[1] The figures given are averages for the two planting dates and the two methods. For the early planting date, all unirrigated Fordhook 242 plots averaged only 1220 lbs. per acre, and Bridgeton only 654 lbs., due to severe drought.

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PROGRESS REPORT ON WISCONSIN BEAN ROOT ROT RESEARCH

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The root rot disease of processing beans (*Phaseolus vulgaris*) in Wisconsin is caused by a complex of microorganisms which include the fungus pathogens *Fusarium solani* f. *phaseoli*, *Rhizoctonia* sp. and *Pythium* sp. These soil inhabitants, interacting with environmental and other soil factors, combine to create a more or less severe root rot problem on beans in our state, especially on beans being grown on the irrigated Central Sands.

We have recently obtained evidence that the Pythium organisms may play a much more important role in the Wisconsin bean root rot complex than was earlier the case. This may be especially true of the root rot found in the irrigated Central Sands. So far, we have repeatedly isolated *Pythium spendens*, *Pythium ultimum* and *Pythium aphanidermatum* from root-diseased beans from this area. These pathogens are generally thought to be especially important during the early part of the growing season. Thus, one would think that they would have a relatively low optimum temperature for infection. Preliminary experiments do not necessarily show this. Most, but not all, Pythium cultures appear to be more infectious at warmer temperatures (82°F). Others can be damaging at lower temperatures (60°F). See Table 1. We are continuing to study this problem of how temperature effects epidemiology. Recent studies do show that certain Pythium isolates cause little root or hypocotyl lesioning, but bring about root pruning instead. This root pruning causes stunted plants.

Table 1. Effects of temperature on Wisconsin bean root and hypocotyl rot incited by several Pythium species as indicated by disease indices.

Pythium species	Isolate No.	Temperature 16°C (60°F)	20°C (68°F)	24°C (75°F)	28°C (82°F)
P. spendens	184	35	32	45	65
P. spendens	222	40	30	67	65
P. ultimum	213	47	37	53	65
P. ultimum	220	62	35	68	65
P. aphanidermatum	216	25	28	43	90
Naturally infested soil		5	48	70	67

An integrated control program appears to hold the most promise for the immediate future. Therefore, we are pursuing several approaches to control through improved cultural practices. The first of these is a crop rotation study.

Our bean root rot research activities are mainly concerned with the development of control measures for the disease. Most of the field experiments are carried out in infested soil at the Hancock Experiment Farm with the excellent cooperation of Professor Gavin Weis.

The crop rotation experiment was begun in 1973 and is expected to last through 1978. This randomized and replicated plot contains five crop rotations. Rotation 1 consists of beans for each of the 6 years. Rotation 2 alternates corn with peas and beans. Rotation 3 consists of 2 years of alfalfa-brome, 2 years of beans, then goes back to alfalfa-brome. Rotation 4 uses 1 year of beans, 2 of corn, 1 of beans and 1 of corn. Rotation 5 alternates beans with rye. All the plots will be planted with beans in 1978.

Another potential change in common cultural practices is concerned with the rye fall cover crop. Some bean production specialists and researchers have noticed inferior bean stands and reduced plant vigor when beans have followed the rye cover crop. We are studying alternative cover crops including a sudan grass-sorghum hybrid, corn, oats and barley. Only preliminary results have been obtained so far, but they suggest that cover crops such as oats may be preferable to rye.

We are also studying the effect of Treflan and Eptam herbicides and three depths of planting on bean root rot severity and yield. Standard dosages of these chemicals plus 2X the normal Treflan dosage have been used. Beans were planted at 1, 2 and 3 inch depths. Two dates of planting have also been used. Preliminary results suggest that root rot is not more severe in Eptam treated soil and that the disease may be slightly less in soils treated with Treflan. This study has been made in cooperation with Dr. Bliss and his students.

From 1969 through 1973, we tried many approaches to chemical control of the bean root rot disease complex as it is found on the Central Sands. Treating seed with such materials as Terracoat, Captan, TD 1771, Difolatan, Demosan, Kocide, Benlate and Dexon was not an effective control measure. Treating soil with Benlate, Mertect, Terraclor, Demosan and TD 1771 was also ineffective. Our 1973 plots included soil treatments with PCNB, Difolatan, Dexon, Dow 269 and PCNB-Dexon combinations. Four dosages of most of the chemicals were used. None of these treatments gave good control of bean root rot, although the roots of some plants growing in Dexon-treated plots appeared to be very healthy. (See recent paper on this subject--Appendix I.) Regretfully, there was no room for chemical control plots in 1974.

