cutting and in some instances may show definite inhibition.

HUGH STEAVENSON: Our next speaker doesn't need any introduction. Bill Snyder has been mixing up some hormone formulations that may become as popular as the Gibson. At Rutgers he is known as synergism Snyder.

HORMONE-FUNGICIDE COMBINATIONS IN ROOTING

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The propagator's search for chemicals to improve the rooting of stem cuttings has been directed primarily along two lines: first, chemicals which increase the rooting response itself; and second, chemicals which reduce the incidence of disease in the propagation bench.

With the discovery, in the mid-1930's, of the stimulating effect of indoleacetic acid and related compounds on rooting, it was hoped that successful rooting of all stem cuttings would be relatively easy. Such a naive idea, however, was soon expelled for, as was soon learned, the cuttings of many plants remained difficult to root even when treated with these chemicals.

There are numerous factors which contribute to a possibility of disease in the propagation bench. The use of soft, succulent plant tissue, the frequent presence of systemic diseases within the stock plant, the everpresent spores of fungi on the plant, in the air and the medium, the use of warm, humid conditions which are equally suitable for growth of both fungi and roots, and even the dipping or soaking methods frequently used to apply root-inducing chemicals to the cuttings — all of these pose a potential threat to successful rooting of cuttings.

It was only logical that investigations would be made involving the incorporation of a fungicide with the root-inducing chemical treatment.

In 1941, Grace (5, 6) and Grace and Farrar (7) added nutritive salts and an organic disinfectant, ethyl mercuric bromide, to the talc containing indolebutyric acid. Their data show that the disinfectant resulted in an increased rooting response with some plants (*Coleus, Chrysanthemum* and *Deutzia*), no effect with some plants (*Symphiocarpus, Lonicera* and *Taxus*), but with an increased mortality of at least one plant (*Weigela*).

Geranium and carnation cuttings are especially susceptible to fungus diseases. White (15) has shown that ferbam (ferric dimethyldithiocarbamate), sold as Fermate, Chromate, Ferberk, etc., used either alone or in combination with a root-inducing chemical not only significantly reduced the

number of dead or rooted cuttings, but also increased the percentage of healthy cuttings which rooted. Other workers have also reported beneficial effects of adding ferbam to the chemical treatment, for example: *Chamaecyparis Lawsonian Allumi* by Newton and Lines (12); *Taxus cuspidata* and *Viburnum tomentosum* by Snyder (13); carnation by Murakishi and Hendrix (10); and cyprus, tamarix, sequoia and English holly by Newton (11).

In a study of control of *Phomopsis* canker in gardenia, Davis (2) placed disease-free cuttings in *Phomopsis*-infested sand which had been mixed with ferbam at rates of ¼ to 2 pounds of dry powder per 100 pounds of sand. The cuttings remained free from *Phomopsis*, however, the higher concentrations of ferbam gave a slight, temporary retardation of root elongation.

Probably the most spectacular results with ferbam have been reported by Tinley with the rubber plant (*Hevea brasiliensis*) (14). Treatments with indolebutyric and naphthaleneacetic acids were not effective in stimulating rooting. Mixtures containing 75% ferbam and 25% talc, however, increased the rooting of one clone (BRIM 501) from 10 to 70% and of another clone (PB 86) from 78 to 100%. Other fungicides tested, including zeram, parzate and manzate, were less effective than ferbam.

Two closely related mercuric materials used as seed disinfectants (Ceresan and Semesan) were reported to be detrimental to rooting by Newton and Lines (12).

Dichlone (2,3-dichloro-1,4-naphthoquinone), sold as Phygon, was treated by Doran on cuttings of a wide range of ornamental plants (3). Cuttings treated with a root-inducing chemical and dichlone rooted better than untreated cuttings and, with a number of the plants tested, a combination of the growth regulant and fungicide gave superior results to treatments consisting of either of the materials used alone. A beneficial effect of dichlone has also been reported for cacao cuttings by Alvin and Durante (1) and Mora (9) and for olive cuttings by Hartmann (8).

Thiram (tetramethyl thiuram disulfide), sold as Arasan, Tersan and Thylate, has also been used effectively with *Chamaecyparis Lawsoniana Allumi* (12), carnation (10), and cyprus, tamarix, sequioa and English holly (11). At Rutgers, we have been using a mixture consisting of equal parts of thiram (75% active) and Hormodin No. 3 with algin as a suspension agent. Rooting of a wide range of florist and nursery crops has been equal to or superior to the use of powdered root-inducing treatments. Our cuttings have been remarkedly free of disease and rotting.

Captan (n-trichloromethylmercapto-4-cyclohexene-1, 2-dicarboximide), sold as Captan and Orthocide 58-W, mixed in the rooting medium at a rate of 100 to 150 grams per cubic meter or added to a powder containing 1% indolebutyric acid

has been reported to improve the rooting of geranium cuttings (4).

The most extensive tests with fungicides in combination with root-inducing chemicals have been made at the Boskoop Experiment Station. The reports of these tests are contained in the Yearbooks for 1961 to 1965 in several articles prepared by Van Doesburg, Van Elk and Ravensberg (16-30). Cuttings of approximately seventy-five species or varieties of ornamental plants have been treated with growth regulators and fungicides both alone and in combination. The two fungicides used were captan and ferbam.

