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The Effect of Sowing Bruchid Damaged Bean (*Phaseolus vulgaris* L.) Seeds on Germination, Plant Development and Yield

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Abstract: A study to investigate the effect of sowing bruichid-damaged bean seeds on germination, plant development and grain yield was conducted at Sokoine University of Agriculture, Morogoro, Tanzania during the year 2000 cropping season. Unperforated and bruchids damaged seeds with one to four holes were planted in plastic pots and placed in the glasshouse. Germination, plant development and subsequent grain yield were compared using a randomized complete block design. Results indicate that planting bruchid-damaged seeds significantly reduced germination and plant development, negatively impacted bean yield components, increased fungal disease (powdery mildew) severity and reduced seed quality.

Key words: Bruchids, yield components, plant development

INTRODUCTION

The common bean, *Phaseolus vulgaris* L. is Tanzania's most important grain legume. The crop is considered an important source of dietary protein for the majority of the people who cannot afford expensive animal protein on a daily basis and hence plays a significant role in eliminating human malnutrition (Mphuru, 1981). In many developing countries including Tanzania, beans supply a cheap and high proportion of plant proteins (Karel *et al.*, 1980). Due to its importance as a food crop, every region in Tanzania grows some amount of beans, but more beans are grown in high altitude regions with well-drained soils and high organic matter content (Misangu, 1997).

Bean seed is subject to attack by bruchids of the species *Zabrotes subfasciatus* (Boh.) and *Acanthoscelides obtectus* (Say.). Unless beans are protected from these pests in storage, bruchid-damage can be very detrimental, rendering beans unfit for human consumption and for sowing. Most of the farmers in Tanzania plant their own saved seeds and generally, farmers cannot completely protect their stored beans from bruchid attack. Consequently, in the absence of bruchid-free seeds, farmers plant bean seeds with varying levels of bruchid damage. Information on losses due to planting bruchid-damaged seeds is very scanty or unavailable in Tanzania. Larson (1924) observed that bean seeds that were heavily damaged by bruchids did not produce a good crop. Studies by Jetwani *et al.* (1967) showed low germination and below normal seedling stands due to planting weevil-damaged bean seeds. Other studies showed that holes in beans due to bruchid attack provided sights for easy entry and growth of fungi in the infected seeds which leads to poor plant development (Misangu, 1997). Powdery mildew (*Sphaerotheca fuliginea*) is an important disease of common beans and has been reported to cause low bean grain yields (Master Gardener, 2000). This study was therefore aimed at gaining more information on the effect of sowing bean seeds with varying degrees of bruchid damage on the overall performance of beans under Morogoro conditions.

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MATERIALS AND METHODS

A 200 g sample of newly harvested, undamaged seeds of the breeding line EP 9-1 was placed in a small glass jar. A second 1 kg sample from the same seed source was placed in a large glass jar and infested with adult Z. *subfasciatus* bruchids. Both jars were placed in an incubator at 28±2°C and 70% relative humidity and left undisturbed for three months. After the three months of seed storage in the incubator, both jars were then removed from the incubator and damaged seeds having 1, 2, 3 and 4 holes each were sorted out from the bruchid infested bean seeds. For each treatment, 16 seeds were selected. Similarly, 16 undamaged seeds were sampled from the small glass jar which contained bruchid free seeds and were designated as the control. The 16 undamaged seeds and the four damaged seed categories resulted in five treatments being 0, 1, 2, 3 and 4 holes per seed. The seeds of each treatment were planted in a glasshouse using the RCBD with 4 replications. Twenty, 4 L size plastic pots were each filled with fertile, well-drained soil and arranged in four rows on benches in the glasshouse. Each row acted as a replication. Four seeds of each treatment were planted in each pot at a depth of 2 cm. Spacing between the pots was 50×50 cm.

