Loss Assessment Study on Haricot Bean due to Anthracnose

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Abstract

Bean anthracnose, caused by *Colletotrichum lindemuthianum* Sac. and Magn. is widely spread and economically one of the most important diseases of haricot bean in Ethiopia. To evaluate severity of this disease and its effect on yield, field experiments were conducted at Ambo (on-station) and Meki (on-farm) between 1992 and 1995 crop seasons, using the susceptible commercial bean genotype 'Mexican 142'. Varying levels of disease severity and epidemics conditions were maintained in the experiment by spraying a systemic fungicide, benomyl, at the rate of 0.4 kg ha^{-1} at different intervals. Highly significant differences in disease level and yield were recorded between sprayed and unsprayed plots. Severity of anthracnose varied between 11.8% and 83.5% in the on-station and between 17.2% and 76.6% in the on-farm trials. This high disease severity resulted in mean yield losses of 62.4% in on-station and 67.2% in on-farm trials. There was an estimated net gain of approximately Birr 2376 ha^{-1} from on-station trial whereas in the on-farm trial, the net gain by controling anthracnose with benomyl was Birr 1915 ha^{-1}.

Introduction

Haricot bean is an important food legume that provides an essential part of the daily diet of the Ethiopian people. It is grown as a subsistence crop under traditional farming systems and is usually intercropped with sorghum, maize, coffee or enset (Habtu & Dereje 1985). Although improved cultivars have been introduced in the system, seed yields are still low averaging only about 600 to 800 kg ha^{-1} (CSA 1995). These low yields are attributed to a combination of several yield constraints among which diseases play a major role (Habtu & Dereje 1985, PPRC 1989).

The most important haricot bean diseases include anthracnose, rust, common bacterial blight, angular leaf spot, floury leaf spot, ascochyta blight, and bean common mosaic virus. Of these, bean anthracnose is widely distributed in the major bean growing regions of Ethiopia (Tesfaye 1992). Anthracnose is associated with heavy yield losses whenever susceptible bean cultivars are grown in locations with cool to moderate temperatures and high humidity or free moisture (Schwartz et al. 1979). In Tanzania, on a highly susceptible variety, 22.4 - 41.1% of the crop was found completely defoliated at mid-flowering which resulted in heavy reduction of grain yield; about 92% yield loss was reported in Malawi (Allen 1983). Yield loss due to this disease in Ethiopia has not been quantified. Hence, this study was initiated to determine losses incurred due to anthracnose in haricot bean in this country.

Materials and Methods

On-station Trial

The experiment was conducted at the Institute of Agricultural Research, Plant Protection Research Centre, Ambo (2225 m above sea level, clay loam soil), between 1992 and 1995. 'Mexican 142', a susceptible variety to anthracnose, was planted in a randomized complete block design in six replications. The systemic fungicide benomyl 50 WP was used to generate four levels of disease severity by spraying at intervals of 7, 14, 21 and 28 days. The spraying began at seedling stage and continued till maturity. In another treatment benomyl was applied as seed dressing for comparison. A check plot was left unsprayed to allow maximum development of the disease. Plot size was 4 m x 3.2 m with eight rows, each 40 cm apart. There were 40 plants per row at 10 cm spacing. The four central rows were harvested for determining yield.

To enhance the severity of anthracnose in the experiment, two rows of the susceptible genotype, Mexican 142, were sown around the test plots and were inoculated with a mixture of

C. lindemuthianum isolates at primary leaf stage.

Data collected included severity at different stages (V4, R5, R6, R7, R8), pods per plant, infected pods per plant, seeds per pod, seed yield, and seed weight. Severity of anthracnose was assessed eight times commencing one week after germination to near harvesting. Disease severity was rated using the CIAT disease assessment scale (Schoonhoven & Pastor-Corrales 1987). Yield loss was calculated as the difference between mean yield of fungicide-sprayed and unsprayed plots (FAO 1971).

On-farm Trial

The on-farm trial was conducted on six peasant farms near Meki (1650 masl, sandy loam soil). The farmers' cultural practices including no weeding, local variety, broadcasting, and farmers' seed rate were used. Data collection and analysis was the same as stated in the on-station experiment. Plot size was 4 m x 4 m with 10 rows. All rows were harvested to assess yield.

Results and Discussion

On-station Trial

Highly significant differences (P=0.01) in anthracnose severity were observed between the sprayed and unsprayed plots (Table 1). Anthracnose severity increased with a decrease in spray frequencies, ranging between 11.8% for the 7 days spray interval and 83.5% for the untreated check. Seed treatment was also effective in reducing the severity of anthracnose to as low as 16.1%. Disease severirty in the unsprayed plots increased every week (data not shown).

