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Estimation of yield loss due to pulse beetle, *Callosobruchus chinensis* (L.) on different mung bean cultivars

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Abstract
Ten interspecific progenies of mungbean were tested for their host preference of pulse beetle, *Callosobruchus chinensis* (Linn.) (Coleoptera: Bruchidae)under laboratory conditions during the year 2019-20 at Department of Entomology, Institute of Agricultural Sciences, Siksha 'O' Anusandhan, Deemed to be University, Bhubaneswar, Odisha. This study was conducted to screening the resistant or tolerance of these cultivars against pulse beetle. The cultivars with small, rough, wrinkled, hard and thick seed coat were show more resistant to those having smooth, soft and thin seed coat. There were significant differences among the interspecific progenies in terms of seed infestation and weight loss caused by *C. chinensis* on progenies. Considering the overall mean seed damage at different days of storage period, GP 74(15.40%) recorded lowest seed damage followed by GP 76(15.78%), MH 421(16.18%), OBGG 52(16.70%), GP 75(17.13%), OUM 11-5(17.85%), IPM 2-14(18.33%), IPM 2-3(18.75%), GP 78(19.35%), and DHAULI (20.10%) in order of their susceptibility. The order of susceptibility from lowest to highest in overall mean seed weight loss (%) in cultivars were GP 74(19.73%), GP 76(21.38%), MH 421(22.28%), OBGG 52 (23.05%), GP 75 (24.10%), OUM11-5(25.15%), IPM2-14 (25.70%), GP78 (26.28%), IPM 2-3(26.73%) and DHAULI (29.14%).

Keywords: Seed damage (%), Seed weight loss (%), *Callosobruchus chinensis* (L.), host preference, green gram

Introduction
Globally, 900 million people are undernourished due to inadequate intake of proteins, vitamins and minerals in their diets. Pulses are the important sources of nutrients such as carbohydrates, proteins, fats and vitamins (Gill *et al.* 1980) [5]. Among the pulses, *Vigna radiata* (L.) Wilczek is the third most important pulse crop cultivated throughout India. It is short duration legume crop grown mostly as a fallow crop in rotation with rice and more than 70% of world's mung bean production comes from India. Mungbean is popular among farmers for its short life cycle and drought tolerance; nitrogen fixation in its root nodules in association with soil rhizobium allows it to thrive in N-deficient soils (Yaqub *et al.*, 2010) [23]. India is the biggest producer of mungbean, with 3.5 million ha under cultivation and the production of 1.2 million tons (IIPR, 2011) [22].

Mungbean production is constrained by destructive pests, a notable group of which are the storage pests. Among the bruchids, pulse beetles, *C. maculatus* and *C. analis* are major pests causing serious damage and are cosmopolitan in distribution.The economic loss of the bruchids in various pulses ranged from 30-40 per cent within a period of six months and when left unattended losses could be up to 100% (Dongre *et al.*, 1996; Akinkurolere *et al.*, 2006; Sharma *et al.*, 2011) [4, 1, 12].The pulse beetle alone under storage condition require special attention, as in India about 8.5% of loss have been reported in post-harvest handling stages. It is reported that the pulse beetle may cause 10-95 per cent loss in the seed weight and 45.5-66.3 per cent loss in protein content of the seeds under normal condition and the severity of damage increases with the duration of storage condition.

The germination of pulse seed is also reduced to a great extent (Yadav, 1985) [21]. Losses caused in storage of blackgram, mungbean, chickpea and pea by *Callosobruchus chinensis L.* are 56.26, 46.70, 44.08 and 30.26 per cent respectively (Rustamani *et al.*, 1985).In mungbean, bruchid infestation occurs both in the field and in storage, for which storage losses are heavy and sometimes total losses occur within few months (Tripathy, 2016) [19].

