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Pawara NR
P.G. Scholar Department of Entomology, College of Agriculture, Badnapur, Maharashtra, India

Bantewad SD
Senior Scientist (Entomology), Agril. Research Station Badnapur, Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani, Maharashtra, India

Patil DK
Senior Scientist (Breeding), Agril. Research Station Badnapur, Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani, Maharashtra, India

Correspondence
Pawara NR
P.G. Scholar Department of Entomology, College of Agriculture, Badnapur, Maharashtra, India

Assessment of different interspecific progenies of mungbean against pulse beetle, *Callosobruchus chinensis* Linn. and It' s influence of seed physical characteristics on infestation

Pawara NR, Bantewad SD and Patil DK

Abstract

Twenty one interspecific progenies of mungbean were tested for their resistance against pulse beetle, *Callosobruchus chinensis* L. under laboratory conditions during the year 2017-18 at Department of Entomology, Agril. Research Station, Badnapur, Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani. This study was conducted to screening the resistance/tolerance of 21 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, seed infestation, weight loss and growth index of *C. chinensis* on progenies. Out of twenty one interspecific progenies *viz.,* BWUC 5-1-17-1-1-7, BWUC 6-1-1-Plant, BWUC 5-1-17-1-17, BWUC 5-1-8A-2-1 and BWUC-5 progenies were found to be tolerance against pulse beetle in respect of lowest ovipositional preference, shortest developmental period, minimum adult emergence, weight loss and survival and seed infestation as compared to check. While, the progenies *viz.,* BWUC 71-5-1-3-1, BWUC 22-1-6-1-1,BWUC-4, BWUC-3 and check- BM 2003-2 were highly susceptible to pulse beetle in respect of above parameters.

Keywords: Interspecific progenies, oviposition behavior, *Callosobruchus chinensis*, green gram

1. Introduction

Pulses (grain legumes) are the second most important group of crops worldwide. Globally, 840 million people are undernourished mainly on account of inadequate intake of proteins, vitamins and minerals in their diets. Pulses are excellent sources of proteins (20-40%), carbohydrates (50-60%) and are fairly good sources of thiamin, niacin, calcium and iron. Out of total 12.6 million tones, 8.5 percent is lost due to the non-availability of proper storage facilities with the farmers and vulnerability of pulses to store grain pests. One of the major constraints in production of pulses is the insect pests which inflict severe losses both in the field and storage. 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) [33]. India is the biggest producer of mungbean, with 3.5 million ha under cultivation and the production of 1.2 million tons (IIPR, 2011) [9]. 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.

In India, over 200 species of insects have been recorded infesting various pulses (Anon, 2007) [1]. Among the storage pests, bruchids incur greater importance. Among the bruchids, pulse beetles, *C. maculatus* and *C. analis* are major pests causing serious damage and are cosmopolitan in distribution.

The *C. maculatus* and *C. chinensis* are the most destructive and attack almost all edible legumes, including mungbean, pigeon pea, black gram, cowpea, chickpea, and lentil, and are cosmopolitan in distribution, encompassing Australia and Oceania, Europe, Asia, Africa, and America (Rees, 2004) [17]. Bruchids are the most destructive pests of mungbean during storage and take a heavy toll on yield (Talekar, 1988) [27]. In mungbean, bruchid infestation occurs both in the field and in storage. However, storage losses are heavy and sometimes total losses occur within 3–6 months (Tripathy, 2016) [29].

