

reaches 140°F, at which time the steam is turned off, but the blower is continued until the soil mass has cooled to ambient temperatures.

A special steam outlet point from a greenhouse steam supply, together with an electric outlet point, were installed for use in operating the unit (Figure 1).

This soil pasteurizing unit has been in operation for about six months with completely satisfactory results.

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NEW FUNGICIDE EVALUATED FOR CONTROL OF ROOT ROT FUNGI

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Abstract: A new fungicide, Subdue (CGA 48988)¹, has shown a high level of activity in controlling Phycomycetous root rotting fungi that attack ornamental plants. *Juniperus sabina* 'Tamariscifolia,' *Pinus radiata* and *Brassaia*

¹ Manufactured by CIBA-GEIGY Company.

actinophylla plants growing in an inoculated soil mix and treated with Subdue had more top growth than plants growing in the untreated inoculated soil mix.

Root rotting fungi are a frequent cause of loss in the production of container-grown plants and fungicides are frequently used as an aid in their control.

Studies were conducted to determine the effectiveness of the fungicide Subdue (N-(2,6-dimethylphenyl)-N-(methoxyacetyl)-alanine methyl ester) working with *Juniperus sabina* 'Tamariscifolia,' *Pinus radiata*, and *Brassaia actinophylla*.

MATERIALS AND METHODS

Plants of each species were established in 2.25-inch square pots using a steam sterilized soil mix. The plants were then transplanted into 4-inch square pots using a steam sterilized soil mix and a water mold fungus was introduced into the soil mix except for one replication of plants for each species for growth comparison. This one replication of plants of each species were grown in the steam sterilized soil mix with no fungicide treatments being used or the fungus added.

The soil mix consisted of equal parts on a volume basis of sandy loam soil, peat, and perlite. The fungus cultures were grown on millet seed and thoroughly incorporated into the soil mix at a rate of 50 ml of a millet seed culture to 10 liters of soil mix except for *Brassaia*. With *Brassaia* 5 ml of a soil mix colonized with the fungus was introduced into each 4-inch pot 7 days before the treatments were made.

For the juniper and *Brassaia* a *Pythium* species was used which had been isolated from diseased plants of the same species. A *Phytophthora* sp. was used with the Monterey pine which had been isolated from diseased Monterey pine trees. Liners were selected for uniformity before being transplanted into 4-inch pots and treated with the fungicides. Several rates of Subdue were used (see Table 1) to establish the range of effectiveness; Truban was used at a label rate.

Table 1. Mean Fresh Weights of Plant Tops in Grams.

Treatments	Rate per 100 gal.	Juniper	Pine	Brassaia
1. Subdue 5W	2.5 oz	—	—	19.6
2. Subdue 5W	5.0 oz	5.6	9.6	18.2
3. Subdue 5W	10.0 oz	5.9	13.1	19.2
4. Subdue 5W	20.0 oz	6.2	11.4	—
5. Truban 30W ¹	10.0 oz	3.5	8.4	15.8
6. Inoculated soil mix	—	2.4	4.1	9.1
7. Steam sterilized soil mix	—	5.7	16.4	18.4

¹ 5-ethoxy-3-trichloromethyl 1-1,2,4,-thiadiazole

The chemicals were mixed in water and 80 ml of the solution was added to each 4-inch pot which is equal to 2 pints per square foot and was adequate to wet the soil volume. The pines and *Brassaia* were grown in the greenhouse and the junipers were grown outdoors in a shade house. The *Brassaia* plants were grown for 9 weeks in the 4-inch pots, the pine for 12 weeks and the juniper for 16 weeks and then the tops of the plants were cut at the soil level and weighed. The average fresh weights of plant tops are given in Table 1. With *Brassaia*, 4 single pots were used per treatment; 8 single pots were used per treatment with the juniper, and with the pine 10 single pots were used per treatment.

RESULTS

Plants treated with Subdue had more top growth than the untreated plants growing in an inoculated soil mix (see Table 1). Truban-treated plants also had improved top growth over the plants growing in the untreated inoculated mix though the growth was usually less than the Subdue-treated plants. The growth of the juniper and *Brassaia* Subdue-treated plants was comparable to the plants grown in the steam sterilized soil mix.

DISCUSSION

Findings of these studies indicate that Subdue is an effective fungicide for controlling some *Pythium* and *Phytophthora* species that can cause root rot diseases of *B. actinophylla*, *J. sabina* 'Tamariscifolia' and *P. radiata*.

BRUCE BRIGGS: We will now have a short question period.

CHARLES PARKERSON: John, how wide is the ring bark you used on your etiolated shoots?

JOHN DELARGY: It is 4 mm roughly.

CHARLES PARKERSON: Is that width significant?

JOHN DELARGY: I haven't done any experimentation on the width. As long as the girdling is complete — that is the essential thing.

