Int.J.Curr.Microbiol.App.Sci (2021) *10*(03): 90-99

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 10 Number 03 (2021)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2021.1003.014

Fecundity and Preferential Oviposition of Pulse Beetle, *Callosobruchus chinensis* (L.) on Different Interspecific Progenies of Mungbean

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Keywords

Resistant progenies, Growth index, *Callosobruchus chinensis*, Fecundity

Article Info

Accepted:
04 February 2021
Available Online:
10 March 2021

A B S T R A C T

Ten interspecific progenies of mungbean were tested for their resistance against pulse beetle, *Callosobruchus chinensis* L. 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 resistance/tolerance of 10 interspecific progenies of mungbean against pulse beetle. The cultivars with small, rough, wrinkled, hard and thick seed coat were more resistant compared to those having smooth, soft and thin seed coat. There were significant differences among the interspecific progenies in terms of number of eggs laid, development period, adult emergence and growth index of *C. chinensis* on progenies. Out of 10 green gram cultivars used in the investigation, two cultivars *viz*., GP 74(1.04) and GP 76 (1.24) were classified as resistant entries in respect of low ovipositional preference, lowest developmental period, minimum survival, while four cultivars, MH 421 (1.27), OBGG 52(1.30), GP 75 (1.35) and OUM 11-5(1.54) were categorized as moderately resistant; three cultivars, IPM 2-14(1.68), IPM 2-3(1.69) and GP 78(1.83) as moderately susceptible and the remaining one cultivar *viz*., DHAULI(2.03) was grouped as susceptible entries.

Introduction

Pulses (grain legumes) are the second most important group of crops worldwide. Globally, 840 million people are undernourished mainly due to inadequate intake of proteins, vitamins and minerals in their diets. Pulses are major sources of proteins (20-40%), carbohydrates (50-60%) and are good sources of thiamin, niacin, calcium and iron. Among the pulses, *Vigna radiata* (L.) Wilczek is the third most important pulse crop cultivated throughout India. Mung bean 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). India is the biggest producer of mung bean, which is cultivated annually in an area of 3.83 million hectares with a total production and average productivity of 1.60 million tonnes and 418 kg/ha respectively (IIPR, 2011).

One of the major constraints in production of pulses is the insect pests which inflict severe losses both in the field and storage. Mungbean production is constrained by an array of destructive pests, a notable group of which are the storage pests. Among them, bruchids belonging to the genus *Callosobruchus* (Coleoptera: Bruchidae) are the most critical (Pawara *et al.*, 2019).

The pulse beetle alone under storage condition requires special attention, as in India about 8.5% of loss has 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). Losses caused in storage of black gram, mung bean, chickpea and pea by *Callosobruchus chinensis* L. are 56.26, 46.70, 44.08 and 30.26 per cent respectively (Rustamani *et al.*, 1985). The growth and development, ovipositional preference, suitability index and fecundity of *C. chinensis* were comparatively faster in mung bean as compared to other pulses (Wijenayake and Karunaratne, 1999).

Materials and Methods

Study site: The experiment was carried out with 10 different mung bean cultivars in a Complete Randomized Design (CRD) with three replications each at laboratory of the Department of Entomology, Institute of Agricultural Sciences, Siksha 'O' Anusandhan, Deemed to be University, Bhubaneswar. Screenings of 10 interspecific progenies of mung bean (Fig. 2) were maintained against pulse beetle under storage condition lasting for a period of 55- 60 days.

Rearing of test insect in the laboratory

Mass rearing was carried out in the laboratory of the Department of Entomology, Institute of Agricultural Sciences, Siksha 'O' Anusandhan, Deemed to be University, Bhubaneswar. Twenty adults of *C. chinensis* (L.) were confined in jar containing 500 g of mung bean [*Vigna radiata* (L.) Wilczek] seeds and mouth of the jar was fastened with muslin cloth. The jar was maintained at 27±5 °C, 60±5 per cent RH for four weeks. After four weeks, freshly emerged adults were used for conducting the experiments.

External identification of male and female bruchids

Male and female can be identified on the basis of their antennae and body size. Males are having pectinate antennae and pygidium without dark patches. While females are having strongly serrate antennae and pygidium with two dark patches, one on each side of the line (Fig. 1). Generally female is slightly larger than male.

