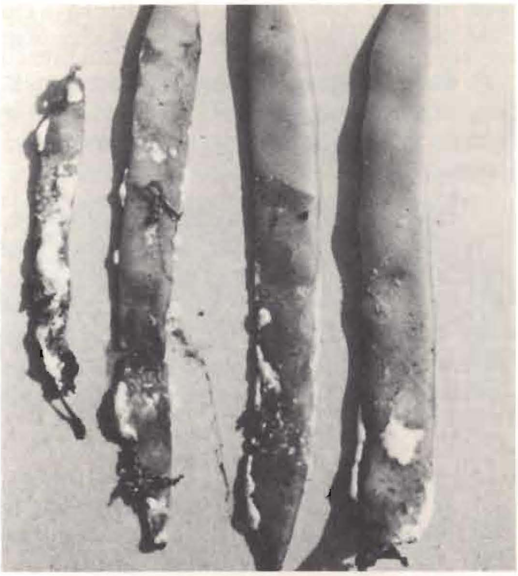
Fungicidal Control of Sclerotinia White Mold in Pinto Beans



Masses of white mold develop into sclerotia that perpetuate the disease.

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White mold or watery soft rot caused by Sclerotinia sclerotiorum (Lib.) d By. is an economically serious disease of dry edible beans (Phaseolus vulgaris L.) in North Dakota. The disease has been troublesome for several years in Idaho, Wyoming, Colorado and Nebraska.

White mold infection first shows as small, soft, watery spots on stems, leaves or pods. These spots enlarge and girdle branches and main stems. Patches of white mold develop on stems and pods. Sclerotia, which form in these masses of mold, are small, elongate or round to irregular-shaped fungal bodies that are light gray at first but become gray-black and hard.

Sclerotinia infection begins when mycelium from sclerotia on the soil surface colonizes older leaves and stems which contact the mold (2, 7, 8) or by spores from apothecia (tiny mushrooms growing from sclerotia) that infect plant crown tissue by first colonizing senesced flowers or leaves lodged in the plant canopy (2, 6, 7). Which of these methods is operative appears to be governed largely by microclimatic conditions and plant growth stage (8). Natti (6) also suggests that wind-blown particles of dried infected tissue and soil organic matter serve to spread mycelium of the fungus to bean plants.

Control of white mold with Benlate 50W (benomyl) applied to the foliage has been achieved with varying degrees of success on snap, great northern and pinto beans (3, 4, 6). Campbell (1) found that early application of pentachloronitrobenzene (PCNB) to the soil surface reduced **Sclerotinia** stem rot of beans by 37 per cent.

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The objectives of this experiment on dry beans in 1973 were to (a) evaluate PCNB 24EC applied to the soil surface and Benlate 50W sprayed on the foliage for the control of white mold, and (b) study the epidemiology of Sclerotinia white mold.

MATERIALS AND METHODS

Plots were established in commercial fields of Pinto 111 beans in Pembina county, North Dakota. The cooperating farmer had planted beans every third year. Fields chosen for the test had been seriously damaged in past years. Sections of fields adjacent to shelterbelts had become so infested that they were being continuously planted to cereal grain rather than beans.

PCNB 24EC and Benlate 50W were evaluated separately and in combination for their effectiveness in controlling white mold. Three trials (I, II and III) were made, each consisting of three replications with 60-foot rows. PCNB was applied during the last cultivation July 12 at 1, 2½ or 5 gallons per acre, respective to Trials I, II and III. Spray nozzles were positioned above the ground behind the chisels to deliver a pattern that covered the area between the 22-inch bean rows, but did not contact the foliage because of reported phytotoxicity (5). In all three trials Benlate was applied to the foliage with a hand sprayer at 1¾ pounds per acre at mid-bloom, July 19. In Trial III, Benlate was also applied at post-bloom, August 10.

Percentage of diseased plants per treatment was observed in Trial III on August 10 by counting plants that showed any white mold on foliage or stems.

Plots were cut August 27, collected and dried. The number of pods per plant were counted, then beans were threshed, graded over a 10/64 screen, weighed, and visually graded for quality. Disease was measured by longitudinally sectioning main stems from the base node to ground line and evaluating them for presence of **Sclerotinia** sclerotia.

