# Increased Incidence of Pythium Stem Rot in Cowpeas Treated with Benomyl and Related Fungicides

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Journal Series Paper No. 24 of the International Institute of Tropical Agriculture.

## ABSTRACT

In six replicated field trials during a 3-year period the incidence of cowpea wet stem rot caused by *Pythium aphanidermatum* was significantly greater in plots treated with benzimidazole (BZ) fungicides than in plots treated with non-BZ fungicides and nontreated plots. In laboratory studies, the growth of *P. aphanidermatum* in corn-meal agar was unaffected by the addition of up to 250 $\mu$g/ml active ingredient of the BZ fungicides. It seems likely that the broad-spectrum, yet selective, BZ fungicides favor the activity of *P. aphanidermatum* by suppressing antagonists and competitors.

Phytopathology 65:217-218

*Additional key words:* thiabendazole, biological balance.

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Wet stem rot of cowpea *(Vigna unguiculata* (L.) Walp.) caused by *Pythium aphanidermatum* (Edson) Fitzp., is characterized by a grey-green water-soaked girdle of the stem extending from soil level up to and sometimes including the lower portions of the lower branches. The stem cortical tissue becomes packed with oospores of the causal fungus. Infected plants quickly wilt and die. Field incidence normally ranges between 0.5 - 10.0%, although occasional incidences of up to 30% have been observed (R. J. Williams, *unpublished).* This paper reports a positive correlation between the application of benzimidazole (BZ) fungicides and the increased incidence of cowpea wet stem rot (WSR).

From April 1970 to October 1973 the BZ fungicides benomyl, thiabendazole (TBZ), and 2-(methoxycarbamoyl)-benzimidazole (MBC), and the non-BZ fungicides mancozeb, zineb, dithianon, anilazine, metiram, chlorthalonil, captafol, thiram, copper hydroxide, and cuprous oxide were evaluated in six replicated field trials for the control of the major stem and leaf diseases of cowpea. The fungicides were applied in aqueous suspension containing 0.1% or 0.2% active ingredient (a.i.) and stems and leaves were sprayed to run-off by means of a knapsack sprayer. Applications were made weekly or bi-weekly from about 14 days after planting. The plants were also regularly treated with lindane, dimethoate, and tetrachlorvinphos for insect control. The disease incidence data collected included counts of plants with WSR. In all trials, the greatest WSR incidence occurred in plots treated with BZ fungicides (Table 1), and in a group comparison analysis the differences in WSR incidence between BZ-treated and other plots were statistically highly significant *($P = 0.001$).* Of the three BZ fungicides, benomyl gave the greatest WSR increase, but the differences between benomyl and MBC-treated plots were not statistically significant *($P = 0.05$).*

TABLE 1. Incidence of cowpea wet stem rot in plots treated with benzimidazole (BZ) fungicides, non-BZ fungicides and nontreated plots in six field experiments, 1970-73

| | Number of plants/plot with wet stem rot[a] | | |
|---|---|---|---|
| Field trial | BZ fungicide(s) | Nontreated | Non-BZ fungicide(s) |
| 1 | 22.5 | 4.0 | 1.0 |
| 2 | 11.6 | 0.9 | 2.3 |
| 3 | 8.0 | 1.5 | 2.6 |
| 4 | 61.0 | 12.0 | 26.3 |
| 5 | 20.9 | 8.3 | 6.1 |
| 6 | 18.5 | 6.0 | 7.9 |
| Mean | 23.8 | 5.5 | 7.7 |

[a] In a group comparison analysis, differences between plots treated with BZ fungicides and all other plots were statistically highly significant *($P = 0.001$)* in each trial.

To examine the in vitro effect of the BZ and other fungicides on the growth of *P. aphanidermatum,* corn meal agar (CMA) was prepared containing 0, 50, 250, 500, 1,000, and 2,000 $\mu$g/ml a.i. of benomyl, MBC, TBZ, mancozeb, chlorthalonil, captafol, thiram, and cuprous oxide. Following a report of stimulation of a basidiomycete by low concentrations of benomyl (8), CMA containing 0.1 and 1.0 $\mu$g/ml a.i. of this fungicide was also prepared. A single disk (4-mm diameter) of a 3-day-old culture of *P. aphanidermatum* was transferred to the center of each of four plates for each fungicide-concentration combination. Plates were incubated at 32.0 ± 0.5 C and colony diameters were measured after 12, 24, 48, and 74 hours. The lowest concentration of each fungicide inhibiting colony diameter by at least 50% compared with that in nonamended CMA was designated the $ED_{50}$ value. $ED_{50}$ values for MBC, benomyl, and TBZ were $>2{,}000$ $\mu$g/ml, $>500$ $\mu$g/ml, and 500 $\mu$g/ml a.i. respectively. $ED_{50}$ values for all the non-BZ fungicides were $<50$ $\mu$g/ml a.i. There was no stimulation of *P. aphanidermatum* in CMA containing 0.1 or 1.0 $\mu$g/ml a.i. benomyl. Thus the BZ fungicides had no stimulating or inhibiting effect on the growth of *P. aphanidermatum* in CMA except at high concentrations when they became inhibitory.

The data presented clearly demonstrate a positive correlation between the use of the BZ fungicides benomyl, MBC, and TBZ and the increased incidence of *Pythium*-induced wet stem rot in cowpea field plots. The benzimidazole derivatives are known as a group to be effective against a wide range of fungi, with certain exceptions including the Oomycetes (7, 11) to which *P. aphanidermatum* belongs. The tolerance of *P. aphanidermatum* to the BZ fungicides reported in this study is similar to that reported by several workers for other *Pythium* spp. (1, 2, 5).

In view of the wide spectrum of activity of the BZ fungicides and their lack of direct effect on *P. aphanidermatum,* except at extremely high concentrations when some of them become inhibitory, their introduction into a microbial ecosystem in which *P. aphanidermatum* occurs would probably disrupt the microbiological balance in favor of this pathogen and other nonsensitive organisms. We therefore suggest that the increased WSR incidence in cowpeas treated with BZ fungicides is a result of enhanced activity of the causal agent in the soil at and near the stem bases brought about by a suppression of competitors and antagonists, which may be other pathogens or saprobic microorganisms.

Similar effects of pathogen-pathogen and pathogen-saprobe interactions induced by the BZ fungicides have been observed in turf in which *Helminthosporium* leaf spot (6) and a basidiomycete (8) were promoted when benomyl and TBZ were used to control other diseases; in pears in which increased *Alternaria* decay occurred when benomyl and TBZ were used to control *Penicillium* infection (9, 10); in rye in which increased sharp eye spot occurred when benomyl was used to control other foot and root diseases (4); in some bulb crops in which application of benomyl has led to increased damage by *Pythium* spp. (4); and in cyclamen in which benomyl-tolerant strains of *Botrytis cinerea* more severely attacked plants treated with benomyl than nontreated plants, probably because of a reduction of competition from *Penicillium* spp. (3).

Detailed microbiological studies are needed to elucidate the exact mechanisms involved in the phenomenon reported. Such studies would help clarify the role of pathogen-saprobe interaction in plant health and disease. The BZ fungicides offer an excellent opportunity for such studies because they have a wide spectrum of activity with the exception of certain important plant pathogens. The results also highlight the necessity for awareness of the possible effects of disruption of biological balances through the widespread use of broad-spectrum, yet selective, pesticides.

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