33%. (2) Under Dow 401 Polyethylene Film two feet wide and .00075 inch thickness, Rhodotypos tetrapetala 43%, Ligustrum ovalifolium 63%, and Forsythia intermedia (Spring Glory) 85%. There is thus an indication that various plastics may give different results depending on their density and thickness.

In the future the methods of supporting the plastic may prove a problem. However in 1962 we hope to try using humidified airblowers to hold up the polyethylene.

Bibliography

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MODERATOR MARCH: Our next topic "Industry's Role in Screening New Herbicides and Rooting Hormones" will be presented by Mr. John H. Kirch, Amchem Products, Inc., Ambler, Pennsylvania.

INDUSTRY'S ROLE IN SCREENING NEW HERBICIDES AND ROOTING HORMONES

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Probably the most simple way of defining the chemical industry's role in the plant growth regulator field is to say that it is their responsibility to discover, formulate and market new compounds for man's use in regulating plant growth. More specifically, to the plant propagator this means providing chemicals that stimulate the formation of roots on cuttings, inhibit or stimulate plant growth, break seed or bud dormancy, control weeds, initiate the formation of flower buds and regulate fruit set or maturing.

Most people are aware that many new chemicals have been introduced in this field of plant growth regulators during the past twenty years. What is perhaps not too familiar to many are the methods used by industry to find these compounds. The remainder of this paper describes a method used by the author's company in its research toward finding useful chemicals in the plant growth regulator field.

This method involves three steps: 1) primary screening, 2) secondary screening, 3) field development.

Primary Screening

The first step toward finding a new growth regulator is to screen chemicals and determine whether or not they may have biological activity. Standard screening flats are prepared, each containing 16 representative weed and crop species.

The new chemical is applied as a pre-emergence spray to one set of flats and a post-emergence spray to another similar set. In this manner the compound's activity on newly germinating weed and crop species as well as its activity through the foliage can be observed.

Observing the biological activity of a compound in these flats is the critical part of primary screening. It is here that the first leads on the compound's potential are picked up. All biological activity, however slight, is carefully noted. Typical of the activity shown by the various compounds in this stage of screening would be stunting, epinasty, stem elongation, discoloration, proliferation, death and selectivity. Based on the degree of this activity a decision as to whether to drop the compound or pass it on to secondary screening is made.

Secondary Screening

In secondary screening the activity exhibited in primary screening is investigated more thoroughly. For example, compound "X" has shown the following activity in primary screening: Epinasty on snapbeans and stimulation of brace roots on corn. The compound is referred to secondary screening with a notation, "Test for root initiating properties."

The first step in secondary would be to run a series of concentrations of this new chemical in a rooting test in comparison with the same concentrations of 3-indolebutyric acid, which is a standard rooting compound.

Concentrations ranging from 500 to 20,000 ppm are used in this step. This broad range is used to give reasonable assurance that no compound with activity will be missed. Liquid quick-dip treatments are employed because it is usually simpler to prepare a liquid than a dry formulation when only a small amount of material is available. It might be of interest to note here that at this stage of screening only microgram quantities of a new compound may be available and these are frequently costly.

The cuttings selected for this test are generally two species representing two different rooting response groups, such as easy-to-root and difficult-to-root. *Chamaecyparis obtusa var. aurea*, the difficult-to-root Golden Hinoki Cypress, and *Taxus cuspidata*, the easy-to-root spreading yew, are used most frequently.

Cuttings are made following standard propagating procedures for these species. Since fall and winter appear to be the best time to take cuttings of these two species most of the promising rooting compounds are held for testing until this time.

Ten cuttings of each species per treatment are usually sufficient for this initial test. The cuttings are treated and inserted in a medium of 1/3 peat and 2/3 sand.

Evaluation of the cuttings is made at periodic intervals, usually 30, 60 and 90 days. Percent rooting is recorded and appropriate notations are made on the quality of rooting, such as heavy, medium or light.

After the initial test to determine the approximate concentration at which rooting occurs, additional tests are run to narrow the concentration down to the optimum for the compound and species tested. Tests are also run on a broader range of species at this time.

The variation in rooting response to a given compound is quite marked in these tests. Table I shows the rooting response of two evergreen species to six different compounds applied as a quick-dip treatment at 10,000 ppm. Table 2 shows the variation in rooting response due to differences in concentration of three of the six compounds on the same two evergreen species.

In addition to concentration, formulation is also a variable in testing compounds for root initiating properties. Table 3 shows the difference in rooting response of six evergreen species to three different formulations of 3-indolebutyric acid applied at 20,000 ppm.

Recently considerable emphasis has been placed on the quick-dip liquid method of treating cuttings rather than the powder treatment. In formulating rooting compounds for use in liquids solubility is a key factor. For example, 3-indolebutyric acid in its pure form is not soluble in water. However, prepared as a diethanolamine salt or the sodium or potassium salt it is readily soluble in distilled water. From Table 3 the importance of selecting the proper formulation can be seen. For rooting Japanese holly, the potassium salt appears to be better than either the acid in a talc carrier or the diethanolamine salt. On English holly the diethanolamine salt would be preferred. There is apparently little difference in formulation when 3-indolebutyric acid is applied to Japanese yew.

Continuing with our example of indolebutyric acid, though the salts of indolebutyric acid are generally soluble in water they may not be soluble in hard water. In such a case a formula containing the salts of indolebutyric acid might form a white precipitate when added to hard water. This precipitate is generally the calcium salt of indolebutyric acid which is very difficult for cuttings to absorb. To remedy this the salt formula could be used in alcohol, or it can be sequestered to go into hard water. These are typical problems that the formulating chemist must solve.

When the optimum concentration and formulation for a new compound has been established and some knowledge of the rooting response it produces on certain species is known, the compound is ready for field development, the third step in finding a new rooting substance.