Generally, bruchids Infestation starts from the field, where adult female oviposits on the green pods and cause only minor damage. Grubs penetrate the pod and remain concealed within the developing seeds as hidden infestation (Southgate 1979) [16]. Such infected seeds carry over the bruchid population to storage and causes-secondary infestation which causes maximum damage (Talekar, 1988) [17]. Due to high variability in infestation levels from season to season, a quantitative assessment of loss by these storage pests has been difficult. When left unattended, they can cause up to 100% loss (Sharma *et al.*, 2011) [12]. The seed is rendered unfit for human consumption as well as for sowing purposes due to quality loss and mould growth (Singh and Jackai, 1985) [14].

Host plant resistant against insect pests is determined through antibiosis, antixenosis and/or tolerance (Edwards and Sing, 2006). The first encounter between insect pests and host plants is oviposition by insect pests; the pest's preference or non-preference determines the resistance and/or susceptibility of the host plants. A successful oviposition is necessary for successful population build-up and high infestation. Any type of adverse effect on insect oviposition will have detrimental effects on the subsequent pest population build-up. Thus, the suitability of the host plant surface for insect oviposition will give a good indication for the progeny's survival and development.

Material and Method

Study site

This experiment was conducted in Completely Randomized Design (CRD) with three replications at Department of Entomology, Institute of Agricultural Sciences, Siksha 'O' Anusandhan, Deemed to be University, Bhubaneswar, and Odisha during the year 2019-20. The cultivar susceptibility to *C. chinensis* was determined on the basis of percent grain damage and loss in seed weight.

Rearing of test insect in the laboratory

Adults were collected directly from mother culture of *C. chinensi* sand introduced into mungbean containing plastic jars and allowed them to lay eggs for seven days.Then adults were transferred into another set of containers and such procedure was repeated. At the time of release of pulse beetle in treatment, the culture was sieved before four days 0 to 4 day's old beetles. This culture was maintained in laboratory condition at 27 ± 2 0C and relative humidity 70-80 percent.

Details of different interspecific progenies of mungbean

Screening ten healthy insect free and genetically pure seed of interspecific progenies and one local check 'Dhauli' of mungbean as per availability of the seeds was procured from IIPR Regional Centre Khordha, Odisha.

Method of recording observation

Percent seed infestation by pulse beetle on mungbean progenies: The 55 days after starting experiment 100 grain on tray of each were used to calculate the percent seed infestation. The damaged and healthy grains was sorted out and counted in each replication. One or more holes per seed were considered as damaged grains. Following formula was used to work out the percent seed infestation (Pawar 2019) [8].

$$\text{Percentage of seed damage} = \frac{\text{No. of damaged seed}}{\text{Total no. of grains}} \times 100$$

Percent weight loss: For working out the weight losses, the beetles, frass, excreta etc. was remove from each compartment and then weighted by using single pan electronic balance. The 55 days after starting experiment 100 grain on tray of each was used to calculate the weight loss. The percent loss in weight was calculated by using following formula. (Pawar 2019) [8].

$$\text{Per cent seed weight loss} = \frac{I - F}{I} \times 100$$

Where

I=Initial weight of seed (g)

F= Final weight of seed (both sound and damaged seed) (g)

Data analysis

Analysis of variance (ANOVA) was used to check the oviposition behaviour of *Callosobrochus chinensis* and its host preference for egg-laying behaviour was analyzed and a single classification ANOVA was used to compare the mean number of eggs laid among different pulses and among different cereals. All statistical tests were carried out at P 0.05 level of significance.

Result and Discussion

Percent seed infestation due to pulse beetle on different progenies

The data presented in Table 1 showed that ten interspecific progenies of mungbean shows significantly variations of percent seed infestation by pulse beetle *Callosobruchus chinensis*. Perusal of percent seed infestation on different interspecific progenies of mungbean seed infestation 50 gm of seeds among different progenies ranged from 15.40 to 20.1 percent. The significantly minimum percent seed infestations (15.40 percent) were recorded on interspecific progenies GP 76 which was found significantly superior over the progenies. The next promising group of interspecific progenies recorded moderate seed infestation in MH 421(16.18 percent) followed by OBGG 52 (16.70 percent), GP 75 (17.13 percent),OUM 11-5 (17.85 percent),IPM 02-14 (18.33 percent),IPM 02-3 (18.75 percent) and GP 78 is (19.35 percent) which was found statistically significant as compared to check DHAULI (20.1 percent).

