(3-methoxycarbonyl-2-thioureido)benzene (thiophanate methyl) against T. basicola.

Since the root-infecting fungi rarely occur singly in the field, various combinations of fungicides were tested in the greenhouse and field for the control of root rot caused by F. solani f. sp. phaseoli, R. solani, and T. basicola. Root rot caused by the three pathogens combined was reduced considerably by Difolatan + chloroneb, Difolatan + TSX + benomyl, Difolatan + chloroneb + benomyl, and especially by Difolatan + chloroneb T + thiophanate methyl. When tested in the field at Beltsville with the cultivars Gallatin 50 and Gold Coast Wax, the last combination increased plant stand and resulted in excellent plant appearance. Significant yield differences were observed with the Difolatan + chloroneb T + thiophanate methyl combination in one field experiment but not in a second one. Bean varieties varied considerably in their sensitivity to single fungicides and fungicidal combinations.

Root Rot of Dry Beans in Nebraska

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Initial surveys and bean root collections were conducted with E. D. Kerr in western Nebraska in 1970 and 1971. Out of a total of over 1000 isolations, Fusarium solani was identified in 70 percent of the isolations. Samples of the F. solani cultures were found to produce the same symptoms (small reddish lesions which coalesce as the disease progresses on the taproot, small lateral roots, and hypocotyl) in the greenhouse as were observed in the field. Although Rhizoctonia solani was identified in 7 percent of the islolations, the field symptoms are different and normally appear earlier than the F. solani symptoms. Fusarium solani f. sp. phaseoli is considered to be the primary pathogen in root rot of dry beans in Nebraska

In studies to appraise the yield loss due to root rot in Nebraska, data were gathered from an average of 38 bean fields per year over three successive summers. From statistical analysis of the data, adventitious root formation (sometimes observed in association with the disease symptoms) was not found to be related to root rot index or seed yield by simple correlation. Although the number of pods per plant was not related to root rot index, total seed yield was inversely correlated with root rot index. Based on a multiple regression analysis and specifying a mean seed yield of 40 $\pm$ 14 bu/A and a root rot index interval from 1-4 (1-5 scale), a loss of 3-4.5 by/A was estimated per unit of root rot rating. This model, however, could only account for 45 percent of the variation in grain yield indicating that other variables are not accounted for.

Chemical control of Fusarium root rot using seed treatment fungicides has not been effective. Studies in cooperation with E. D. Kerr on the use of soil fumigation as a preplant treatment has shown some promise in root rot control and increasing bean yields. In evaluating Phaseolus vulgaris Plant Introduction material in cooperation with D. P. Coyne, PI No. 165-426 was found to have a good level of root-rot resistance or tolerance as well as good horticultural characters. In crosses with lines of bacterial common blight tolerant Great Northern #1 sel. 27, root rot tolerant selections also exhibiting earliness and white seed have been made. Further crosses will be made with these selections with the hope of developing a root rot tolerant or resistant variety with good seed quality and yield.

Bean Root Rot Research

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Chemical control of bean root rot in Wisconsin has been researched for several years in plots on infested soil at the University of Wisconsin Experimental Farm near Hancock, WI on the overhead irrigated "central sands." In 1971 we studied the chemical Mertect applied at three different dosages to the soil in two differ-

ent ways. There was no significant control of bean root rot. The 1972 chemical control investigations involved several materials in various combinations applied as seed treatments. Two varieties, Early Gallatin and BBL 274, were used and the effect of the herbicide Eptam was included. None of the chemicals studied controlled root rot on either variety and Eptam did not predispose the beans to root rot. An experiment where three dosages (normal, 2x and 3x) of Eptam were used likewise failed to indicate that this herbicide increased root rot severity. In 1973 we tested the following chemicals for their ability to control bean root rot in Wisconsin: PCNB, Difolatan, Dexon 70W, Dowco 269, PCNB-Dexon combinations. Four dosages were applied as a liquid near the seed at planting time. The higher dosages of Dexon were phytotoxic, but some plants in plots treated with the low rate (0.67 lb/A) of Dexon looked promising. However, there was no strikingly successful bean root rot control.

Bean root rot tolerant breeding lines from Geneva, NY, Prosser, WA, and Corvallis, OR, were tested in our plots in 1972, together with some of our bean lines and commercial bean varieties from several seed companies. The most tolerant bean line was Dr. Frazier's number 71-169-1-37 which had a disease index (D.I.) of 26 in comparison to the control which had a DI of 50. The most tolerant commercial bean variety was Tendergreen which showed a DI of 38. The 1973 plot contained 22 of our breeding lines and about 20 of Dr. Bliss' lines. From our 22 lines we selected 122 single plants which looked very promising from the standpoint of root rot resistance and/or plant type.

During the past two years we have been studying more closely the makeup of the pathogens involved in our bean root rot disease complex. Rhizoctonia sp. and Fusarium solani have been considered the primary pathogens. Recently we have obtained evidence that Pythium sp. may be playing a more important role than we had known previously.

We have begun some new "cultural control" studies to determine whether or not bean root rot can be alleviated by this means. Different cover crops are being studied and crop rotation is being investigated. In addition, in cooperation with Dr. Bliss, the effects of fertilizer placement and herbicide depth of planting combinations are being researched.

Program to Develop Fusarium Resistance

Roger Schmidt
Del Monte
(From tape of talk)

We have had a program to develop Fusarium resistance for quite awhile and my predecessors working on the bean pathology, Drs. Virgin and Minion, developed a technique which utilized a Fusarium isolate which they found in California which is very highly sporulate. They grew it in V-8 juice medium and it produced a tremendous amount of spores. This allowed us to easily quantitate the number of spores that we put into our inoculation media. A couple of plates of this material is ground in a Waring blender and diluted to produce a spore concentration of 1×10^5/cc. This is then sprayed over bean seeds which have been placed in sand and perlite in 4 ft. boxes in the greenhouse. Using a standard concentration and an automatic pipette, we obtain a very even distribution of the spores which are sprayed directly on top of the seed and in the canal, where the seeds are planted. They are immediately covered and after 14 days we read them for disease and get a very good disease index which correlates with our field ratings. We have been running field tests for several years now and are very happy with this greenhouse test as it allows us to go through a tremendous amount of material very quickly. We screen 3,000 seeds per box and six replications.