LITERATURE CITED

1 Braun, A C. 1965. The reversal of tumor growth Scientific American 213:75-83.
2 Hackett, W. P and J. M. Anderson 1967. Aseptic multiplication and maintenance of differentiated carnation shoot tissue derived from shoot apices Proc Amer. Hort Soc. 90 365-369
3 Halperin, W. and D J Philips 1964. Obtaining pathogen-free stock by shoot tip culture. Phytopathology 52 1242-1244.
4. Heller, R. 1953. Recherches sur la nutrition minerale de tissus vegetaux cultivees in vitro Ann. Sci. Nat Bot Biol. Veg 14 1-223
5 Kassanis, B 1954 Heat therapy of virus-infected plants Ann Appl. Biol 41.470-474
6 Morel, G. M 1960 Producing virus-free Cymbidiums. Am. Orchid Soc. Bull. 29·494-497
7 Morel, G M 1964. Tissue culture — a new means of clonal propagation of orchids. Am Orchid Soc. Bul. 33 473-478.
8 Murashige, T and F. Skoog. 1962 A revised medium for rapid growth and bioassays with tobacco tissue cultures Physiol Plant 15 473-497
9 Sagawa, Y., T. Shoji and T. Shoji. 1966. Clonal propagation of Cymbidium through shoot meristem culture Am. Orchid Soc Bul 35 118-122
10 Skoog, F. and C. O. Miller 1957. Chemical regulation of growth and organ formation in plant tissues cultivated in vitro. Soc Exper Biol Symp 11:118-131
11. Steward, F C et al 1958 Growth and organized development of cultured cells I. Amer. J. Bot. 45 693-703. II. Am J. Bot. 45 705-708 III Am J. Bot 45.709-713.
12 Stone, O M 1963. Factors affecting the growth of carnation plants from shoot apices. Ann Appl Biol. 52 199-209.
13. White, P. R 1963. The Cultivation of Animal and Plant Cells, 2nd ed. Ronald Press, New York

MODERATOR FLEMING: Thank you very much Dr. Horst. Any questions?

GUS MEHLQUIST: Do you know of anyone who has successfully used this method to propagate typical woody plants? I could not find anything in the literature.

KEN HORST: No I do not but we are trying to do some work with roses at the present time. I don't know if we will be successful but I think if we had the proper medium it could be done.

MODERATE FLEMING: Our next speaker is Dr. L. V. Edginton from the University of Guelph where he has been working for the past 3 years with systemic type fungicides and his subject this morning concerns systemic fungicides: Dr. Edgington.

CONTROL OF PLANT DISEASES WITH SYSTEMIC CHEMICALS

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A chemical which is taken up by a plant and transported within the plant may be considered as systemic. If the chemical controls diseases of the plant caused by fungi, bacteria,

viruses, or mycoplasma, we call it a systemic fungicide, systemic bactericide, etc.

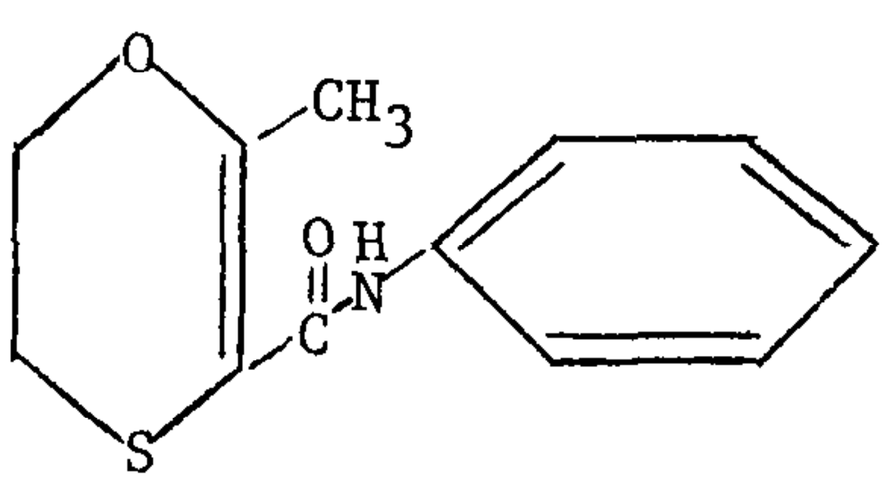
Are such compounds for disease control available? Certainly the entomologists can control insects with systemic insecticides like phorate and dimethoate. The physiologists can supply us with a host of systemic herbicides. Where do we, as plant pathologists, fit in this development of systemic compounds to control the pathogens?

