Yield Response and Resistance of Dry Beans to Powdery Mildew in Colombia

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ABSTRACT

Schwartz, H. F., Katherman, M. J., and Thung, M. D. T. 1981. Yield response and resistance of dry beans to powdery mildew in Colombia. Plant Disease 65:737-738.

An epidemic of powdery mildew (*Erysiphe polygoni*) reduced dry bean yields 17–69%, depending on the cultivar or breeding line. The pathogen was controlled by benomyl, and several resistant dry bean cultivars and breeding lines were identified.

Additional key words: *Phaseolus vulgaris*

Erysiphe polygoni DC. ex Merat., the causal agent of powdery mildew of beans (*Phaseolus vulgaris* L.), is distributed worldwide (7,9). The pathogen is usually observed on foliage and pods of mature plants near the end of the growing season, but it seldom causes any significant production loss in dry beans (7). Severe infection of young snap bean plants, however, can seriously impair pod quality and reduce production by 50% (3,6,9).

The disease can be controlled in snap beans by various fungicides, such as sulfur-lime and dinocap (6,9). However, neither these nor mancozeb, propineb, or benomyl provided effective control of powdery mildew on snap beans in the Dominican Republic (2). Although some varieties are resistant to one or more physiologic races of the pathogen (4,5,8,9), no new source of powdery mildew resistance has been identified in dry beans for more than 40 yr.

During 1980, a severe epidemic of powdery mildew occurred within a dry bean yield trial planted in southwestern Colombia. We took advantage of the opportunity to evaluate the disease reactions and subsequent yield losses attributable to powdery mildew.

MATERIALS AND METHODS

The trial was conducted at Popayan (Las Guacas site) in the Department of Cauca. Popayan, which is located at an elevation of 1,850 m, has an annual mean temperature of 18 C and a rainfall of 1,600 mm. The soil is classified as Typic Dystrandept, and it is characterized by high levels of free aluminum and

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Accepted for publication 9 January 1981.

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0191-2917/81/09073702/$03.00/0

Table 1. Effect of powdery mildew on yield of selected dry bean cultivars and breeding lines in Colombia as affected by fungicide application

Entry	Protected[a] Disease severity[b]	Protected[a] Yield (kg/ha)	Unprotected Disease severity	Unprotected Yield (kg/ha)	Yield loss (%)[c]
Black Marvel (G 3742)	1	2,324	5	713	69*
Windsor Long Pod (G 0687)	1	2,720	5	1,294	52*
BAT 950	1	2,213	5	1,222	45*
BAT 790	1	2,492	4	1,602	36*
BAT 963	1	2,434	4	1,721	29*
Carioca (G 4017)	1	3,002	4	2,329	22*
Zamorano 2 (G 4482)	1	2,725	3	2,268	17*
Nep Bayo 22 (G 4000)	1	2,139	3	1,905	11[NS]
BAT 1113	1	2,310	2	2,105	9[NS]
BAT 527	1	2,691	2	2,627	2[NS]

[a] Protected treatment received three applications of benomyl and one application of oxycarboxin.
[b] On a five-point scale with 1 = no infection and 5 = severe infection.
[c] Yield loss of each entry was significant (*) or not significant (NS) according to Student's t-test (P = 0.05).

manganese, high phosphorus-fixing capacity, but low phosphorus content. Therefore, the soil was amended with 2 metric tons of dolomitic lime and 1 metric ton of 10-30-10 (NPK) fertilizer per hectare. Linuron (1 kg/ha) and fluorodifen (7 L/ha) were applied preemergence to control weeds, supplemented by periodic hand weeding.

The trial was then divided into two physically separated treatments, one protected with pesticides and the other unprotected. Both treatments included 145 dry bean cultivars and breeding lines planted 9 April 1980 in an incomplete block design, replicated three times and randomized within growth habit and seed color groups. Plant density was adjusted according to growth habit, with populations of 250,000 and 180,000 plants per hectare for determinate and indeterminate entries, respectively. Each plot had four rows 3 m long and spaced 50 cm apart. The 50 cm at the end of each row was not used for disease evaluation or yield assessment, leaving an effective plot of 4 m^2.

Oxycarboxin was applied once at 0.6 kg/ha to control bean rust, and benomyl was applied three times at 20-day intervals at 3.0 kg/ha to control other anticipated fungal diseases (eg, anthracnose and white leaf spot) in the protected treatment. The protected treatment also received four periodic foliar applications of NPK (4 L/ha) and insecticides (methomyl at 0.5 kg/ha and monocrotophos at 0.5 L/ha) to control such pests as stem borers and chrysomelid beetles.

We evaluated disease 60 days after germination when the entries were flowering and beginning to set pods. The severity of powdery mildew was measured according to a scale based on the percentage of foliage infected: 1 = no infection, 0%; 2 = light infection, 1–5%; 3 = moderate infection, 6–25%; 4 = heavy infection, 26–75%; and 5 = severe infection, 76–100%.

Entries were harvested at maturity and yields were adjusted to a standard 14% seed moisture content. Student's t-test was applied to determine whether the yield response of each selected entry, infected to varying degrees only by powdery mildew, was significantly less in the unprotected than in the protected treatment.

RESULTS AND DISCUSSION

The epidemic of powdery mildew was severe and uniform, infecting all unprotected, susceptible entries in every replicate. Various entries were also infected by such fungal pathogens as *Uromyces phaseoli, Colletotrichum lindemuthianum*, and *Pseudocercosporella albida* (Schwartz, *unpublished*; 7). These pathogens, however, were effectively managed by the fungicides applied to the protected treatment. The control of powdery mildew in this treatment was also complete, with a disease incidence of 0%. Control was presumably attributable to benomyl, because oxycarboxin is specific for rust.

Other dry bean trials planted in adjacent fields confirmed the effectiveness of three to four 20-day-interval applications of benomyl (1 kg/ha) in controlling powdery mildew on dry beans (Schwartz, *unpublished*). The insecticidal applications were not considered to have significantly increased production in the protected treatment, as the pest populations were very low in the unprotected treatment. Similarly, the foliar fertilizer did not appreciably affect yield in the protected treatment, as shown in Table 1 for entries (eg, BAT 527 and BAT 1113) that were unaffected by powdery mildew.

Table 1 lists yield and disease severity data for 10 selected entries that were infected to varying degrees only by *E. polygoni* in the unprotected treatment and that were free of any disease damage in the protected treatment. Powdery mildew significantly reduced yields of susceptible dry bean germ plasm and cultivars such as Black Marvel, which had a 69% loss. The disease ratings were closely associated with the corresponding losses, which we concluded were representative of the yield reductions that powdery mildew can cause in dry beans infected before and during the critical production periods of flowering and pod formation.

Various dry bean cultivars, as well as breeding lines developed at CIAT (eg, BAT 858), were immune or highly resistant (1–5% of the foliage infected) to the *E. polygoni* population endemic in our trial at Popayan (1). The highly resistant materials were Brazil Aete 2, Porrillo Sintetico, A 40, BAT 527, BAT 799, BAT 838, BAT 871, and BAT 1113. All of these entries except BAT 527 and BAT 1113 were infected in the unprotected treatment to some degree by pathogens causing rust, anthracnose, or white leaf spot. Their potential usefulness as sources of powdery mildew resistance should thus be further substantiated in the absence of these other pathogens. Because *E. polygoni* is pathogenically variable (4,5,8,9), these new resistance sources should also be evaluated for their reactions to other populations of the fungus.

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