

spiration in the stems of the roses so that at the end of a month they are not dried out. If any want more details on this, contact me.

## COMPLIMENTARY, SUPPLEMENTARY AND SYNERGISTIC EFFECTS IN ROOT INDUCING COMPOUNDS

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The following presentation will be less of a revelation than an appeal. My own experience is limited to a few empirical trials and word of mouth suggestions. It is my feeling that virtually every propagator who works with recalcitrant materials has done and discovered as much. This is particularly true of our academic colleagues who have the opportunity to test ideas which they conceive themselves and ideas stimulated by their more or less constant contact with researchers in the area of auxins and hormones and also contact with the literature.

Unfortunately for everyone this information is diffuse, and difficult to come by. Most of it is considered to be insufficient in content and scope for publication and when published it appears sparsely scattered and so lost from sight and mind.

My intention is to try to accomplish two things today:

1. To illustrate that this scattered information on the subject of my title is of tremendous potential value, and
2. To convince this society that it would be worth while to finance a search of the literature, circulate a fact finding questionnaire, and publish the aggregated information in a concise, useful, practical form.

As stated above, there are few of us who have not experienced beneficial results from using mixtures of things as rooting aids. Ordinarily these contain an auxin plus divers and sundry other classes and genera of chemicals.

In discussing and thinking about these mixtures three kinds of effects may be observed: 1. complimentary, 2. supplementary, and 3. synergistic. The latter, of course, may be a feature of either 1 or 2. There is a fourth event as well called negative results, but I shall exclude failures from this discussion. However, in preparing a good survey, things that don't work need summarization as well as those that do.

In my discussion I shall construe these terms as follows: complimentary—producing an additional benefit in a different way; supplementary—producing an additional benefit through the same kind of event or in the same or similar way; synergistic—the combined effect of two or more substances is greater than the sum of their individual effects.

For example, a mixture of an auxin and an oxidizing agent which gives better results than either alone would be a complimentary event. A mixture of two auxins giving a greater or

better result than either alone would be supplementary. In either case if the combination of substances exceeded the benefits to be derived from their use individually the event would also be synergistic. Synergism as far as the practical propagator is concerned is simply increased efficiency.

Many of us have enjoyed the benefits of using small amounts of 2,4,5-T in conjunction with IBA and NAA in rooting Rhododendrons. Similar exotic brews have been successfully employed with other difficult materials.

Several years ago Dr. Charles Hess showed us benefits from the use of Methylene Blue. I also have data which show that Methylene Blue used with IBA is highly beneficial for widely different genera. I also have data showing an even greater effect when purine denatured ethanol is used as the solvent for IBA. (Since this talk was presented I have learned that this is very old knowledge which I feel reinforces my conviction that a thorough summarization is in order). There are many many other instances. At the time of Dr. Hess's methylene blue disclosure, Dr. Stoutemyer raised the question of Pyrocatechol as an even stronger oxidizing agent. This chemical has a long and successful history of use on potato seed pieces. I have used it with benefit on piece root cuttings. Someone must have tried it with IBA if I knew who, if you knew who, it would obviously save us both a lot of time.

My basic mission today is to encourage this society to locate all of the many people, often our reticent colleagues, who have information on any effect of any substance on rooting and get it effectively assembled in one practical place.

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Post Mortem: At the conclusion of my talk and during the question and answer period the value and importance of my proposal became more and more obvious. I learned that my experience that 8-hydroxyquinoline sulfate as an extremely useful aid in propagating cuttings was due not only to fungistasis but probably also to stomatal anesthesia. A few moments later I learned from Prof. A. M. Roberts of Oregon State University that a student of his had "discovered" a paper bearing on this subject. He kindly sent me a copy. He also tells me that Mr. David Adams the discoverer has surveyed the literature in this connection. This article,\* however, illustrates my thesis well. It was published in 1940 and covers trials in which nitrogenous compounds of many types were used in rooting mixtures, many of which proved beneficial, and a few of which were spectacular. There must be many other hidden gems which a simple questionnaire would uncover.

MR. CARL SCHMIDT: What is 2-4-5-T?

DR. MOREY: It is a brush killer. It's related to 2-4-D

\*B. W. Doak 1940. The effect of various nitrogenous compounds on the rooting of Rhododendron cuttings treated with a Naphthalene-acetic acid. New Zealand Journal of Science and Technology pp. 336A to 343A. April, 1940.

only apparently more reactive on woody plants. However in low concentrations it evidently assists in the rooting of hardwood cuttings.

MR. CARL SCHMIDT: What is it chemically?

DR. MOREY: 2-4-5-trichlorophenoxyacetic acid.

MR. JOHN IKELSER: Would you have any comment on the use of fungicides?

DR. MOREY: I think it's a very valuable practice to include a fungicide in a root inducing compound. My own experience has been that I get a synergistic effect. Of course, this is an illusion. If one does not lose cuttings to fungi, he gets a better stand. In my experience one of the more useful compounds is 8-hydroxy quinoline sulphate. I prefer to use it with rooting solutions rather than trying to mix it with talc. I use it at rates of about 1:2000. If used regularly, particularly if it is used as a dip (e.g. a twenty-four hour dip), one will find that the cuttings will take up enough to give a significant decrease in losses, particularly if any bacterial problems exist. In this connection in growing seedlings I've found out that regular use of 8-hydroxy quinoline sulphate is very helpful in damping-off. It won't stop damping-off. If a damping-off problem is already at hand, don't think you're going to cure it with 8-hydroxy quinoline sulphate. However, if you run a test putting a weekly application at about one to ten thousand from the time the seeds are planted on a portion of a planting, you'll find that you have some significant decrease in damping-off as against the controls( providing you have a problem develop). If one carries on an experiment in which no problem arises, he may automatically come to the conclusion that the treatment is not doing any good. This is another reason for accumulating the experiences of a lot of people on any problem. Practical experience of a lot of people will show whether or not the same practice is good, bad or indifferent, due to chance alone.

