase in root quality.

Table 1. Effect of IBA and benomyl on rooting of stem cuttings of woody ornamental plants

	Treatment											
	4.5% IBA		4.5% IBA + 5.0% benomyl		3.0% IBA		3.0% IBA + 5.0% benomyl					
Cultivar + propagation period	No. Roots *	%	No. Roots	%	No. Roots	%	No. Roots	%	No. Roots	%	No. Roots	%
R. 'English Roseum' 10/25—2/2/71	1.4	95	2.2	100	1.1	95	2.3	100.0	0.9	95.0	1.6	95.0
R. 'Cat. Grandiflora' 10/27—2/2/71	2.4	100.0	1.3	100.0	2.0	100.0	1.6	66.7	0.0	50.0	1.2	83.0
R. 'Cunningham's White' 10/27—2/2/71	0.8	75.0	1.6	87.0	1.3	57.0	1.3	71.0	1.1	100.0	1.0	57.0
Ilex glabra 'Leucocarpa' 10/22—12/12/71	1.7	80.0	2.1	83.3	1.5	60.0	2.4	100.0	1.0	63.3	1.5	79.2
Sciadopytis verticillata 11/3—6/28/71	0	0	1.0	25	0	0	40.5	25.9	8.0	7.1	8.0	54.4
Magnolia conspicua 7/5—10/15/70	2.9	60.2	20.9	100.0	3.0	60.2	11.3	92.3	0.0	0.0	0.0	0.0

* Root ball diameter for rhododendron cultivars

Table 2. Rooting response of woody cuttings to treatment with IBA and benomyl

Cultivar + Propagation period	Treatment							
	4.5% IBA		4.5% IBA + 5.0% Benomyl		3.0% IBA		3.0% INA + 5 0% Benomyl	
	No. Roots	%	No. Roots	%	No. Roots	%	No. Roots	%
Ilex opaca								
12 / 30 — 3 / 18 / 71								
Female	4.3	45.0	8.4	36.3	6.6	37.5	23.2	81.8
Male	11.3	80.0	30.5	100.0	15.4	100.0	35.8	100.0
Juniperus chinensis 'San Jose' 12 / 29 — 3 / 5 / 71	13.5	90	14.5	95	14.1	90	16.8	90
Vitis labrusca 'Moores Early' 3 / 10 — 4 / 4 / 71	6.1	18.7	18.7	56.2	—	—	—	—
Rhodendron 'Lee's Dark Purple'								
11 / 25 — 2 / 26 / 71								
Curly Leaf	0.9 *	70.0	2.5	90.0	—	—	—	—
Smooth Leaf	3.5	90.0	3.8	100.0	—	—	—	—

* Data for rhododendron expressed as rootball diameters.

Hoitink (6) reported a decrease in time required to obtain a good root system when systemic fungicides were used in combination with auxin. This was also observed with some of the clones tested, particularly *Vitis* and *Magnolia*. This would have commercial importance even if no substantial increase in rooting was observed.

One fairly consistent trend observed in this study but not shown in the data was the number of primary root connections on cuttings treated with IBA and benomyl. This has significant commercial importance since a heavily rooted cutting with few primary roots cannot be handled in commercial planters and may be lost even with manual planting. It has been consistently observed at this station that when cuttings with fibrous root systems develop after treatment with systemic fungicide alone, without auxin, few primary roots develop but when the fungicide and auxin are used together the number is increased. This is not necessarily reflected in the data and was not tabulated here because no way has been derived to obtain the data without destroying the cutting.

The question of why fungicide-auxin combinations are effective as root promoters cannot be answered at this time. The first objective of this work was to determine if they were effective and to determine if the differences were significant for a larger number of plant species. This has been determined. Research will now be directed toward answering the more basic questions of how the fungicides act to stimulate root initiation and development when used alone and with auxin.

Structurally BCM resembles many compounds that are known to have biological activity as growth regulators or auxins. BCM may act in woody plants as either a weak auxin or as a mobilizer to cause other endogenous materials to move to the site of root initiation and stimulate more rooting.

Other researchers have found that BCM interferes with DNA synthesis in some but not all fungi (1, 2). Sels (8) reported that it acts as a purine antimetabolite and can replace nicotinamide in NAD. Kapoor (7) stated that it forms a benzimidazole adenine nucleotide in yeast but how this may relate to higher plants is not known at this time. Benomyl has been shown to retard senescence and in this respect it may be thought to resemble kinetin or benzyladenine. If this is the case, BCM could well be a mobilizer as has recently been reported for kinetin (5).

Most researchers agree that since very small quantities of the systemic fungicide are taken up by the plant the site of action must be quite specific. Though the site for improved rooting and that for fungicidal action may not be the same it does appear that small quantities are needed for rooting also. Since growth regulators have been used in excess in most rooting experiments reported here it is believed at this time that the action of the fungicides cannot be that of a weak auxin and is more likely that of a mobilizer. Work will be done over the next two years to accept or reject this hypothesis.

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MODERATOR FLEMER: That was very well presented, John. We do have time for a couple of questions.

JIM WELLS: I would just like to add that we have been using Benlate this year just as we were using Captan in the past and it does have a good effect on many, many varieties. It not only improves the rooting, it improves the quality of the rooting. Captan improves rooting one step, Benlate improves it two steps.

JOHN McGUIRE: I have heard of two cases of injury from the use of Benlate. Dave Leach mentioned one of them. Perhaps he would like to comment here.

DAVE LEACH: What I found was that it inhibited rooting with the system I used. I used Nearing propagating frames which are essentially a cold frame with a visor on the south side and no heat. It would seem to me that when you are using mist propagation there is a good possibility that the Benlate is diffused. Using about 120 clones and a 1000 cuttings, the evidence was rather strong that in using this method of rooting, Benlate inhibited rooting.

MODERATOR FLEMER: Thank you once again, John.

As part of our program this afternoon, we have a panel which is going to brmg us some short reports on "Propagating Experiences, Old and New". Mr. Zoph Warner will act as moderator for this panel.

MODERATOR WARNER: When Bill asked me to organize this panel, I decided to choose some individuals who I thought might have some interesting things to talk about and then give them as much leeway as possible in choosing their subject. So I didn't ask them to stick to the panel title too closely, but I think we are all right because I heard one of the participants say he wasn't even going to talk about propagating. We are a little short of time and so no questions will be taken until each of the participants has presented his paper.

In choosing people for this panel one of the things I thought about was the fact that in the commercial world one is often judged by how much money he makes and so with this in mind, I would like to lead off the panel with Joe Cesarini because before he got into this business he was a bricklayer and everyone knows how much money they make.

PROPAGATION OF CARPINUS BETULUS 'FASTIGIATA'

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At Johnson Avenue Rare Plants Nursery, I used to propagate cultivars of *Carpinus betulus* by grafting them, during the winter months, on previous spring-potted understock of *Carpinus betulus* or *Carpinus caroliniana*. The grafting was done in the greenhouse at a temperature of 65° F, using the modified veneer system. I was somewhat annoyed by the unpredictable results so I explored a different way of propagation.