Bruchid infestation in mungbean results in weight loss, low germination, and nutritional changes in seeds, thereby reducing the nutritional and market value, rendering it unfit for human consumption, agricultural and commercial uses (Duan *et al*., 2014) [5]. Infestation by bruchids leads to an increase in trypsin inhibitor activity by 25%, saponin by 16%, and phytic acids by 46%, thus, making the seeds unfit for consumption. Bruchids are controlled by treating stored seeds with carbon disulfide, phosphine, or methyl bromide, or by dusting with several other insecticides. These chemicals are highly toxic and environmentally undesirable, and pose a threat to food safety. Although some plant-based extracts such as soy oil, maize oil, neem oil, hot pepper powder, custard apple extracts, and banana plant juice have been found useful in controlling bruchids (Swella and Mushobozy, 2007) [26], they are slow in action, are easily degradable, and can affect seed germination (Yusuf *et al*., 2011) [34]. Botanical extracts also affect non-target organisms to some extent (Sharma *et al*., 2012). The use of dust and wood ashes in spaces between seeds provides some control of bruchids.

Host plant resistance against insect pests is manifested through antibiosis, antixenosis (non-preference) and/or tolerance (Edwards and Singh, 2006) [7]. The resistant traits can be morphological, physiological and/or biochemical, and affect growth and development of insect pests (Edwards and Singh, 2006) [7]. The morphological traits in legumes include color and shape of the pod and seed, while the physiological / biochemical traits include secondary metabolites and anti-nutritional compounds affecting the metabolic activity of bruchids (Somta *et al*., 2007) [24].

The first encounter between insect pests and host plants is oviposition by insect pests; the pests preference or non-preference determines the resistance and/or susceptibility of the host plants. Successful oviposition is necessary for successful population build-up and high infestation. Any 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 show how good it is for the progeny's survival and development.

A number of antixenotic traits are implicated by plants to avoid insect oviposition in both field plants and storage seeds (War *et al.*, 2013) [30]. These traits determine the host plant/seed resistance or susceptibility to oviposition and include surface chemicals, plant volatiles, spines, hairs, etc. (War *et al.*, 2013) [30]. The host plant/seeds avoid insect oviposition either directly or indirectly by killing the insect eggs to avoid hatching of the larvae, thus, preventing future damage (Petzold-Maxwell *et al.*, 2011) [13]. Traits contributing to resistance/susceptibility of mungbean to bruchids include seed color, texture, hardness, size and chemical constituents (Somta *et al.*, 2007) [24]. Seed texture of legumes affects the oviposition capacity of *C. maculatus* and *C. chinensis* (Sarikarin *et al.*, 1999) [21]. Female bruchids prefer to lay eggs on smooth surface seeds rather than rough surface seeds covered with an inner pod membrane that renders the seed dull (Watt *et al.*, 1977) [31]. Thus, the morphological traits such as seed coat, seed smoothness/roughness, pod hairiness, and seed shine/dullness could form important morphological markers in plant breeding for developing bruchid-resistant mungbean.

2. Material and Methods

2.1. Study Site: This experiment was conducted in Randomized block design with two replication at Department of Agril. Entomology, Agril. Research Station Badnapur, under laboratory conditions during the year 2017-18. Screening of different interspecific progenies of mungbean against pulse beetle under storage condition lasting for a period of 55- 60 days.

2.2. Rearing of test insect in the laboratory: Obtain adequate culture of *Callosobruchus chinensis* the adults were collected from the store house of Agril. Research Station Badnapur along with pulses on which eggs were laid by pulse beetle. These eggs laid on seeds were kept in plastic container covered with muslin cloth and allowed the adult to emerge from the seeds. Adults thus collected, were directly introduced into mungbean plastic container and allowed them to lay eggs for seven days. Then adults were transferred into another set of container 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 ^{0}C and relative humidity 70-80 percent.

2.3 External identification of male and female bruchids : Male and female can be identified on the basis of their antennae. 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. 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) [4].

2.4. Details of different interspecific progenies of mungbean: Screening twenty one healthy insect free and genetically pure seed of interspecific progenies and one local check BM 2003-2 of mungbean as per availability of the seeds was procured from the Breeding Section, Agricultural Research Station Badnapur. The seeds were further examined and foreign material removed from the lot.