RESULTS

White mold developed rapidly the last of July and early August, but weather conditions the last of August were unfavorable for continued disease development.

Abundant apothecia were developed by August 10. More apothecia formed in the field containing Trial II than the field with Trials I and III, and the apothecia formed abundantly between rows, whereas only limited apothecia formed primarily between plants within a row in Trials I and III.

Apothecia formed from sclerotia in PCNB-treated soil as well as nontreated soil. Often several apothecia arose from a single sclerotium with stipes varying in length from several mm to three cm.

Trials I and II

Benlate was effective in protecting against yield loss in both trials (Table 1). Significant differences existed between Benlate treatments and PCNB and non-treated check in Trial I, but although yields were better in Trial II the differences were not statistically significant.

PCNB was not effective in controlling white mold at either the 1 or 2½-gallon rate.

Table 1. Average Yields of Pinto Beans Treated with PCNB or Benlate to Control White Mold Caused by Sclerotinia sclerotiorum.[1]

Treatment[2]	Average Yield (cwt/A) Trial I	Trial II
PCNB + Benlate	19.91a[3]	30.76 N.S.
Benlate	19.27ab	28.86 N.S.
PCNB	14.10 c	26.72 N.S.
Nontreated	14.76 c	28.54 N.S.

[1] *Readings are average of three replications.*

[2] *PCNB applied July 12, 1973 during last cultivation at 1 gallon per acre in Trial I, and 2½ gallons per acre in Trial II. Benlate applied July 19 at 1¾ lb. per acre.*

[3] *Level of significance 99 out of 100; where any two means followed by the same letter are not significantly different. N.S. is no significance.*

Trial III

Observations on the percentage of plants that were diseased by August 10 showed the non-treated check with 40.4, PCNB, 32.2, Benlate applied mid-bloom, 2.2, and Benlate applied mid-bloom plus PCNB, 1.8.

Final evaluations showed all fungicides and combinations effective in preventing disease and improving yield per acre (Table 2). However, only the treatments receiving a mid-bloom Benlate spray (July 19) whether alone or in combination with PCNB or a post-bloom Benlate spray (August 10) yielded significantly more beans than the non-treated check. Plots to which Benlate was

Table 2. Average Yield, Per Cent of Plants Diseased and Per Cent Defects of Pinto Beans Treated with a Fungicide to Control White Mold Caused by Sclerotinia sclerotiorum.[1]

Treatment[2]	Blossom Development When Benlate Applied	Average Yield (Cwt/A)	Range Test[3]	Average Plants Diseased (%)	Range Test[3]	Average Defective Beans (%)	Range Test[3]
PCNB + Benlate	Mid-bloom + Post-bloom	20.18	a	4.17	a	4.43	a
Benlate	Mid-bloom + Post-bloom	19.37	ab	4.50	a	3.67	a
PCNB + Benlate	Mid-bloom	19.06	abc	6.60	a	4.91	a
Benlate	Mid-bloom	17.38	bcd	7.27	a	4.70	a
Benlate	Post-bloom	15.94	de	53.57	de	9.54	de
PCNB + Benlate	Post-bloom	15.76	de	39.53	bcd	7.48	bcd
PCNB	—	14.98	de	46.87	cde	10.95	e
Nontreated	—	14.13	e	60.60	e	8.25	cd

[1] *Readings are average of three replications.*

[2] *PCNB applied July 12, 1973 during last cultivation at 5 gallons per acre rate. Benlate used at 1¾ lb./A July 19 at mid-bloom, and August 10 at post-bloom.*

[3] *Level of significance is 99 out of 100; where any two means followed by the same letter are not significantly different.*

applied twice did not differ significantly in yield from plots which were treated with Benlate only at mid-bloom, further indicating that the post-bloom treatment was not significantly important for control. The most effective treatment was Benlate sprayed at mid-bloom and post-bloom which resulted in about a 5½ cwt per acre increase. The use of PCNB at 5 gallons per acre improved yield on the average of about one cwt per acre.

Disease evaluation showed that the average percentage of plants diseased among treatments receiving a mid-bloom Benlate spray was significantly less than the non-treated check (Table 2). Neither the post-bloom Benlate nor PCNB soil surface spray significantly reduced disease incidence.