The pots were regularly watered throughout the study. Seven days after sowing, all seeds that had germinated in each plot were counted and percent germination was calculated. Pots that had less than 2 seedlings were replanted with seeds from the same category. Seedlings in remaining pots were thinned to two plants per pot. Data were collected on plant developmental characteristics, disease severity, yield components and grain yield per plant. Disease severity was recorded using a 1-5 scale where 1 was least infested and 5 were the most infested. Disease rating was based on the 2 whole plants per plot. On the other hand, seed quality as to whether the seed was normal or abnormal in terms of shape and colour was recorded.

RESULTS AND DISCUSSION

The results for the effect of sowing bruchid damaged bean seeds on plant developmental characteristics and disease severity are shown in Table 1. For all measured variables, negative impact increased when bruchid damage increased. There were significant differences ($p<0.05$) among the treatments with respect to percent germination, which ranged from 25.0-81.3%. However, there were no significant differences in percent germination between undamaged seed and those with a single hole, indicating that farmers are not likely to experience significantly lower germination by planting seeds with the single holes. On the other hand, germination was significantly lowered in treatments having two, three and four holes per seed. These results indicate that if farmers were to plant seeds with more than one hole per seed, then a higher seeding rate would be necessary in order to attain the required plant population per unit area.

Table 1: Means of plant developmental characteristics and disease severity due to sowing undamaged and bruchid damaged seeds

Treatments	Germination (%)	No. days to first flower	Pod length (cm)	Plant height (cm)	Days to physiological maturity	Severity powdery mildew
0 hole	81.3a	30.9b	10.9a	31.7a	63.9d	1.0c
1 hole	81.3a	30.9b	10.2a	29.4a	63.9d	1.0c
2 holes	68.8b	30.9b	10.0a	28.7a	66.1c	1.4b
3 holes	43.8c	31.8b	8.8b	27.2b	69.4b	4.1a
4 holes	25.0d	37.5a	8.4b	26.2b	76.5a	4.1a
$LSD_{0.05}$	1.242	1.045	1.375	3.897	1.691	0.119
$\bar{x}$	60.4	32.4	9.7	28.7	67.8	2.3
SE	0.3606	0.3035	0.3991	1.1309	0.4909	0.0361
CV (%)	33.59	2.10	9.23	8.81	1.62	3.48

*Means in the column followed by the same letter(s) are not statistically different ($p<0.05$) following separation by least significant difference test

The number of days to first flower ranged between 30.9 and 37.5. Bruchid damage of 0-3 holes per seed did not significantly affect the number of days to first flower appearance. However, seed damage of four holes per seed did significantly delay flowering, most likely due to the replanting in this treatment due to very poor germination.

Bean pod length ranged from 8.4-10.9 cm and the sowing of seed with up to 2 holes per seed did not significantly reduce pod length. Significant reduction in pod length was observed in the treatments with three or four holes per seed, possibly due to the heavy powdery mildew disease infestation in these treatments.

Plant height ranged from 26.2-31.7 cm and was also not significantly reduced by bruchid damage on seed up to the level of 2 holes per seed. Significant plant height reduction did occur in treatments with three or four holes per seed. Generally plant height was reduced as the number of holes per treatment increased possibly also due to increased powdery mildew disease infestation as the number of holes per seed increased (Davis *et al*., 2001). The disease can also weaken the plants and it is unsightly (Master Gardener, 2000).

Bruchid damage of 2, 3 and 4 holes per seed significantly delayed physiological maturity but there was no significant difference between plants grown from undamaged seeds and seeds with single holes. Generally, the number of days to physiological maturity increased as the number of holes per seed increased. The highest number of days to physiological maturity (76.5 days) was recorded on plants originating from seeds with 4 holes each while the lower number of days (63.9 days) was recorded on plants grown from undamaged seeds. The delayed physiological maturity in treatments with more holes per seed may be attributed to poor germination that resulted in replanting as well as the poor development of the plants.