2.5 Categorizations of mungbean genotypes on the basis of morphological characters: Hundred 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 twenty one compartments prepared by rectangular plastic tray with the stripe of thermocole. In the centre of the tray small petri dish was placed for releasing the insects. Ten pairs of one or two days old adult of *Callosobruchus chinensis* were release in the petri dish so that the female had an equal chance to choose the genotype for egg laying. Then the cage was covered with muslin cloth and tide with the rubber band. The experiment was replicated two times 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±10C. 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. (Plate-1.)

Mother culture of pulse beetle

A. Male **B. Female**

A

B

Plate 1A: Ovipositional preference and **B:** total developmental period of pulse beetle on different interspecific progenies.

3. Method of recording observation

3.1 No. of egg laid on progenies; The number of eggs laid on each variety was count after 72 hrs. of the release of *C. chinensis* with the help of hand lens.

3.2 Percent adult emergence: Percent adult emergence was calculated using following formula (Howe, 1971) [8]

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

3.3 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) [8].

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

Where, d1 = day at which the adults started emerging (1st day), a1 = number of adults emerged on the day

3.4 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.

3.5 The growth index of pulse beetle on different progenies: The growth index was calculated by the formula given by Singh and Pant (1955) 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.

3.6 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.

$$\text{Per cent seed infestation} = \frac{\text{Number of damaged grains}}{\text{Total number of grains}} \times 100$$

3.7 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.

$$\text{Weight loss (\%)} = \frac{I - F}{I}\ 100$$

3.8 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.

4. Results and Discussion

Study the assessment of different interspecific progenies on mungbean against *Callosobruchus chinensis* L. in laboratory condition on stored condition. The results thus obtained were critically analyzed and incorporated in the given below.

4.1 Morphological characteristics and moisture contents of different interspecific progenies of mungbean

The data presented in Table 1 were recorded in various physical characters of seed of different interspecific progenies of mungbean determined by standard methods. The weight of 100 seeds of each varieties of mungbean was taken by electronic balance. The length and width of seeds was measured with the help of vernier caliper. The characters of seeds and its colour were also taken 10 seeds from each variety were selected randomly and observation was recorded.

The differences in the seed width observed in twenty one interspecific progenies of mungbean was found varied during course of study and the progenies range of seed width BWUC 22-1-6-1-1 (2.69 mm) to BWUC 71-5-1-3-1 (4.32 mm). The length of grains observed in interspecific progenies of mungbean was found varied during course of study and the progenies range of seed length BWUC 5 (3.31 mm) to BWUC 23-1-2-17 (5.48 mm). In respect of seed physical characters and colour of grains were observed, were progenies are small to medium size, oval and round shapes, smooth and rough surface and its colour of seed almost black and some green in colours/ The present findings are accordance with Pankaj and Singh (2011) [11] who revealed that seed characters such as size, colour, shape, valume and texture of seed coat did not perform any significant role in oviposition preference of *C. chinensis* L. in storage mungbean. However, in the present investigation seed length, seed coat thickness and weight of 100 seed had a significant impact on oviposition preference given by female adult of *C. chinensis* L. These all the parameters were negatively associated with number of eggs laid by the female adult. Hence, the varieties having higher length of seed, higher seed, width and bold seed (100 seed weight) were less preference by adult of *C. chinensis* L. for egg laying. Similarly, Winn (1988) [32] reported the seed characteristics like size, colour, luster etc., are known to affect resistance or preference of bruchids. Bruchids species predation is considered selection criteria for smaller seeds in legumes.

The data indicated that the moisture percent of 100 seed in all progenies were recorded at beginning of experiment. The moisture percentage of different interspecific progenies of mungbean in the range of BWUC 5-1-17-1-1-7 (9.49 percent) to BM 2003-2 (12.82 percent).

The lowest moisture percentage were recorded in progenies BWUC 5-1-17-1-1-7 (9.49 percent) followed by BWUC 6-1-1 (9.68 percent), BWUC 5-1-17-1-17 (9.87 percent) and BWUC 5-1-8 A 2-1 (9.93 percent), respectively it's indicating tolerance to pulse beetle. In contrast to that, moisture percent maximum in BM 2003-2 (12.82 percent) followed by BWUC 71-5-1-3-1 (12.78 percent) indicating susceptibility to pulse beetle. Thus, the highest moisture percent that demonstrated more susceptibility as compared to lowest moisture percent of the grains.