The length of male adult measured with an average 3.25 ± 0.23 mm and breadth is 2.16 ± 0.05mm whereas the length and breadth of female adult measured with an average 3.60 ± 0.08mm 2.02 ± 0.04mm, respectively (Devi and Devi, 2014).

Details of different interspecific progenies of mungbean

Screening ten healthy insect free and genetically pure seed of interspecific progenies (OUM 11-5, GP-78, GP-74, GP-76, GP-75, MH 421, OBGG 52, IPM 2-14, IPM 2-3) and one local check DHAULI of mung bean as per availability of the seeds was procured from the Center for pulse Research

Station, Berhampur, OUAT.

Categorizations of mungbean genotypes on the basis of morphological characters

Grains of each progenies of mungbean were selected on the basis of morphological character like size of grain, texture and seed colour. The selected grain of each variety was placed randomly and separated in the ten plastic jars. Twenty five gram seed of each cultivar were kept separately in bottles of 200 gm capacity and two pairs of fresh adult of *C. chinensis* (L.) was released obtaining from stock culture. Each bottle was considered as one replication.

The mouth of the bottles was covered with double folded muslin cloth and fastened with rubber band to avoid the escape of adults. The bottles were kept at the ambient conditions in BOD incubator at 30±10C and kept for 60 days. The number of eggs laid on each variety was count after 72 hrs of the release of *C. chinensis*.

Developmental preference in terms of number of adults emerged from known number of eggs was study, for this a single egg per grain was kept while other egg on the grain was puncture with the help of needle and these grains were kept individually in plastic vials in BOD incubator at 30 ± 10^{0}C. A set of ten grain with single egg was kept per replication.

After 23 days from the day of initial start of experiment, the first observation for the numbers of adult emergence was record and observations was continued up to 55 days after which no adult emergence noticed. The incidence of pulse beetle (*C. chinensis)* on the different interspecific progenies of stored mungbean was studied and observation on following parameters was record.

Method of recording observation

No. of egg laid on progenies

The number of eggs laid on each variety was count after 72 hours of the release of *C. chinensis* with the help of hand lens.

Percent adult emergence

Percent adult emergence was calculated using following formula (Howe, 1971).

$$\text{Per cent adult emergence} = \frac{\text{Number of adult emerged}}{\text{Number of eggs laid}} \times 100$$

Total developmental period of pulse beetle on progenies

The mean developmental period of the pulse beetle in the test varieties was calculated by using the data obtained from the number of adults emerged on each day and the number of days required for adult emergence. This can be determined by subtracting the first day of egg lying from first day of adult emergence as suggested by Howe, (1971).

$$\text{Mean Development Period} = \frac{d1a1 + d2\,a2 + d3a3 + \cdots + dnan}{\text{Total Number of adult emerged}}$$

Where, d1 = day at which the adults started emerging (1st day),

a1 = number of adults emerged on the day

Percent adult survival: Number of adult emerged from 10 grains (with single egg) was recorded and percent adult emergence or survival was work out in each genotype.

The growth index of pulse beetle on different progenies: The growth index was calculated by the formula given by Jackai and Singh (1988) as- Growth Index = S / T

Where, S = Percent of adult emergence,

T = Average developmental period (days).

The genotypes susceptibility to *C. chinensis* was determine on the basis of percent grain damage and loss in seed weight.

Data analysis: Analysis of variance (ANOVA) was used to check the oviposition behavior of *Callosobrochus chinensis* and its host preference for egg-laying behavior 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.

Results and Discussion

Ovipositional preference of pulse beetle on different progenies

The number of eggs laid on the varieties by adult female of *C. chinensis* differed non-significantly and presented in Table 1. Oviposition ranged from 102.00 to 109.00 eggs/2 pairs of adults. Less number of eggs were laid on the seeds of GP 75(102.00) followed by MH 421(103.00), GP74 (103.30), OUM 11-5 (103.70), OBGG 52(104.40), IPM 2-3(105.00), IPM 02-14(107.60), GP 78(108.70), GP 76(108.80) and DHAULI (109.00) which were found at par with each other.