Rajendra Prasad *et al*. (2013) [10] studied the seed damage in twenty eight *Dolichos* bean varieties and recorded the lowest seed damage of 13.4% which ranged to 18.34% and none of the entries were completely free from bruchid damage which supports the present findings where the seed damage varied from 15.40 to 20.10%. Similarly the findings are in accordance with Shaheen *et al*. (2006) [13] who evaluated the resistance of fifteen chickpea cultivars against pulse beetle and recorded higher seed damage of 24.35 to 54.46% partially contradicting in percentage of seed damage.

Usha *et al*. (2018) [20] reported that at 90 days after the release of insects, the seed damage showed a significant variation in damage and differed from 70.0 to 95.3%. The maximum damage was noticed in Pant mung-2 (95.3%), and the minimum in ML-935 (70.0%). The damage caused by *C. maculatus* after 120 days of release varied from 81.6 to 99.3%. But the present study was carried out for 60 days only where the percentage of seed damage ranged from 30.70.to 39.70%. It is confirmed that the percent seed damage recorded by Usha *et al*., 2018 [20] in green gram increased with the advancement of storage period because of the relative increase in the population. Further, Chaudhary *et al*. (2017) [3] found that% infested grains after three months was significantly maximum (99.0%) in mung bean. Similar results were also reported by Prasad *et al*. (2011) [9] on chick pea.

Percent seed weight loss

The data presented in Table 2 showed that interspecific progenies of mungbean were significantly different for percent weight loss due to pulse beetle *C. chinensis*. Percent weight loss 50 gm of mungbean among different progenies ranged from 19.73 to 29.14 percent. Significantly minimum percent weight losses (19.73 percent) were observed in interspecific progenies DHAULI which was found significantly superior over the other progenies. The next moderate promising interspecific progenies recorded in GP 76 (21.38 percent) followed by MH 421 (22.38 percent), OBGG 52 (23.05 percent) and GP 75 (24.10 percent) respectively. Significantly maximum percent weight loss was recorded on DHAULI (29.14 percent) followed by IPM 2-3 (26.73 percent), GP 78 (26.28 percent), IPM 02-14 (25.70 percent) and OUM 11-5 (25.15 percent) and respectively.

The present findings are in accordance with Sumia *et al.*, (2015) who introduce loss in seed weight of green gram due to infestation by *C. chinensis* significant different was observed among the genotypes with Gang-8 with having higher percent weight loss (46.46 percent) and whereas Km12-5 recorded the lowest percent weight loss (5.61 percent). The present findings are confirmed with Tripathi *et al.*, (2012) who studied on other crop the resistance of cowpea against *C chinensis* and reported that, the loss in seed weight is related to the usefulness of the food. Seed weight loss was higher in the preferred accessions as compared to resistant ones. Whereas, Padmavathi *et al.* (1999) [7] who studied the preferential behaviour of *C. maculates* on twelve fodder cowpea genotypes, 10.39 to 56.53 percent losses in seed weight were observed in different cowpea genotypes.

Table 1: Effect of pulse beetle (*C chinensis*) on seed damage (%) of mungbean cultivars at different days of storage