I must admit we are far in arrears of the entomologist and physiologists but developments are rapidly emerging. The egg has hatched!

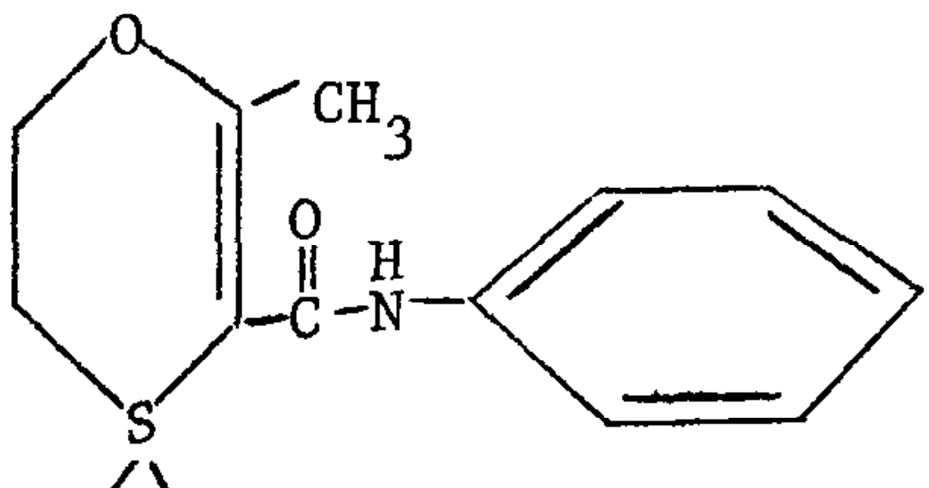
Prior to 1966 our only meager achievement was in antibiotics such as actidione and blasticidin S. The former controls several diseases such as hawthorne leaf spot caused by a fungus. A single application of 1 part per million in late June will control this disease, even though fungal infection was beginning back in May.

Blasticidin S has been used extensively for control of blast of rice caused by a fungus in Japan. This antibiotic is being supplanted by a newer antibiotic, kasugamycin, for control of rice blast. These antibiotics are very specific and will only control certain diseases.

In 1966, the first breakthrough in synthetic systemic fungicides was reported by von Schmeling and Kulka. They discovered seed treatments with compounds called oxathiins would control the loose smut fungus in the embryo of barley seed, *Rhizoctonia*, a fungus causing damping-off of cotton seedlings, and rust on leaves of bean. The initial compound called Vitavax (a) is very fungitoxic but protects plants for only about 10 days while an analog (b) called Plantvax is less fungitoxic but protects plants for at least a month.



(a)



(b)

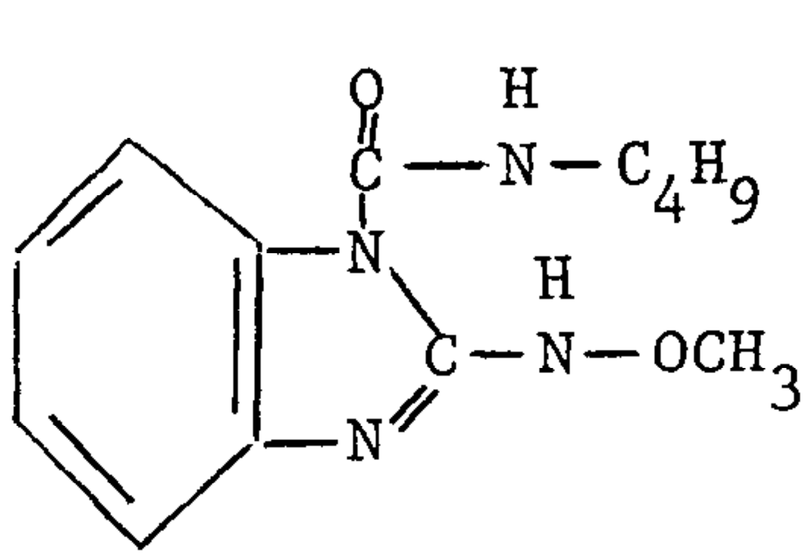
We have found these compounds were only effective against disease caused by Basidiomycetes, the class of fungi causing rusts, smuts and certain root and stem canker diseases.