The present results are more or less identical to the previous works. Earlier studies indicated that oviposition preference was influenced by host availability to a greater extent and had nothing to do with the actual resistant nature of an accession. Thus more the number of seeds, higher would be the oviposition (Dick and Credland, 1984). On the other hand, the oviposition by *C. chinensis* had no significant difference on varieties in chickpea (Siddiqa *et al.,* 2015) corroborating to our results.

Moreover, bruchids had the unusual habit of laying eggs on unsuitable surfaces under conditions of host deprivation as observed (Soumia *et al.,* 2015) which strengthen the present findings.

Percent adult emergence of pulse beetle

The data presented in Table 1 showed that ten cultivars of mung bean varied significantly for adult emergence of pulse beetle, *C. chinensis*. The number of adult emerged from 2 pairs of adults on different progenies were in range of 34.30 to 52.40. The significantly lowest number of adult emerged on progenies, GP 74 (34.30) which was found to be superior over other cultivars. The next promising progenies with respect to adult emergence was recorded in GP 75(36.40) and GP 76(37.10); MH 421 (38.00), OUM 11-5 (38.70) and OBGG 52(39.40) which were found to be at par with each other. Significantly highest number of adults were emerged in IPM 02-14(42.60), IPM 2-3 (45.00) and DHAULI (52.40) and these were significantly differed among them. Our conclusions are more or less identical to the researchers (Prajapati, 2015; Sekar and Nalini, 2017).

Total development period of pulse beetle on different progenies

The mean developmental period of *C. chinensis* from the days of egg laying to the days of adult emergence on different progenies was calculated, statistically analyzed and presented in Table 2. In other words number of days taken by the adults to emerge since the oviposition period was the mean development period.

The data presented in Table 2 showed that ten cultivars of mung bean differed significantly with respect to mean developmental period of *C. chinensis* and ranged from 23.70 to 31.80

days. The highest mean developmental period of pulse beetle was noticed in the cultivar GP 74(31.80 days) and was statistically significant to others. OBGG 52(29.10 days) and MH 421(29.10 days) recorded the similar mean developmental period. The lowest mean developmental period was observed in DHAULI (23.70 days), GP 78 (23.90 days) followed by OUM 11-5(24.10 days) which were statistically found at par with each other. The other varieties, IPM 02-14 (25.00days), IPM 2-3 (25.50 days), GP 75 (26.50 days) and GP 76(27.40 days) were statistically different among themselves. The present findings indicated that the developmental period was more or less in progenies showing tolerance/ resistant or susceptible respectively.

The data pertaining to mean developmental period of *C. chinensis* did not follow any trend with respect to oviposition, adult emergence, percent weight loss and percent insect damage. The present findings are in contrast with the findings of Deeba *et al.*, (2006) and Pawar *et al.*, (2019) who reported that genotypes with least ovipositional preference or tolerant genotypes took shortest mean developmental period.

But our results are in conformity with Kavitha *et al.*, (2018) who observed a significant variation in the mean development period of *C. chinensis* on different genotypes of green gram. The longest mean development period was found in PM-5 (33.83 days) followed by GGG-1 (32.72 days) and LGG-607 (32.39 days) which were found to be on par with each other indicating resistance/tolerance capacity of the varieties.

Table.1 Fecundity and Developmental performance of *C. chinensis* on mung bean cultivars