CHARLES PARKERSON: I didn't quite follow your etiolation procedures.

JOHN DELARGY: The shoots on the plant are grown in darkness for etiolation until they are 10 cm long, then the black tent is removed. Etiolation is maintained by wrapping the lower segment with black polythene tape. But in the upper segment of stem, which is exposed to light, the effects of etiolation are reversed; it greens up. Where it is protected by the black tape it does not green up.

CARL PERLEBERG: Is there a chance that you could do the same thing by painting the stem with black asphalt paint?

JOHN DELARGY: I think so, as long as there is no toxic effects from the paint. Of course, the essential feature is the exclusion of light. Anything that would exclude light would achieve the same effect.

VOICE: What is the man's name with the paper from the thirties who experimented with etiolation?

JOHN DELARGY: Dr. F.E. Gardner (Proc. Amer. Soc. Hort. Sci. 34:323-329. 1937).

WESLEY HACKETT: Have you thought about how the basal ringing is promoting the rooting? It doesn't seem to fit in with the idea of a promoter moving from the apex with the leaves.

JOHN DELARGY: I imagine it dams up the promoter. So instead of flowing on into the branch in which the shoot is borne, the rooting promoter(s) accumulates in the etiolated segment. Sugars and amino acids, I believe, are known to accumulate above girdling cuts.

WESLEY HACKETT: The ring is made a long time before taking the cuttings — is that right?

JOHN DELARGY: The ring is made about 15 days before taking the cuttings.

VOICE: Ring barking without etiolation, what is the effect?

JOHN DELARGY: It is completely without effect. No rooting occurs on the apple shoots without etiolation.

CARL PERLEBERG: How old are the oldest plants that you have growing and how well are they growing?

JOHN DELARGY: I have never followed through to see how the plants grow.

CARL PERLEBERG: So you have gone all this way and you do not know if they will grow in the field?

JOHN DELARGY: Well, this etiolation effect seemed to be so striking that it was more important to me to determine the mechanism of the effect rather than try to use it commercially. It is so cumbersome and laborious, as it stands now, that the commercial possibilities are nil. It is not practical to use it. It seems more important to try and understand what is going on so that some use may be made of it later based on a complete understanding of the mechanisms involved rather than try to employ the method as it now stands.

VOICE: Did you find any large differences among the apple cultivars you have tried?

JOHN DELARGY: No, but Gardner did. He found no cul-

tivar which did not respond. Some responded better than others.

VOICE: Was there any correlation with the standard size vs. dwarf apple trees?

JOHN DELARGY: I can't recall that this comparison was made.

PHILIP McMILLAN-BROWSE: Was the length of the cutting that you took determined by individual length or did you take the cutting flush with the stem and thereby incorporate the complete girdled area?

JOHN DELARGY: We usually took the cutting in the center of the ring bark so it would be on the new wood. Of course, other control cuttings would have to be taken at comparable positions.

PHILIP McMILLAN-BROWSE: So you didn't take the cuttings completely back to the old wood?

JOHN DELARGY: No, I did not.

PHILIP McMILLAN-BROWSE: I ask the question because it is very evident that with the apple you get an increase in rooting potential if you incorporate the base of the shoot in the cutting.

JOHN DELARGY: I have known about this but it didn't seem to be important particularly with these cultivars.

VOICE: What is the intensity of light on them?

JOHN DELARGY: The intensity of light, the total quantity of light — the photon flux — the higher it is, the less the rooting which eventually took place. Obviously, when you use black polyethylene you exclude all light and rooting is at a maximum. Conversely, when you use material which lets more light through, rooting is at a minimum.

TOM WOOD: Recent work along this line at East Malling Research Station, England, was explained at a nurserymen members day only last week. They were doing the same thing with black polythene tents on apple stock plants. They treated the plants for 3 weeks without light and then took the shoot growth, irrespective of whether they continued the etiolation at the base of the stem, or not. They used foil to cover the base of the shoots. They found that they could get the same amount of rooting whether they used foil or not; similarly, they could go back six weeks later and use any regrowth that had taken place after the first batch of cuttings had been taken; these would root also. So I think that the development along these lines is that whatever happens when the initial period of darkness takes place carries throughout the season.

BRUCE BRIGGS: There are some people at East Malling that have done a lot of work in this area. There are indications — I hope it has been published — that possibly part of this phenomenon has to do with the condition of the tissue, as sunlight seems to destroy something that is essential in root initiation. At East Malling they found they could substitute some chemicals for those that seemed to be destroyed by sunlight. So this is another approach to part of the etiolation effects.