Sl. No.	Cultivar	Seed damage (%)				Over all mean
		15 days	30 days	45 days	60 days	
1	OUM 11-5	4.10^{bcd} (11.73)	8.30^{cde} (16.74)	23.90^{de} (29.27)	35.10^{e} (36.11)	17.85
2	GP 78	4.60^{d} (12.43)	8.90^{f} (17.36)	24.70^{e} (29.82)	39.20^{h} (38.76)	19.35
3	GP 74	3.20^{a} (10.25)	7.30^{a} (15.67)	20.40^{a} (26.87)	30.70^{a} (33.63)	15.40
4	GP 76	3.30^{a} (10.52)	7.50^{ab} (15.85)	21.00^{abc} (27.27)	31.30^{b} (34.04)	15.78
5	GP 75	3.80^{abc} (11.18)	8.10^{cd} (16.50)	23.10^{cd} (28.70)	33.50^{d} (35.37)	17.13
6	MH 421	3.40^{ab} (10.67)	7.50^{ab} (15.85)	21.50^{ab} (27.65)	32.30^{c} (34.61)	16.18
7	OBGG 52	3.60^{abc} (10.93)	7.90^{bc} (16.32)	22.10^{b} (28.06)	33.20^{d} (35.20)	16.70
8	IPM 02-14	4.10^{bcd} (11.72)	8.60^{def} (17.02)	24.10^{de} (29.45)	36.50^{f} (37.15)	18.33
9	IPM 2-3	4.30^{cd} (11.97)	8.70^{ef} (17.19)	24.40^{e} (29.60)	37.60^{g} (37.80)	18.75
10	DHAULI (Check)	4.80^{d} (12.70)	9.70^{g} (18.21)	26.20^{f} (30.79)	39.70^{i} (39.70)	20.1
	SE m (+)	0.25	0.17	0.39	0.13	
	CD	0.73	0.50	1.16	0.39	
	CV	3.68	1.68	2.33	0.61	

1. Figures in parentheses are arcsine transformed values.
2. Treatment mean with letter(s) in common are at par with each other at P=0.05 under DMRT.

Table 2: Effect of pulse beetle on seed weight loss (%) of mung bean cultivars at different days of storage

Sl. No.	Cultivar	Seed weight loss (%)				Over all mean
		15 days	30 days	45 days	60 days	
1	OUM 11-5	6.20^{cde} (14.46)	18.30^{d} (25.33)	30.00^{bcde} (33.21)	46.10^{e} (42.74)	25.15
2	GP 78	6.60^{f} (14.96)	19.40^{e} (26.16)	31.10^{def} (33.87)	48.00^{f} (43.87)	26.28
3	GP 74	5.2^{a} (13.22)	15.30^{a} (23.03)	25.60^{a} (30.37)	32.80^{a} (34.10)	19.73
4	GP 76	5.30^{ab} (13.35)	15.50^{a} (23.18)	27.70^{ab} (31.73)	37.00^{b} (37.48)	21.38
5	GP 75	5.90b^{cde} (14.05)	17.50^{c} (24.75)	29.40^{bcde} (32.81)	43.60^{d} (41.340	24.10
6	MH 421	5.60^{abc} (13.64)	16.30^{b} (23.81)	28.30^{bc} (32.11)	39.30^{c} (38.80)	22.38
7	OBGG 52	5.70^{abcd} (13.77)	17.20^{c} (24.50)	28.70^{bcd} (32.37)	40.60^{c} (39.58)	23.05

8	IPM 02-14	6.30^{def} (14.49)	18.30^{d} (25.35)	30.30^{cde} (33.37)	47.90^{ef} (43.80)	25.70
9	IPM 2-3	6.50^{ef} (14.76)	18.70^{d} (25.65)	33.30^{f} (33.37)	48.40^{f} (44.12)	26.73
10	DHAULI (Check)	6.80^{f} (15.15)	20.70^{f} (27.11)	35.30^{g} (36.45)	53.77^{g} (47.16)	29.14
	SEm (+) CD CV	0.22 0.65 2.61	022 0.64 1.49	0.83 2.47 4.37	0.59 1.76 2.79	

1. Figures in parentheses are arcsine transformed values.
2. Treatment mean with letter(s) in common are at par with each other at P=0.05 under DMRT.

Conclusion

We noticed that the minimum seed damage recorded in cultivar GP 74 (3.20%) which was at par with GP 76(3.30%), MH 421(3.40%), OBGG 52(3.60%) and GP 75 (3.80%), DHAULI (4.80%) had the maximum seed damage. Weight loss percent varied significantly in cultivars between 5.20 to 6.80%. Minimum weight loss was observed in cultivar GP 74 (5.20%) followed by GP 76 (5.30%), MH 421(5.60%), OBGG 52(5.70%). The next cultivars *viz*., GP 75(5.90%), OUM 11-5(6.20%), IPM 2-14(6.30%), IPM 2-3 (6.50%), GP 78 (6.60%) and DHAULI (6.80%) which were arranged in order of their weight loss percentage.

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