Sl No.	Cultivars	No of eggs laid/2 pairs of adults*	No. of grubs emerged*	No of pupae developed*	No. of adults emerged*
1	OUM 11-5	103.70 (10.21)	53.70^{d} (7.36)	43.70^{cd} (6.65)	38.70^{cd} (6.26)
2	GP 78	108.70 (10.45)	62.40^{h} (7.93)	52.40^{g} (7.27)	47.70^{g} (6.94)
3	GP 74	103.30 (10.19)	49.30^{a} (7.06)	39.30^{a} (6.31)	34.30^{a} (5.90)
4	GP 76	108.80 (10.46)	52.10^{b} (7.20)	42.10^{b} (6.45)	37.10^{b} (6.04)
5	GP 75	102.00 (10.12)	52.00^{b} (7.24)	41.40^{b} (6.47)	36.40^{b} (6.07)
6	MH 421	103.00 (10.17)	53.00^{c} (7.31)	43.00^{c} (6.60)	38.00^{c} (6.21)
7	OBGG 52	104.40 (10.24)	54.40^{e} (7.41)	44.40^{d} (6.70)	39.40^{d} (6.32)
8	IPM 02-14	107.60 (10.40)	57.60^{f} (7.62)	47.60^{e} (6.93)	42.60^{e} (6.56)
9	IPM 2-3	105.00 (10.27)	60.00^{g} (7.77)	50.00^{f} (7.10)	45.00^{f} (6.74)
10	DHAULI (Check)	109.00 (10.46)	67.40^{i} (8.24)	57.40^{h} (7.61)	52.40^{h} (7.27)
	S E$_{m(\pm)}$	**0.09**	**0.23**	**0.26**	**0.27**
	CD (P=0.05)	**NS**	**0.68**	**0.76**	**0.82**
	CV (%)	**1.36**	**5.32**	**6.47**	**7.31**

*Value in parenthesis is square root transformed value

Table.2 Developmental period (days) of *C. chinensis*

Sl No	Cultivar	Incubation period (days)*	Grub period (days)*	Pupal period (days)*	Mean developmental period (days)*
1	OUM 11-5	5.20^{d} (2.38)	15.40^{d} (3.98)	3.50^{a} (2.01)	24.10^{b} (4.96)
2	GP 78	4.80^{b} (2.29)	14.40^{b} (3.85)	5.40^{c} (2.41)	23.90^{ab} (4.94)
3	GP 74	5.30d^{e} (2.41)	18.30^{g} (4.33)	8.30^{g} (2.96)	31.80^{h} (5.68)
4	GP 76	5.00^{c} (2.34)	17.00^{f} (4.19)	5.40^{c} (2.43)	27.40^{f} (5.28)
5	GP 75	5.00^{c} (2.35)	15.20^{cd} (3.97)	6.20^{d} (2.59)	26.50^{e} (5.19)
6	MH 421	5.40^{e} (2.43)	16.20^{e} (4.09)	7.50^{f} (2.83)	29.10^{g} (5.44)
7	OBGG 52	5.80^{f} (2.52)	16.20^{e} (4.09)	7.00^{e} (2.74)	29.10^{g} (5.44)
8	IPM 02-14	4.10^{a} (2.14)	15.40^{d} (3.98)	5.50^{c} (2.43)	25.00^{c} (5.04)
9	IPM 2-3	5.30^{de} (2.49)	15.00^{c} (3.94)	5.50^{c} (2.44)	25.50^{d} (5.09)
10	DHAULI(Check)	4.80^{b} (2.39)	14.10^{a} (3.83)	4.70^{b} (2.28)	23.70^{a} (4.91)
	$SE_m(\pm)$	0.03	0.07	0.09	0.07
	CD (P=0.05)	0.10	0.21	0.27	0.23
	CV (%)	2.54	2.98	5.98	2.69

*Value in parenthesis is square root transformed value

Table.3 Survivorship/ Adult emergence (%) of *C. chinensis* cultivars

Sl No.	Cultivar	No of eggs laid/2 pairs of adults*	No. of adults emerged (B)*	Survivorship/ Adult emergence (%) {B/A} ×100
1	OUM 11-5	103.70 (10.21)	38.70 (6.26)	37.32
2	GP 78	108.70 (10.45)	47.70 (6.94)	43.88
3	GP 74	103.30 (10.19)	34.30 (5.90)	33.20
4	GP 76	108.80 (10.46)	37.10 (6.04)	34.10
5	GP 75	102.00 (10.12)	36.40 (6.07)	35.69
6	MH 421	103.00 (10.17)	38.00 (6.21)	36.89
7	OBGG-52	104.40 (10.24)	39.40 (6.32)	37.74
8	IPM 02-14	107.60 (10.40)	42.60 (6.56)	39.59
9	IPM 2-3	105.00 (10.27)	45.00 (6.74)	42.86
10	DHAULI (Check)	109.00 (10.46)	52.40 (7.27)	48.07
	SEm (±)	0.09	0.27	
	CD(P=0.05)	NS	0.82	
	CV (%)	1.36	7.31	