Let's take rhododendron plants grown both in the north and in the south. You can go into a lathhouse with low light and take cuttings and usually they will root much better than those taken out in the hot sun. Their explanation over at East Malling was that sunlight destroyed some rooting factor in the cuttings. In shade, the rooting chemical lasted longer and you could take the cutting over a longer period of time.

VOICE: For the aerated steam unit do you have an automatic shutoff when the temperature reaches 140°F?

HUDSON HARTMANN: No, we shut the steam off manually when we see that the temperature has reached that point. We could make it more automated than we have done here.

VOICE: Have you investigated how uniform the temperature is throughout the soil mix?

HUDSON HARTMANN: Yes, it is important to see that the temperature is the same throughout the mix — that you don't have hot spots. One of the problems is that there could be a blowout, where the force of the steam-air going up through the mix could open up a hole and the steam-air would go out through the hole. Some of the units have the plenum at the top with the steam-air introduced at the top moving down. Then if you have a blowout the loose soil tends to fill up the hole.

VOICE: Is the soil being agitated inside the chamber?

HUDSON HARTMANN: No, it is not agitated. The mix is fairly loose, but it is not agitated during the pasteurizing treatment.

VOICE: Do you have any trouble with the holes in the plenum chamber being clogged up, or excess soil getting down into the plenum?

HUDSON HARTMANN: We haven't so far. The size of the holes and their distance apart is quite critical. There are certain limits to it or there could be trouble.

BRUCE BRIGGS: Over in Australia, on our recent IPPS tour, we were looking at all the forms of aerated steam used for soil pasteurization. A man with us on the tour said "We have known that principle for forty years and we have used it in the

lumber business." They found that when they were drying lumber in the kilns that if they mixed air with their steam heat the lumber dried about four times as fast as with heat alone. You better look around and see what your neighbor is doing and use some of his procedures at times.

MIKE SMITH: I have a question for Wes Humphrey about this compound, SUBDUE. Have you done experiments under field conditions with one-time application once the plants are established? For most crops, unless you are talking about a very expensive crop as rhododendrons or higher priced azaleas, two to three month reapplications scheduled throughout the term of the crop would be prohibitive for most crops. Generally, we are interested more in either preventive applications or routine applications on those we know to be trouble plants. We need one-time applications as soon as the plants have been established a month or two in the can; we try to get away with one corrective application when we see the first signs of symptoms of water molds.

WES HUMPHREY: Good question, Mike. As far as the work that we have done under grower's conditions, no. Typically there we have been using either a 60 day or 90 day retreatment. Work that we did, however, say under greenhouse conditions or under our conditions there at the South Coast Field Station with the junipers, that was just a single treatment. The same thing was true with Monterey pines that we worked with at the South Coast Field Station. There we carried those through for a reasonable period of time depending on the species and then we harvested that particular crop. So, there was only a single treatment and we got a favorable response. What we are doing now, and the work that we did last year under field conditions, no — it was repeat treatments. Your point is well taken and one that would be a good thing for us to evaluate under field conditions.

Bruce, let me mention a couple of other things that were brought up during the break that some of the rest of you might be interested as well in relation to this particular material. Somebody asked, "is it going to be released under an experimental permit use basis". The answer is — no. The material is far enough along, close enough to registration, that the company hopes to have a full label product available for any and all use by ornamental producers soon after January, 1980. So they don't, as with many other materials, expect to produce a fair amount of it for purposes of experimental use. The other thing was about its effect on *Rhizoctonia*. I may not have made that clear in the presentation that I made. It is not effective on *Rhizoctonia*. It is only effective on the *Phycomycetes*, a particu-

lar group of fungi which include *Pythium* and *Phytophthora* and some other fungi of that type. If *Rhizoctonia* is a concern, and you are not controlling it by good clean culture, then another fungicide would need to be brought in for control of that disease.

JUDY GARLOCK: You mentioned sensitivity; some crops are sensitive. How do we recognize symptoms of sensitivity to SUBDUE?

WES HUMPHREY: One thing to watch when the product does become available is what is stated on the label. One of the plants that shows sensitivity at normal label rates is variegated euonymus, where the variagation is on the margin of the leaf. There the chemical causes an additional bleaching of that tissue that doesn't have any chlorophyll in it. On *Monstera deliciosa*, with some work that we have done, using repeat applications at label rates, we experienced some additional chlorosis — marginal chlorosis on the leaves.

BRUCE BRIGGS: In both Europe and Australia this chemical is being used. We found in Australia they were not too excited about it in controlling *Phytophthora cinnamomi*. Wes, have you checked it on this? What form of *Phytophthora* were you working on? They were disappointed, it wasn't giving that good a control; but it was really excellent on mildew.