By far, the most desirable way to control bean root rot would be through the use of resistant bean varieties. We are making this approach to control one of our major research efforts. Seed was saved from plants selected in 1970 as being highly resistant to the root rot complex in the Central Sands. These resistant beans were intercrossed in many combinations in the greenhouse during the winter of 1970-71. The seeds from these crosses were planted at Hancock in 1971. The most desirable plants, chosen on the basis of plant type and root rot resistance, were harvested for seed. Subsequently, we have crossed and back-crossed these beans with acceptable commercial bean varieties and tested them for type and resistance each summer at the Hancock Experimental Farm. In 1972, we studied the reaction of 125 beans from 9 sources to root rot in the field--see Appendix II. When new sources of resistance have been discovered, we have also made crosses with this material, hopefully adding new genes to enlarge the genetic resistance base.

In 1974, we had two plots on heavily infested soil at the Hancock Experimental Farms, in which our new bean lines were tested again for plant and pod type, maturity and root rot reaction. In field C-2, we had 66 lines in a randomized and partially replicated plot which contained small lots consisting of single plant selections and back-cross seeds. In another field, we had 265 lines randomized and replicated in 35 rows, 150 feet long. Most of these lines were rather good size (plants of 20-30 feet of row could often be made) being bulk increases.

We made a substantial number of promising plant selections from both of these plots, and we are hopeful that they will be the fore-runners of resistant varieties which will someday be grown in Wisconsin. See Tables 2 and 3 for summary of 1973 and 1974 studies.

Sincere appreciation is hereby expressed to the Wisconsin Canners and Freezers Association and to its specific members and associates which contributed financial support for this research.

Table 2. Summary of recent field experiments on the development of resistance to Wisconsin bean root and hypocotyl rot.

	1973	1974	
	C-21 Plot	C-2 Plot	W-7 Plot
No. Lots	47	66	255
No. Families	22	36	55
No. Reps	3	3 & 4	1
Size of Plantings	6-10 ft	3-8 ft	10-40 ft
No. of SPs	122	28	61

Table 3. Samples of disease indices for new beans being developed to resist Wisconsin bean and hypocotyl rot.

1973		1974	
Lot No.	D.I.	C-2 Lot No.	D.I.
26	19	1	5
28	19	2	8

1973		1974	
Lot No.	D.I.	C-2 Lot No.	D.I.
30	18	4	8
31	27	5	8
35	21	10	5
36	22	15	13
38	20	20	15
47	33	22	23
Res.	15	Res.	15
Sus.	75	Sus.	75

D.I. = Disease Index where 100 = all plants dead; 0 = all plants healthy.

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FOLIAR SPRAYS FOR THE CONTROL OF HALO BLIGHT OF BEANS

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Seed of Phaseolus vulgaris cv. 'Cherokee Wax' was artificially inoculated with Pseudomonas phaseolicola Race 1 by vacuum infiltration. Inoculated seed was mixed with healthy seed of cv. 'Gallatin 50' to give approximately 1% infection. Seed was sown in three plots, two of which were irrigated. Four sprays of Cuprox (2.8 kg/ha and 5.6 kg/ha) and Agrimycin 17 (0.6 kg/ha and 1.1 kg/ha) were applied at a rate of 455 l/ha at 10 day intervals from emergence of seedlings. The effects of the spray treatments in controlling halo blight were assessed and the spread of infection plotted throughout the growing season in sprayed, unsprayed, irrigated and non-irrigated plots.

Cuprox (2.8 kg/ha) and Agrimycin 17 (0.6 kg/ha) were equally effective in controlling halo blight in irrigated and non-irrigated plots. Both plant and pod infection were reduced by approximately 80%. Cuprox was not phytotoxic and did not depress yield when applied at 2.8 kg/ha, but at 5.6 kg/ha some phytotoxic symptoms were evident on plants in the non-irrigated plots.

Primarily infected Cherokee Wax plants were easily distinguished by their purple stems. Leaf and stem lesions were visible soon after emergence. Secondarily infected plants bore lesions with typical halos on the young foliage.

In the dry 1973/74 season the effect of irrigation on the spread of infection was dramatic. In the unsprayed plots, approximately 60% of pods were infected at the optimum picking time compared with 30% in the non-irrigated plots.