Field Development

Before a compound can be sold as a product in the growth regulator field, it must be tested throughout the country on as many different species and under as many different conditions as possible. This is the purpose of field development. The compound is sent out to various cooperators at universities, experiment stations or commercial establishments with research facilities for this testing. Here it is applied on a large-scale basis in comparison to the best known material available.

Going back to our example of the rooting compound, this material would have to have outstanding new advantages when compared to indolebutyric acid or naphthalene acetic acid in order to find a market. Another factor enters here. Though the compound might not root the majority of species any better than indolebutyric acid or napthaleme acetic acid, if it were to give good rooting on blue spruce only, for example, it might still be a very valuable compound to the propagator. The demand for rooted blue spruce cuttings must, of course, be sufficiently great to assure a profitable market for the chemical. Otherwise packaging, labeling, distributing and advertising costs may not justify marketing the compound, regardless of its activity on blue spruce.

As the reports from the cooperators in the field development stage come in, they are summarized and the results studied to determine whether the material has a real potential. If the compound does the job and the demand appears to be good, a label is prepared and the compound will be sold.

This is the general procedure that is followed in the introduction of new compounds in the growth regulator field by the author's company. What we have talked about here in the short span of ten minutes requires two to three years or longer in actual practice. Only a few compounds ever reach the marketable stage, though many hundreds are screened annually by the chemical industry.

Undoubtedly; a number of propagators have problems rooting specific species on which some of the compounds we now have in screening would be effective. It is only by hearing about these problem species that suggestions can be made as to compounds that might be tried. Through cooperation between commercial propagators, university research men and the chemical industry it should be possible to improve the results now obtained on some of the difficult-to-root species. The chemical industry would be very pleased to hear these problems and to cooperate in their solutions.

MODERATOR MARCH: Thank you, Mr. Kirch.

Our next speaker, Dr. Chadwick of Ohio State University, will tell us about the "Origin of Adventitious Roots and Callus on Stem Cuttings of Ilex opaca as Influenced by Wounding and Synthetic Growth Substances." Dr. Chadwick.

TABLE I

COMPARATIVE ROOTING INDUCED ON TWO EVERGREEN SPECIES BY SIX COMPOUNDS AT 10,000 PPM CONCENTRATION

Cuttings Stuck November 28 -- Data Taken January 28

COMPOUND	PPM CONC.	SPECIES	PERCENT ROOTING	PERCENT DEAD
2,4-dichlorophenoxy ethyl bromide	10,000	Spreading Yew*	100	0
		Golden H. Cypress**	0	0
3-amino 2,5-dichlorobenzoic acid	10,000	Spreading Yew	50	30
		Golden H. Cypress	0	0
2,3,6-trichlorophenyl acetic acid	10,000	Spreading Yew	0	80
		Golden H. Cypress	0	20
2,5-dichlorophenoxy acetic acid	10,000	Spreading Yew	60	80
		Golden H. Cypress	0	10
2,4,5-trichlorophenoxy propionic acid	10,000	Spreading Yew	0	100
		Golden H. Cypress	0	100
3-indolebutyric acid	10,000	Spreading Yew	100	0
		Golden H. Cypress	0	0
Check	0	Spreading Yew	20	0
		Golden H. Cypress	0	0

* Taxus cuspidata
** Chamaecyparis obtusa var aurea

TABLE II

COMPARATIVE ROOTING INDUCED ON TWO EVERGREEN SPECIES BY THREE COMPOUNDS AT THREE CONCENTRATIONS

Data Taken After 60 Days in the Rooting Medium

COMPOUND	PPM CONC.	SPECIES	PERCENT ROOTING	PERCENT DEAD
2,4-dichlorophenoxy ethyl bromide	1,000	Spreading Yew*	30	0
		Golden H. Cypress**	10	0
	10,000	Spreading Yew	100	0
		Golden H. Cypress	0	0
	20,000	Spreading Yew	50	0
		Golden H. Cypress	0	0
2,4,5-trichlorophenoxy propionic acid	1,000	Spreading Yew	10	20
		Golden H. Cypress	10	0
	10,000	Spreading Yew	0	100
		Golden H. Cypress	0	100
	20,000	Spreading Yew	0	100
		Golden H. Cypress	0	100
3-indolebutyric acid	1,000	Spreading Yew	70	0
		Golden H. Cypress	0	0
	10,000	Spreading Yew	100	0
		Golden H. Cypress	0	0
	20,000	Spreading Yew	100	0
		Golden H. Cypress	60	0
Check		Spreading Yew	20	0
		Golden H. Cypress	0	0

TABLE III

COMPARATIVE ROOTING INDUCED ON SIX EVERGREEN SPECIES BY
THREE FORMULATIONS OF 3-INDOLEBUTYRIC ACID AT 20,000 PPM

Cuttings Inserted December 29 -- Data Taken February 20

SPECIES	POTASSIUM SALT*		TALC CARRIER		DIETHANOLAMINE*		CHECK
	% Rooted	% Dead	% Rooted	% Dead	% Rooted	% Dead	
Andorra Juniper (Juniperus horizontalis var Andorra)	70	0	40	10	30	0	70
Hybrid Rhododendron (Rhododendron catawbiense) (purple)	50	10	50	0	0	10	0
English Holly (Ilex aquifolium)	20	70	50	20	100	0	20
Japanese Holly (Ilex crenata)	100	0	70	0	90	0	30
Golden Hinoki Cypress (Chamaecyparis obtusa var aurea)	60	0	20	0	60	0	0
Japanese Spreading Yew (Taxus cuspidata)	100	0	90	10	100	0	50

* Potassium and diethanolamine salts are liquid formulations and were applied as a quick-dip treatment.