*Value in parenthesis is square root transformed value

Fig.1 Pulse beetle adults

Fig.2 Ten interspecific progenies of mung bean

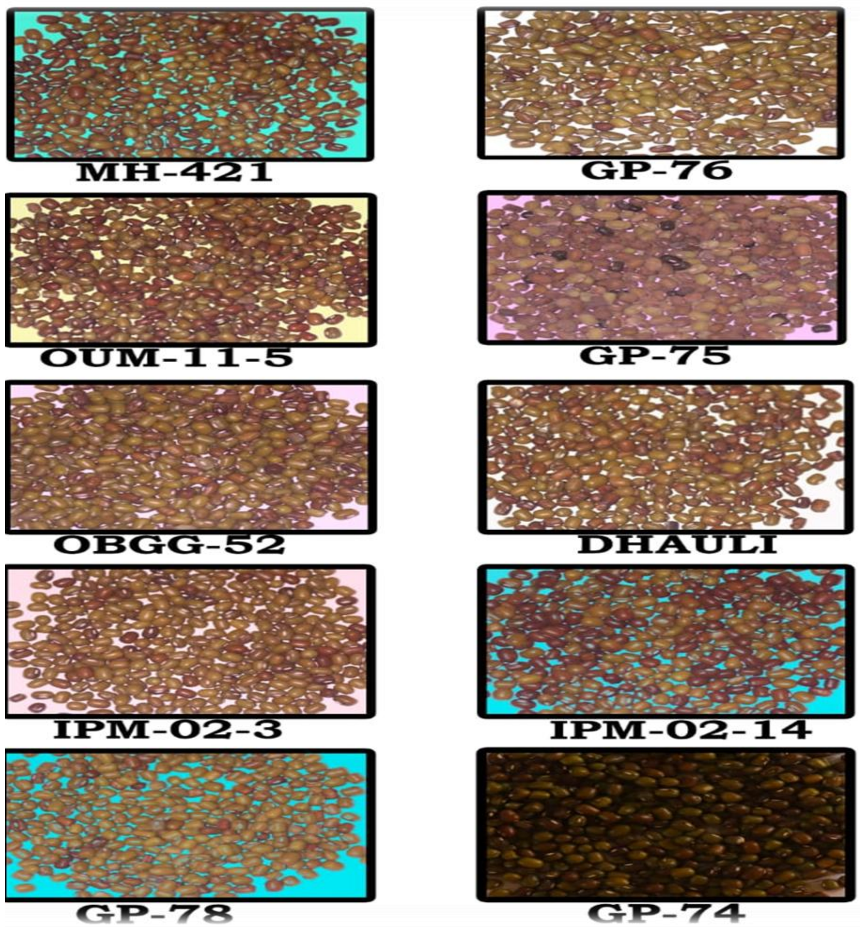

Table.4 Survivorship (%), Development period and growth index of *C. chinensis*

Sl No.	Cultivar	Survivorship (%) (A)	Mean developmental period (days) (B)	Growth Index (A/B)
1	OUM 11-5	37.32	24.10	1.54
2	GP 78	43.88	23.90	1.83
3	GP 74	33.20	31.80	1.04
4	GP 76	34.10	27.40	1.24
5	GP 75	35.69	26.50	1.35
6	MH 421	36.89	29.10	1.27
7	OBGG 52	37.74	29.10	1.30
8	IPM 02-14	39.59	25.00	1.68
9	IPM 2-3	42.86	25.50	1.69
10	DHAULI (Check)	48.07	23.70	2.03

Table.5 Categorization of mung bean cultivars based on Growth Index of *C. chinensis*

Category	Growth Index Range	No. of mung bean Cultivars	Name of mung bean cultivars
Resistant	< 1.25	02	GP 74 ,GP 76
Moderately resistant	1.25-1.55	04	MH 421, OBGG 52, OUM 11-5, GP 75
Moderately susceptible	1.56-1.85	03	GP 78, IPM 02-14, IPM 2-3
Susceptible	1.86-2.15	01	DHAULI (Check)
Highly susceptible	>2.15	-------	--------

Shortest mean development period (25.81 days) was recorded on WGG-42 followed by LGG-586 (26.56 days) and LGG-450 (26.78 days) which indicated that these varieties favoured the development of bruchid, thus facilitating to complete more number of generations in a given period of time.