Unfortunately, many fungi such as *Fusarium*, *Pythium*, and *Cochliobolus* species are not in the Class Basidiomycetes and are very serious plant pathogens. Consequently we must learn to use the oxathiins in combination with our standard protective fungicides.

Another consideration relative to the use of oxathiins is their pattern of uptake and movement within plants. Using isotope labelled compounds we find a bean plant will remove about 70 per cent of the fungicide from a soil solution while only taking up about 30 per cent of the water. The compounds move upward in the sapstream and into the leaves. Here, unfortunately they soon accumulate in leaf margins instead of being evenly distributed throughout the leaf. They only move upward in the direction of the xylem sap movement and never appear to move downward in the phloem tissue. Thus we can't treat leaves and control fungi on the roots. We can only treat seed or soil and control diseases above the point of aplication.

What are examples of diseases the oxathiins will control? As a seed treatment, Vitavax will control smut fungi on cereal crops and onions. Vitavax fails on corn smut, where infection is over a long period. As a foliar spray, or as a soil treatment Plantvax will control any rust fungi such as those on cereals, hollyhock, carnation, bean and safflower. The amounts required and the timing of application must be worked out for each situation. Thus far we cannot make a single application last for an entire growing season.

Now let us consider another recent development of systemic fungicide. An exciting group of compounds are benzimidazole derivatives. One called Benlate (c) has proven very successful for many powdery mildew fungi, apple scab,



(c)

anthracnose diseases and a host of other foliar diseases. This compound also gives control of mites. While the spectrum of fungi controlled by this new type of fungicide is quite broad it is not toxic to the water molds (Phycomycetes e.g. *Pythium* and *Phytophthora*) and is erratic amongst Basidiomycete. The compound is readily absorbed by organic material in soil and thus the foliar sprays have proven most effective thus far. This compound, like the oxathiins, only appears to move upwards in the xylem. We are making an intensive study of Benlate and related compounds in our laboratory.

Very recently researchers in England and the United States have discovered two compounds giving systemic con-

trol of powdery mildew diseases. These new compounds are very specific and only control certain powdery mildews.

Thus, we can generate great enthusiasm for systemic fungicides. However, they are quite specific in the pathogens which they will control and need to be combined with presently used fungicides. The mammalian toxicity of these compounds appears to be very low. Careful residue analyses will naturally prevent their release for sometime, especially on food crops, until safety can be assured.

Let us not limit our thinking to just systemic fungicides. We already have tastes of success in our search for systemic bactericides and viruscides. Recently researchers have found aster yellows, and about 20 other diseases perplexing scientists for years, appear to be caused by minute organisms called mycoplasmas. Already, systemic antibiotic compounds which delay the onset of these diseases are known.

MODERATOR FLEMING: Thank you Dr. Edgington. Any questions at this time?

JIM WELLS: You said these materials are highly specific, is there any chance of combining a group, is there any synergistic effects between them, can we get a group of chemicals which will handle a group of problems?

L. EDGINGTON: That's an excellent question. This is exactly what we need and you can get a beneficial effect because the breakdown of the oxathiins is by organisms. If you add Thiram or Captan with it you can prevent its breakdown and it will last much longer. We are doing work on this now but the art of combining these materials and the incompatibilities have to be worked out yet.

KNOX HENRY: You have done a lot of work with food crops, have you had a chance to work much with ornamentals?

L. EDGINGTON: No, my position requires that I work specifically on food crops but it doesn't matter what the plant is, you have to work out the technology for the plant and the principles hold for other plants.

MODERATOR FLEMING: That completes the morning session.