The present findings are confirmed with Deeba *et al.*, (2006) [3] who reported the susceptibility of five mungbean (*Vigna radiata* W.) genotypes. Based on the criteria of mean pest population and weight loss, genotype No. 25/20 appeared more susceptible, whereas AEM-6/20 was more tolerant/ resistant to bruchid infestation than other genotypes. The peak population of insect and percent weight loss were recorded in No. 25/20 followed by L1 P5/5/89, No. 30/5/8/90, AEM-96 and AEM-6/20. The mean grain moisture ranged from 9.94 to11.37% and was found conducive for pest multiplication. The present findings are in accordance with Chakraborty and Mondale (2016) [2] who have screened the forty-eight species of bruchids have been recorded from different localities of India. Studies revealed that relative preference of *C. chinensis* to different pulses vary widely depending upon their physical and chemical characteristics. Ovipositional preference was dependent on the seed color, seed texture, seed weight, thickness of seed coat, seed moisture and various chemical parameters. The moisture content of the seed was positively and significantly correlated with the percent infestation, protein and fat content while with germination it was significant and negative. These results are comparable with those of Rizwana *et al*. (2011) [18] and Saljoqi *et al*. (2015) [20], reported that the moisture content of seed had significantly effect on the stored seed.

4.2. Ovipositional preference of pulse beetle on different progenies

With the view to test the ovipositional preference of *C. chinensis* free-choice test was used in which ten pairs of one to two days old adults of *Callosobruchus chinensis* were released in petri dish placed in the center of the tray after putting the seeds of twenty one different interspecific progenies of mungbean. Eggs were counted 72 hours after release of pulse beetle and number of grains with eggs worked out and summarized.

The data presented in Table 2 and showed that ovipositional preference on twenty one different interspecific progenies of mungbean against *Callosobruchus chinensis* L. The mean number of eggs laid per 100 seeds of interspecific progenies of mungbean ranged from 12.50 eggs/100 seeds to 78.50 eggs/100 seeds.

The significantly the average lowest number of eggs (12.50 eggs/100 seeds) were laid on interspecific progenies BWUC 5-1-17-1-1-7 which was found at par with BWUC 6-1-1 (13.00 eggs/100 Seeds). These two progenies were found significantly superior over the other progenies along with check.

The ovipositional response of bruchids prefers to ovipositor on smooth surface, healthy and longer surface seeds as compare to small and rough surface. In present finding comparatively lowest number of eggs laid on seed of BWUC 5-1-17-1-1-7 and BWUC 6-1-1- Plant which are small size, smooth and rough surface. However, the maximum number of eggs were laid on seed of BWUC 71-5-3-1, BWUC 22-1-6-1-1 and check- BM 2003-2 which had larger to medium size, dark to medium colour and smooth surface. Thus, it indicated that medium to bold seed with smooth surface attract the pulse beetle for oviposition. This result were in agreement with finding of Pankaj and Singh (2011) [11] who revealed that seed characters such as size, colour, shape, valume and texture of seed coat did not perform any significant role in oviposition preference of *C. chinensis* L. in storage mungbean. However, in the present investigation seed length, seed coat thickness and weight of 100 seed had a significant impact on oviposition preference given by female adult of *C. chinensis* L. These all the parameters were negatively associated with number of eggs laid by the female adult. Hence, the varieties having higher length of seed, higher seed, width and bold seed (100 seed weight) were less preference by adult of *C. chinensis* L. for egg laying. In some other studies by Parmar and patel (2016) [12] who was recorded on mung bean for their susceptibility against *C. chinensis* L. under storage. The lowest number of egg laid was recorded in Vishal (7.97 eggs/20 seeds) and Smarth (8.99 eggs/20 seeds) and GM 4 (9.17 eggs/20 seeds). In some other studies by Sekar and Nalini (2017) [22] were screened the fifty two genotypes of green gram against *C. chinensis.* The mean number of eggs laid on the test genotypes ranged from 3.00 to 258.00 egg /10 gm seed. The minimum number of eggs laid in KM-14-53 (3.00 egg/10 gm seed) and maximum number of egg laid in VGG-10-002 (258.00 egg/10 gm seed).