The present results are also corroborating with the results of Chavan *et al*., (1997); Ofuya (1987) and Singh and Sharma (2003) who reported that the development period was significantly longer in resistant varieties of cowpea than the susceptible varieties. Further, they also noted that it was prolonged by 8 to 10 days on least preferred cowpea varieties.

Percent adult survival

The percent adult survival among different progenies of mung bean ranged from 33.20 to 48.07 percent (Table 3). The lowest of 33.20 and 34.10 percent adult survival was observed in GP 74 and GP 76 respectively which were found to be superior over the other cultivars (Pawar *et al.,* 2019).

The variety DHAULI was found to be highly preferred variety by pulse bruchid with highest survivorship (48.07%) among the different varieties which have partially similarity with Singh (2009).

Growth index

The growth index of *C. chinensis* (GI) ranged from 1.04 to 2.03 in ten cultivars (Table 4). GP 74 recorded the lowest GI value of 1.04, whereas DHAULI the highest (2.03) showing resistant and susceptibility to pulse beetle respectively. Overall GP 76, MH 421,OBGG 52and GP 75 were found to be the least preferred, with GI ranging from 1.24 to 1.35. On the other hand OUM 11-5, IPM 02-14, IPM 2-3 and GP 78 appeared to be the most preferred, with GI ranging from 1.54 to 1.83 (Table 4).

The present results are in line with the findings of the earlier workers (Soumia *et al.*, 2015). Eight green gram accessions evaluated based on the growth index and the results showed that, Pusa Baisakhi, PS-10 and PS-16 were found to be resistant against three species of pulse beetles (Jha *et al.*, 2011). Similar kind of results obtained in *C. chinensis* against 335 accessions of green gram, where four accessions were moderately resistant with minimum growth index ranging from 0.051 to 0.055 (Duraimurugan *et al.*, 2014).

In the present study, growth index was calculated based on the adult emergence and developmental period of the pulse beetle. Out of 10 green gram cultivars used in the present investigation, two cultivars *viz*., GP 74(1.04) and GP 76 (1.24) were classified as resistant entries, while four cultivars, MH 421 (1.27), OBGG 52(1.30), GP 75 (1.35) and OUM 11-5(1.54) were categorized as moderately resistant; three cultivars, IPM 2-14(1.68), IPM 2-3(1.69) and GP 78(1.83) as moderately susceptible and the remaining one cultivar *viz*., DHAULI(2.03) was grouped as susceptible entries (Table 5).

The present findings are in concurrent with Sing *et al.*, (2003) who differentiated the various cultivars of cowpea into susceptible groups on the basis of growth indices. They also observed higher growth index values on susceptible varieties of various pulses which prove our results completely.

In conclusion the present study, Out of 10 green gram cultivars used in the investigation, two cultivars *viz*., GP 74(1.04) and GP 76 (1.24) were classified as resistant entries in respect of low ovipositional preference, lowest developmental period, minimum survival, while four cultivars, MH 421 (1.27), OBGG 52(1.30), GP 75 (1.35) and OUM 11-5(1.54) were categorized as moderately resistant; three cultivars, IPM 2-14(1.68), IPM 2-3(1.69) and GP 78(1.83) as moderately susceptible and the remaining one cultivar *viz*., DHAULI(2.03) was grouped as susceptible entries.

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How to cite this article:

Subhashree Subhasmita Paikaray, B. K. Sahoo, Satya N. Satapathy and Dibyajyoti Swain. 2021. Fecundity and Preferential Oviposition of Pulse Beetle, *Callosobruchus chinensis* (L.) on Different Interspecific Progenies of Mungbean. *Int.J.Curr.Microbiol.App.Sci.* 10(03): 90-99.
doi: https://doi.org/10.20546/ijcmas.2021.1003.014