



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 bruchid-damaged bean seeds on germination, plant development and grain yield was conducted at Sokoine University of Agriculture (SUA) in Morogoro between November 1999 and April 2000. Undamaged seed and seeds damaged by bruchids 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, and increased fungal disease (powdery mildew) severity.

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 containing 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 bean seeds and in most cases, farmers cannot completely protect their stored beans from bruchid attack. Consequently, in the absence of bruchid-free seeds, farmers plant bean seeds that have been damaged by bruchids. 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 Jeetwani *et al.* (1967) showed low germination and below normal seedling stands due to planting weevil-damaged bean seeds. Our study was therefore aimed at gaining more information on the losses caused by sowing bean seeds with varying degrees of bruchid damage under Morogoro conditions. If low levels of bruchid damage cause significant losses in plant productivity, then more effective bruchid control measures, including breeding beans that are resistant to bruchids, are necessary to ensure adequate yields.

MATERIALS AND METHODS

The study design was a randomized complete block with four replications and five treatments (0, 1, 2, 3, and 4 holes per seed). A 200 g sample of newly harvested, undamaged seed 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 $28 \pm 2^\circ\text{C}$ and 70% relative humidity, and left undisturbed for three months. Jars were then removed from the incubator and seeds from the large jar were sorted into categories of one, two, three, or four holes each. Undamaged seeds from the small jar were designated as the control. Sixteen seeds from each of the five damage categories (0, 1, 2, 3, and 4 holes per seed) were selected and planted in a glasshouse study. Twenty 4-litre 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 in this study. Four seeds of each treatment were planted in each pot at a depth of 2 cm. Spacing between the pots was 50 x 50 cm. 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 bean yield per plant. Disease severity was recorded using a 1–5 scale where 1 was least infected and 5 was the most infected.

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 seeds and those with a single hole, indicating that farmers are not likely to experience significantly lower germination by planting seeds with a single hole. 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.

Treatment	% Germination	No. Days to First Flower	Pod Length (cm)	Plant Height (cm)	Days to Physiological Maturity	Severity Powdery Mildew
0 hole	81.3 a	30.8 b	10.9 a	31.7 a	63.9 d	1.0 c
1 hole	81.3 a	30.9 b	10.2 a	29.4 a	63.9 d	1.0 c
2 holes	68.8 b	30.9 b	10.0 a	28.7 a	66.1 c	1.4 b
3 holes	43.8 c	31.8 b	8.8 b	27.2 b	69.4 b	4.1 a
4 holes	25.0 d	37.5 a	8.4 b	26.2 b	76.5 a	4.1 a
LSD	1.242	1.045	1.375	3.897	1.691	0.119
Mean	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 same column followed by the same letter are not statistically different ($P < 0.05$) following separation by least significant difference test.

The number of days to first flower ranged between 30.8 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 the 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 seeds 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 due to increased powdery mildew disease infestation as the number of holes per seed increased.

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.

Significant differences were observed among the treatments with respect to powdery 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 fungal diseases 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 and this was reflected in the disease severity ratings on the plants.

Yield component means for plants raised from undamaged and bruchid-damaged seeds are shown in [Table 2](#). Results indicate that bruchid damage to 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 increased. 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 to 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. 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 a	3.5 a	27.0 a	2.5 a
1 hole	2.5 a	3.1 b	25.9 b	1.9 b
2 holes	2.4 a	2.7 bc	16.9 c	1.0 c
3 holes	1.8 a	2.5 c	14.3 d	0.8 c
4 holes	1.4 a	2.1 c	9.8 e	0.4 d
LSD	1.4	0.4	0.5	0.2964
Mean	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 are not statistically different ($P < 0.05$) following separation by least significant difference test

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 shriveled and sometimes completely deformed. This indicates that planting bruchid-damaged seed has a negative impact on the quality of the seed and the grain produced.

Planting bruchid-damaged seeds significantly reduced bean yield per plant. 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 a 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 was an 88% reduction in yield compared to the yield obtained from plants originating from bruchid-free seeds. Farmers likely lose a substantial amount of their bean crop by planting bruchid-damaged seeds, and because this loss is not visible, they do not know they have a problem. Therefore, they are not making efforts to improve their seed quality.

CONCLUSIONS

This study has revealed that farmers are likely to incur losses in bean grain yield if they plant bruchid-damaged seeds for two main reasons. First, yield may be reduced because of poor germination, which leads to low plant population, that eventually results in low yield per unit area. Second, plants originating from bruchid-damaged seeds are more susceptible to powdery mildew, which drastically reduce plant development and subsequent bean yield. 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 bruchids.

REFERENCES

- Karel, A.K., B.J. Ndunguru, M. Price, G.H. Semuguruka and B.B. Singh. 1980. Bean production in Tanzania. p.123-154. *In* Regional Workshop Proceedings Potentials for field beans in Eastern Africa. Lilongwe, Malawi 9-14 March, 1980.
- Jetwani, M.G., P. Sircar, and T.D. Yavar. 1967. Studies on the extent of damage and germination. II. Germination of some leguminous seeds damaged by *Collosobruchus maculatus*. Indian Journal of Entomology, 20:309–311.
- Larson, A.O. 1924. Effect of weevily bean seeds upon the bean crop. Journal of Economic Entomology, 17:538-548.
- Misangu, R.N. 1997. Distribution of bean bruchid species in the major bean growing regions in Tanzania. Ph.D Thesis, Sokoine University of Agriculture, Morogoro, Tanzania.
- Mphuru, A.N. 1981. Comparative biological and ecological studies of *Callosobruchus* species in Tanzania with particular emphasis on *Callosobruchus chinensis* (L). Ph.D Thesis. University of Dar es Salaam, Tanzania, p 410.