4.3. Percent adult emergence of pulse beetle

The data presented in Table 2 showed that twenty one interspecific progenies of mungbean vary significantly for adult emergence of pulse beetle *Callosobruchus chinensis.* The percent adult emergences per 10 seeds of mungbean among different interspecific progenies were in range of 15.00 to 75.00 percent.

The significantly lowest number of percent adult emergence on interspecific progenies BWUC 5-1-17-1-1-7 (15.00 percent) and BWUC 6-1-1-Plant (15.00 percent) which was found at par with each other's and these found superior over other progenies. The next promising group of interspecific progenies recorded in BWUC 5-1-17-1-17. (20.00 percent) followed by BWUC 5-1-8A-2-1(25.00 percent) which was found at par with each other.

Thus, the results indicated that seed size and seed colour had not much influence on percent adult emergence. However, medium to bold seeded varieties with smooth surface had some influence for the adult emergence.

In some other studies by Sumia *et al.*,(2015) [25] who evaluated susceptibility of eighty five green gram accessions against pulse beetle, *C. analis* and showed significant difference in adult emergence accession *viz.*, Km-12-5 and P-S-16 revealed lesser percent adult emergence of 12.22 and 14.29, respectively these are bold varieties with smooth surface.

Similarly, Prajapati (2015) [14] reported that the adult emerged on different varieties ranged from 22.0 to 43.7 with significantly differences among them. Minimum number of adults (22.0) was emerged from RVS- 201, but was at par with rest of the varieties. Whereas, maximum number of adult (43.7) was emerged in varieties RVS-202.

4.4. Total development period of pulse beetle on different progenies

The data presented in Table 2 showed that the twenty one interspecific progenies of mungbean different significantly. The mean developmental period of *C. chinensis* (number of days taken by the adult to emerge since the oviposition period) ranged 23.72 to 26.33 days. The lowest mean developmental period of pulse beetle was noticed in the cultivar of BWUC 5-1-17-1-1-7 (23.72 days) which was found significantly at par with progenies in BWUC 6-1-1 (24.17 days) followed by BWUC 5-1-8A-2-1(24.29 days), BWUC 22-1-2-27 (24.49 percent), BWUC 5-1-1 (24.58 days), BWUC 5-1-17-1-17 (24.58days) and BWUC 22-1-2-2-1 (24.80 days), respectively which was found at par with each other progenies that means least preference took shortest mean developmental period.

The highest mean developmental period was observed in BM 2003-2 (23.66 days) followed by BWUC 71-5-1-3-1 (26.30 days) followed by BWUC-4 (26.29 days), BWUC 22-1-6-1-1 good plant (26.25 days) and BWUC 5-1-8A-2-1 (26.25 days), respectively which was statistically found at par with each other.

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 genotypes with least ovipositional preference took shortest mean developmental period which was in contrast with the findings of Deeba *et al.* (2006) [3] who reported that the tolerant genotypes exhibited shortest mean developmental period. The lowest mean developmental period of pulse beetle was noticed in the accessions BM 2003-2 (23.72 days) and highest BWUC 5-1-17-1-1-7 (26.33 days) this result were in agreement with finding Sadozai *et al.*, (2003) [19] determined the shortest developmental period of 19.2 days, while the longest 23 days of pulse beetle, *C. maculaus.* Similarly, Tripathi *et al.*, (2012) [28] revealed that the mean developmental period ranged from 27.68 to 34.44 days and *C. maculatus* exhibited a high degree of specificity for their growth and development towards the seeds of various legumes.