WES HUMPHREY: It would be good for downy mildew, but it isn't worth using for powdery mildew. This material is effective on *Phytophthora cinnamomi*. There is enough good evidence to show this. But even though it has an eradicant property it does not mean that if the plant has a root system that is highly contaminated or highly infected with the fungus that you are going to work miracles. It is no miracle material; none of them are. What I am saying is this — it is far better used on a preventive basis. But it also has the ability to do some eradication. If you have an avocado tree growing out in the field that has dropped all of its leaves, and it looks like a dog, no — better jerk that tree out of there and plant a young, fresh tree and use the material as a preventative to gain control of *Phytophthora*.

It is interesting that Bruce picks up this information from discussions in Australia, then one of our plant pathologists returns from Australia with the information that this material in the field looks pretty good on controlling *Phytophthora* on avocados, so it is reported to be effective there.

BRUCE BRIGGS: When we brought the subject up, there were about 100 nurserymen from Queensland in the room, including Ed Bunker; we got our information from people who had been working for a couple of years with SUBDUE. I think

you want to consider that there is a difference on how you use it, where you are located, the weather conditions, and everything else — so look at the whole package.

JAY ALLISON: This is for Hudson Hartmann. How does your steam aerator differ from commercial equipment, like the Lindig steam aerator?

HUDSON HARTMANN: In principle, it would be about the same. It is one that we decided that we would build ourselves rather than buying a commercial one, but they all do the same thing. They have an air stream going in with steam injected into it. I don't think there is any really great difference in principle.

RALPH SHUGERT: Wes, do you have any idea about costs of SUBDUE? Secondly, have you experienced any control of *Phomopsis* — thinking of its use on *Juniperus sabina* 'Tamariscifolia' primarily.

WES HUMPHREY: Let me answer the last part first. *Phomopsis* — no! don't expect it to do a thing for you there. Not active with this group of fungi.

Pricewise, from what I understand in talking to CIBA-GEIGY'S technical people is that SUBDUE isn't going to be any cheaper than other products now available but it will be competitive with what is now on the market. You will be, in effect, paying a higher price for the actual chemical you are paying for now in the formulated Lasan or Truban. But the activity level of SUBDUE is 30 to 40 fold over the other materials so it doesn't make a lot of difference, but you could be buying a lot of dilutant to use with it.

RALPH SHUGERT: Will there be more systemic action with this chemical?

WES HUMPHREY: No, I would not expect so. Let me take just a minute to explain what is probably a question in your mind. The material is formulated as an EC, but with a trade name they will call RIDOMIL. That will be the formulation they will register for agricultural use. What I am saying is that the RIDOMIL label will be for agricultural use, the SUBDUE label will be for ornamental use.

VOICE: I want to know what determines the 140°F temperature required to get rid of the pathogens and yet not eliminate the beneficial mycorrhizal fungi?

HUDSON HARTMANN: Well, there has been a great backlog of work that has been done by plant pathologists over the years; it was 40 to 50 years ago that this work was originally started and a lot of follow up work has been done. Some of the articles by Dr. Baker, which are cited in my paper, de-

scribes these studies. There has been really a tremendous amount of work done by the plant pathologists, and 140°F for 30 minutes is the point arrived at which kills most pathogenic organisms but not most beneficial ones.

HOWARD BROWN: Bruce, I don't have a question but I thought it would be appropriate to elaborate on what Tok Furuta brought out here in regard to nitrogen fertilizer from natural gas. We face a real problem in the state of California now. Natural gas is the main heat source for the production of ammonia, to result in nitrogen fertilizer. Two years ago we had eight major companies manufacturing nitrogen fertilizers. Because of the rapid increase in the price of natural gas, all but two of those companies have gone out of business. Mexico and U.S.S.R. are making a great deal of nitrogen fertilizer now, selling it in the state of California and, I imagine, in the rest of the United States, for much less than our local people can manufacture it for. The California State Board of Agriculture recently passed a resolution sent to the Public Utilities Commission, and other governmental agencies, recommending that the price of natural gas be frozen for at least one year for the manufacturers of nitrogen fertilizers — Union Chemical Company and Valley Nitrogen — so that they can continue to make nitrogen fertilizer domestically. What would happen if we got to the point where we were depending upon an OPEC type of arrangement for purchase of nitrogen fertilizers?

PLANT PROPAGATION IN VIRGINIA

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Lancaster Farms is a small wholesale container nursery located in the southeastern tip of coastal Virginia (zone 8b on the U.S.D.A. Plant Hardiness Zone Map). Production is centered around twenty genera of broadleaf evergreens and ten genera of coniferous evergreen plants. Propagation is mainly by cuttings using three different time schedules. Coniferous evergreens are propagated between January 1 and February 15. Broadleaf evergreens for 1 gallon production are made during December, and broadleaves for 2 and 3 gallon production are made between June 15 and September 15. A few items are propagated by seeds or division.

Propagation Decisions. A propagation system starts with a basic decision as to the type of production that works best for