Siginficant differences were also found in pods per plant, seeds per pod, and seed weight for the various spray intervals. In most cases, the largest differences were obtained between 7 days spray interval or seed treatment and the unsprayed check. Losses calculated for seed weight suggest the importance of anthracnose in affecting the seeds. The loss in seed weight ranged between 14.6% and 43.4%. Seed yields were also highest in the plots where benomyl was sprayed most frequenly. The highest significant (P=0.01) yield reduction recorded was 62.6%. Losses in yield at Ambo varied between 18.6% and 62.6%.

Seed treatment with benomyl showed comparatively good disease control (16.1%) which resulted in the seed weight and seed yield losses of 14.6% and 18.6%, respectively. The reduction in seed yield could be attributed mainly to the combined effects of reduction in the number of pods per plant and seed weight (Table 1). Such reductions are expected when the pathogen attacks the crop at early stages of crop growth (Schwartz et al. 1979).

The net gain from controlling anthracnose with benomyl was calculated to be around Birr 2376 ha^{-1}. It is estimated that there are 300 000 ha under beans in Ethiopia (IAR 1991). Hence, the revenue lost in the country from bean anthracnose could be in millions of Birr since resistant cultivars are not widely grown. Also, disease severity in farmers' fields could often be higher than that observed in this experiment (Tesfaye 1992).

On-farm Trial

Disease development at Meki revealed the importance of anthracnose in farmers' fields (Table 2). Anthracnose severity increased with time reaching the highest at pod filling (R8) for both treatments. Though differences between treatments were not high at flowering, as the season progresses disease severity for the protected plot increased 1-fold from the original value while for the unprotected plot severity increased by more than 3-fold, with 76.6% average.

The difference in the mean severity of the protected plot (17.2%) from the unprotected plots (76.6%) was highly significant. Thus, the highest reduction in seed yield (67.2%) can be attributed to the maximum disease severity recorded in the unprotected plots. Similarly, seed weight was also affected by the high severity of anthracnose where a 32.2% loss was estimated when compared to the protected plot.

Table 1. Effect of anthracnose on yield and yield components of haricot bean at Ambo (1992 - 1995).

Treatment	Severity (%)	Pods/Plant	Seeds/pod	Seed wt. (g)	Loss (%) in seed weight	Yield kg ha^{-1}	Loss (%) in seed yield
7 days	11.8	18.9	5.8	15.8	-	2024	-
14 days	17.9	13.3	4.5	11.1	29.8	1385	31.6
21 days	25.1	13.3	4.3	10.4	32.9	1251	38.2
28 days	27.4	13.6	4.2	9.8	38.0	1189	41.3
Seed treat.	16.1	14.9	5.1	13.5	14.6	1647	18.6
Control	83.5	8.7	3.5	8.0	43.4	756	62.6
$LSD_{0.01}$	2.6	0.7	0.2	0.6		7	-
CV	9.03	5.64	4.98	5.31		5.14	-

Table 2. Disease development, seed yield, seed weight and yield loss of haricot bean in the on-farm trial at Meki, 1994-95.

Crop Season	Treatment	Anthracnose development (%)					Yield/Plot		Seed wt.	
		V_4*	R_5	R_6	R_7	R_8	Gram	Loss(%)	Gram	Loss(%)
1994	P	9.3	13.4	16.1	19.7	19.3	1508.9		157.1	
	UP	15.3	35.3	45.9	55.5	67.8	522.2	65.4	111.8	28.8
1995	P	10.2	17.2	19.5	21.1	15.1	1680.5		146.9	
	UP	25.0	35.0	47.9	65.1	85.4	522.5	68.9	94.4	35.7
Mean	P	9.8	15.3	17.8	20.4	17.2	1594.7		152.0	
	UP	20.2	35.2	46.9	60.3	76.6	522.4	67.2	103.1	32.2

* *V4=3rd trifoliate leaves; R5=pre-flowering; R6=flowering; R7=pod formation; R8=pod filling; P=protected; UP=unprotected.*

Conclusion

The high yield reduction obtained both in on-station and on-farm trials justifies the economic importance of bean anthracnose and the efficacy of benomyl to control the disease. The use of benomyl as foliar spray for the control of anthracnose may be impractical for the majority of haricot bean producers in Ethiopia. The use of resistant varieties and producing pathogen free seeds would be a cheap means of controlling the disease. Bean growers should be encouraged to use seed dressing against anthracnose when growing susceptible cultivars.

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