In these tests, conifer cuttings were soaked for 24 hours in the hormone solution and then dipped or dusted with the fungicides diluted with talc. Other cuttings were dipped or dusted with talc mixtures containing both the growth regulator and the fungicide. When used as a dusting on the base of the cuttings, the concentration of captan was 25% and of ferbam, 40%. Concentrations of 5% captan and 4 to 5% ferbam were used for dipping.

Although the rooting percentages and root ratings for some of the species show variation from year to year, in general, the combinations of growth regulator and fungicides have given comparable or better results compared with treatments of the growth regulator alone.

Based on the data presented in this series of reports, the following plants have shown the greatest response to the combination treatments:

Cornus alba sibirica
Laburnum Watereri vossii
Lonicera brownii fuchsioides
Rhododendron: 'America', 'Pink Pearl' and 'Van Weerden Poelman'
Chamaecyparis Lawsoniana: 'Naberi' and 'Stewartii'
C. nootkatensis: *glauca* and *pendula*
C. obtusa: *filicoides, lycopodioides* and *tetrangana aurea*
Juniperus chinensis: Ketelerri, Pfitzeriana, Pfitzeriana aurea and 'Skyrocket'
J. virginiana: Canaertii, Hillii and *pyramidiformis* Hillii
Tsuga canadensis pendula
T. chinensis

In a recent communication, Dr. D. Dorsman, Director of the Boskoop Experiment Station stated: "At the moment we only advise captan dust (dipping) powder for conifer cuttings. The spraying powder seems too strong. Also with ferbam the number of rooted cuttings is not enlarged on long term."

The Hormo-Root series of commercial products now contain 15% thirma (tetramethyl thiuram disulfide), however at this time neither the Hormodin nor the Rootone series have incorporated a fungicide.

What, then, is the status of mixtures containing fungicides and growth regulants for rooting cuttings?

1. Most of the currently available fungicides have been tested. Dichlone, captan, thiram, and ferbam have generally been superior to other fungicides.
2. Although the use of these fungicides in combination with root-inducing chemicals have given somewhat variable responses, many species root as well as or better than when treated with only a root-inducing chemical.
3. Use of high concentration of the fungicides is often deleterious.
4. With some species, treatment with the fungicide alone apparently results in the stimulation of rooting. Results with combinations suggest that there may be a synergistic effect in some plants.
5. The use of a fungicide in the powder treatment cannot take the place of good cultural practices, such as the use of disease-free stock, sterilization of the cutting knife and the medium, and careful maintenance of the propagation structure and environment.

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A LIST OF FUNGICIDES WHICH HAVE BEEN USED IN COMBINATION WITH ROOT-INDUCING CHEMICALS

1. *CAPTAN* (n-trichloromethylmercapto-4-cyclohexene-1, 2-dicarboximide)
   Sold as: Captan
   Orthocide 58-W
2. *DICHLONE* (2,3-dichloro-1,4-naphthoquinone)
   Sold as: Phygon
3. *FERBAM* (ferric dimethyldithiocarbamate)
   Sold as: Fermate
   Karbam-black
   Chromate
   Niagara-carbamate
   Ferberk
4. *THIRAM* (tetramethyl thiuram disulfide)
   Sold as: Arasan
   Tersan
   Thylate
   Spotrete
5. *ZERAM* (zinc dimethyldithiocarbamate)
   Sold as: Zerlate
   Karbam-white

6. *ZINEB* (zinc ethylene bizdithiocarbamate)
   Sold as: Parzate
   Dithane Z 78
7. ... (tetrachloroquinone)
   Sold as: Spergon
8. . (closely related mercury compounds)
   Sold as: Ceresan
   Semesan

MODERATOR STEAVENSON: Do we have any questions for the four previous speaker?

FLOYD FITTS: Mr. McGuire, isn't Carbowax 400 a solid at room temperature?

JOHN MCGUIRE: No, the higher numbers are solid, this one is a liquid at room temperature.

MODERATOR STEAVENSON: Our next speaker is Walter Peffer, one of our old and faithful members, who I believe attended the first meeting of the Society.

GROWING RHODODENDRONS WITH THE AID OF MERCURY VAPOR LIGHTS

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During the past five years I have experimented with various methods and systems for growing Rhododendrons in the greenhouse with the aid of artificial light.

In October 1965 I purchased a newly developed 100 watt Westinghouse Viscount Mercury Vapor Light, no. 890D569G33, for experimental purposes. The Mercury Vapor Light, according to the electromagnetic spectrum consists of 20% ultra violet rays from bactercidal of 2.500 angstrom units through the erythemal and black light to 3,800 angstroms. These rays do not produce energy. The remaining 80% of light which is energized are the visible rays of 3 800 to 5,800 angstroms. From this information it can be concluded that the mercury light contains more natural sunlight than any other artificial device. Infrared rays are present in small quanities.

Mercury Vapor Lights of higher intensity are also available, for example, Westinghouse no. 890D569G43 175 watt and no. 890D569G53 250 watt.

The plastic shield which is included with the lamp was discarded and an aluminum cone shaped shield was fabricated. This shield was placed in proximity to the rafters of the greenhouse in order to give a uniform distribution of light.

A ¼" rope was fastened to the fixture, drawn through a pulley which was anchored in the apex of the greenhouse, and then taken down a rafter to a holding device at the side of the