There are other fungicides which can be used, Captan and the carbamates Dexon, PCNB, etc. I have not been altogether happy with my experiences with them, but that's personal.

DR. WESLEY HACKETT: Which purine compound are you referring to?

DR. MOREY: I don't know which compound. The one used for denaturing alcohol.

DR. HACKETT: Generically there are several purines. The California Biochemical Corporation produces them.

(\* Imidazo (4,5-d) pyrimidine. Some natural occurring purines include adenine and guanine. Other related compounds are known as cytosine, uracil and thymine. These are constituents of chromosomal material).

MR. RALPH PINKUS: What is the trade name of the fungicide 8-hydroxyquinoline sulphate?

DR. MOREY: There is no trade name as far as I know. It is available from the New York Quinine Chemical Company, from Bryant Labs in Berkeley, California, from Eastman Ko-

dak. The quinolinol itself is insoluble in water. It will go into alcohol, but one wants 8-hydroxy quinoline sulphate in my opinion. If you dislike the smell of quinine or are allergic to it, do not mess with it.

MR. DICK HILDRETH: Is this the same material that also has an effect like colchicine and inhibits spindle formation in mitosis?

DR. MOREY: I have seen no evidence of polyploid induction with the concentration that I have used.

DR. NEAL CUNLIFFE: Have you done any work with the use of cycloheximide as a compliment or supplement to rooting compounds?

DR. MOREY: I have used this material in many ways, and I find it extremely useful, also very touchy. It is to be recommended, but don't treat the whole planting the first time. Regardless of the recommendations the manufacturer gives with antibiotics, it has been my experience that it is better to start out by cutting all recommendations in half. Also I have found that with things like streptomycin and some of the other early antibiotics, phytotoxicity in some plant materials is extremely acute. When using aureomycin or any other antibiotic you undoubtedly will find that certain plant materials will give you problems no matter what concentration is used. But these are very good bacteriocides and many are quite active against many fungi, as well, in my experience.

MR. E. R. VAN CLEVE: Do you have any experience with Agrimycin in your dip solutions in rooting cuttings?

DR. MOREY: Some while back, while I was at Jackson and Perkins we did quite a lot of work with Agrimycin. As I remember it this material is a mixture of streptomycin and terramycin; but here again phytotoxicity was the problem. However, in very weak concentrations cuttings that have been allowed to soak for twenty-four hours will apparently take up enough of the material without phytotoxicity to have some resistance to crown gall formation provided callusing and rooting proceeds within about six weeks. Now with crown gall I think those of us who have to worry about it from a practical point of view are pretty well convinced that after rooting has taken place and callus formation is complete and soft tissues have hardened, galls will not become a problem unless you have nematodes or some other way for infection to take place. It is during the formation period in which the roots develop that crown gall occurs. Agromycin in a soak seems to be beneficial but again the problem of phytotoxicity often is severe. Incidentally, the cheapest way to get terramycin is to buy chicken water treating chemical and adjust your concentrations. I think the diluent in this formulation is sugar, which ordinarily isn't going to hurt ones cuttings.

MR. JOHN WHISLER: Some of our olive people have been working on a control for olive knot and have a control through some of the hydro-carbons. Kerosene will kill these bacteria.

DR. WALTER LAMMERTS: I might state that for the benefit of those that want to try it, that as long ago as 1935 while I was at Armstrong Nurseries and first tried indoleacetic acid as a rooting compound, I found that one can be too antiseptic. One got better results when he made a mixture of green algae and poured it over the plants in order to establish an algal overgrowth.

MR. E. R. VAN CLEVE: We are interested in soak solutions. Does anyone on the panel have any discussion on mixtures for dipping cuttings just prior to sticking them into the greenhouse bench or in the flats?

DR. BROWN: We have found an excellent material to use is Tersan, a fungicide which can be used as a soak or a quick dip for cuttings for fungus control. We use one tablespoon per gallon of warm water. The cuttings can be soaked up to fifteen minutes. However, I think just a complete submersion is just as effective as a fifteen minute soak, and this is a standard procedure we follow at Cal. Poly, San Luis Obispo, in dipping our cuttings before we stick them. It's very important in using any of these materials that you use a wettable powder rather than a liquid, because a liquid often times has oil base carriers and this oil can be toxic. There are only two or three species of plants that we found to even be questionable as far as damage is concerned with the Tersan dip. If we are concerned about insects, we will use a tablespoon of fifty per cent wettable malathion in the dip. There are many more plants that are affected adversely by this. Also where we're handling it with a number of students and inexperienced help, we're not concerned at all about the danger of Tersan, but we certainly wouldn't want them dipping their hands or inhaling the fumes from the malathion.

DR. SNYDER: We have been using a slurry dip composed of Algen, which is a suspension material, Tersan and Hormodon 3 which we just dip the cutting in. A greenish film is left on the cutting which is stuck directly into a two inch peat pot in soil for rooting a wide range of herbaceous and soft wood materials. They root and are immediately transplanted without any set back. Whether it will be effective in reducing disease problems I don't know because we haven't run into that, but I should imagine that it would be.

MR. DON DILLION: We're using Captan and Terrachlor. This is for dwarf citrus.