Beans were handpicked to determine the percentage of splits or damaged beans. Damaged beans included those affected by white mold, which usually caused the bean to be orange colored. The U.S. standards for beans shows a maximum of 3.0 per cent total defects for U.S. No. 1, 5 per cent for U.S. No. 2 and 7 per cent for U.S. No. 3 (10). Above 7 per cent the sample is graded U.S. substandard. Pinto beans are only handpicked and not choice handpicked; therefore, our visual inspection for quality grade was more strict than the U.S. handpicked grade.

Beans receiving a mid-bloom Benlate spray were of significantly better quality than non-treated beans (Table 2). Non-treated beans and beans receiving Benlate applied post-bloom or PCNB were rated substandard quality.

Significant correlations existed between yield and amount of disease, $R = -0.9282$; yield and defective beans, $R = -0.8522$; and amount of disease and defective beans, $R = 0.9035$. The R values greater than 0.8343 are significant at the 99 per cent level. These correlations suggest a strong influence of white mold on reduced yield and bean quality.

DISCUSSION

The results obtained in these trials support those of Natti (6) who found that pre-bloom (3 to 7 days before full-bloom) treatment of snap beans with Benlate 50W gave sufficient **Sclerotinia** control, but the most effective control combined pre-bloom with a full or post-bloom spray.

The larger yields in Trial II are attributable to field position. Trial II was located adjacent to the north side of an east-west shelterbelt and vining was extensive. Trials I and III were located on opposite sides of a field situated to the south of an east-west shelterbelt. Vines in this field never closed in the rows.

It is puzzling to have abundant apothecia and extensive vining but less yield loss (Trial II) than a companion field with sparce apothecia, open rows with limited vining but significant yield reductions (Trials I and III). Evidently, several factors are operating in the epidemiology of white mold that are not readily apparent. Conditions for ascospore infection in Trial II may not have been as favorable as those in the field containing Trials I and III. However, if ascospores were the primary source of infection (2, 6, 7), perhaps heavy vining interferred with their spread to plants within the field. Although other workers have noted irregularities in the epidemiology of **Sclerotinia sclerotiorum** (6, 7) it is well established that wider row spacing and a non-vining type growth habit reduce white mold severity of dry beans (9).

The benefit of the higher rate of PCNB 24EC in Trial III could be attributed to control of rhizoctonia root rot, although this effect was not evaluated.

Further studies could compare indeterminate and determinate "bush" bean types, effectiveness of earlier application and reduced quantities of Benlate, other fungicides that may be effective, and soil treatments to reduce viability of sclerotia.

LITERATURE REVIEWED

1. Campbell, L. 1956. **Control of Plant Diseases by Soil-Surface Treatment.** (Abstr.). Phytopath. 46:635.

2. Cook, G. E., J. R. Steadman, and E. D. Kerr. 1972. **Epidemiology of White Mold in Western Nebraska.** (Abstr.). Phytopath. 62:1107.

3. Fungicide-Nematicide Tests. 1971. **Vegetable Crop Disease Reports.** Amer. Phytopath. Soc. 27:120, 128, 131.

4. Fungicide-Nematicide Tests. 1973. **Vegetable Crop Disease Reports.** Amer. Phytopath. Soc. 29:52, 53.

5. Gabrielson, R. L., R. K. Guilford, and D. R. Cochran. 1971. **Field Control of White and Gray Molds of Beans in Western Washington.** Pl. Dis. Reptr. 55(3): 234-238.

6. Natti, J. J. 1971. **Epidemiology and Control of Bean White Mold.** Phytopath. 61:669-674.

7. Newton, H. C., and Luis Sequeira. 1972. **Ascospores as the Primary Infective Propagules of SCLEROTINIA SCLEROTIORUM** in Wisconsin. Pl. Dis. Reptr. 56(9):798-802.

8. Purdy, L. H. 1958. **Some Factors Affecting Penetration and Infection by SCLEROTINIA SCLEROTIORUM.** Phytopath. 48:605-609.

9. Steadman, J. R., D. P. Coyne and G. E. Cook. 1973. **Reduction of Severity of White Mold Disease on Great Northern Beans by Wider Row Spacing and Determinate Plant Growth Habit.** Pl. Dis. Reptr. 57: 1070-1071.

10. **The United States Standards for Beans.** 1969. U.S.-D.A., Section 69.134, p. 8-9.