Significant differences were observed among the treatments with respect to powder mildew disease, which ranged from 1.0-4.1 where 1 was the lowest disease level and 5 the highest. The severity of powdery mildew increased as the number of holes per treatment increased. Treatments with three or four holes per seed were significantly infested with powdery mildew compared to treatments with fewer or no holes. However, there was no significant difference between undamaged seeds and those with only one hole. Seeds with more than one hole seemed to provide more sites for fungal development in the seeds before planting and this was reflected in the disease severity ratings of the plants (Misangu, 1997).

Results indicate that bruchid damage on bean seeds did not significantly reduce the number of pods per plant but the general trend was towards a gradual decrease in pod number as the number of holes per seed planted increased (Master Gardener, 2000). Pods per plant decreased from 2.5 to 1.4 on plants originating from seeds with one hole and seeds with four holes, respectively. On the other hand, bruchid damage on bean seeds significantly reduced the number of seeds per pod. The number of seeds per pod ranged from 2.1-3.5 on plants grown from seeds with four holes per seed and plants originating from undamaged seeds, respectively (Table 2).

This study also showed significant differences in seed size among the treatments. There was a decrease in seed size from 2.4 g on plants grown from undamaged seeds to 0.2 g on plants originating from seeds with four holes. The decrease in seed size could be attributed to the fact that seeds harvested from plants grown from damaged seeds were shrivelled and sometimes completely deformed. This indicates that planting bruchid-damaged seeds has a negative impact on the quality of the seed and grain produced. Seed quality deteriorated as the number of holes on the planted seeds increased. Plants originating from seeds with one hole had poor colour and slightly shrivelled while those originating from seeds with more than 2 holes appeared quite abnormal in shape and colour as shown in Fig. 1 and 2. The seeds appeared more shrivelled and dark in colour as the number of holes per seed planted increased.

Table 2: Means of bean yield components due to sowing undamaged and bruchid damaged seeds

Treatment	No. pods/plant	No. seeds/pod	Wt. 100 seeds (g)	Yield/plant (g)
0 hole	2.3	3.5a	27.0a	2.5a
1 hole	2.5	3.1b	25.8b	1.0b
2 holes	2.4	2.7bc	16.9c	1.0c
3 holes	1.8	2.5c	14.3d	0.8c
4 holes	1.4	2.1c	9.8e	0.4d
$LSD_{0.05}$	NS	0.4	0.5	0.296
$\bar{x}$	2.1	2.8	18.8	1.3
SE	0.1275	0.1315	0.1684	0.0861
CV (%)	13.14	10.57	2.01	14.81

*Means in the same column followed by the same letter(s) are not statistically different (p<0.05) following separation by least significant difference test. NS = Not significantly different

Fig. 1: Quality of seeds harvested from plants originating by sowing undamaged and damaged seeds with one hole each

Fig. 2: Quality of seeds harvested from plants originating by sowing seeds with 2, 3 and 4 holes each

Planting bruchid-damaged seeds also significantly reduced bean yield per plant (Larson, 1924). Yield was reduced from 2.5 to 1.9 g per plant on plants originating from bruchid-free seeds and seeds with single holes, respectively. This was 25% reduction in yield. Yield per plant decreased progressively as the number of holes per seed increased. When the number of holes per seed reached four, the bean yield per plant was only 0.3 g. This grain yield is equivalent to 88% reduction compared to the yield obtained from plants originating from bruchid-free seeds.

This study has revealed that farmers incur losses in bean grain yield by planting bruchid-damaged seeds for two main reasons. First, yield may be reduced because of poor germination which leads to low plant population and hence low yield per unit area. Secondly, plants originating from bruchid-damaged seeds are more susceptible to powdery mildew. The disease drastically reduces plant development and the subsequent grain yield as well as seed quality. Generally, it is therefore advisable that farmers should refrain from planting bruchid damaged bean seeds and this calls for effective bruchid control measures especially the use of bean varieties that are resistant to bruhids.

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