4.5. Percent adult survival

The data presented in Table 2 showed that on different twenty one interspecific progenies of mungbean regarding percent adult survival of pulse beetle data was found statistically significant. The percent adult survival among different progenies ranged from 20.00 to 75.00 percent. The significantly lowest percent adult survival was (15.00 percent) on interspecific progenies BWUC 5-1-17-1-1-7 and BWUC 6-1-1-Plant (15.00 percent) which was found significantly superior over the other progenies.

The present findings are in accordance with Duraimurugan *et al.*, (2014) [6] who evaluated the four hundred seventy five accessions of two *vigna* species and *Vigna munga* 335 of *Vigna radiata* (green gram) Four greengram accessions of (LN-131, V-1123, LM-371 and STY-2633) were found moderately resistant with less age survival (38.9 to 51.6%). Similarly, the black gram, three accessions (UH 82-5, IC 8219 and SPS 143) were moderately resistant with less percentage survival (33.7 to 42.0 percent).

4.6. Growth index

The data presented in Table 3 showed that twenty one interspecific progenies of mungbean show significantly vary for growth index by pulse beetle *Callosobruchus chinensis.* The growth index per 10 seeds was in range of 0.57 to 2.99. ignificantly minimum growth index (0.57) were observed in BWUC 5-1-17-1-1-7 followed by BWUC 6-1-1 plant (0.58) and BWUC 5-1-17-1-17 (076.). which was found statistically at par with each other.

The present findings are in accordance with Raghuwanshi *et al.*, (2016) [15] who recorded the growth index ranging from 2.37 to 2.89 on other crop like chickpea varieties and revealed that growth index susceptibility was higher (2.68) non kabuli genotypes which had smooth surface than deshi genotypes (2.48) which had rough surface.

The present findings are in accordance with Sumia *et al.*, (2015) [25] who had evaluated the susceptibility of eighty five green gram accessions were evaluated against pulse beetle, *Callosobruchus analis* (F.) Accessions which exhibited lesser susceptibility during index the preliminary free choice tests was further subjected to 'force choice' test for confirmation of bruchid resistance. lesser susceptibility index (0.042 and 0.044 respectively) in comparison to highly susceptible Ganga 8.

4.6. Number of holes on seeds of different progenies:

The data presented in Table 3 showed interspecific progenies of mungbean significantly variations for number of holes on seed by pulse beetle *Callosobruchus chinensis.* Number of holes of mungbean among different progenies ranged from 1.00 to 8.00/10 seeds. Significantly lowest numbers of holes (1.00 holes/10 seed) were on interspecific progenies BWUC 5-1-17-1-1-7 which was found significantly superior over the other progenies.

The present findings are confirmed with of Tripathi *et al*, (2012) [28] evaluated fifty two cowpea genotypes including two checks Pusa Komal and Local variety for their differential reaction to pulse beetle, the minimum number of emergence holes, were recorded in this three genotypes (IC107466, IC106815 and Pusa Komal) were found resistant.

4.7. Percent seed infestation due to pulse beetle on different progenies

The data presented in Table 3 and plate 2 and 3 showed that twenty one 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 per 10 seeds among different progenies ranged from 10.00 to 80.00 percent. The significantly minimum percent seed infestations (10.00 percent) were recorded on interspecific progenies BWUC 5-1-17-1-1-7 which was found significantly superior over the progenies. The next promising group of interspecific progenies recorded moderate seed infestation in BWUC 6-1-1-Plant (20.00 percent) followed by BWUC 5-1-17-1-17 (30.00 percent), BWUC 5-1-8A-2-1(35.00 percent) and BWUC 25-1-1-1-1-1 and BWUC-1 is (40.00 percent) which was found statistically significant as compared to check BM 2003-2 (80.00 percent).

Thus, the result indicated that seed surface plays important role in causing percent seed infestation. However, the variety BM 2003-2 and BWUC 71-5-1-3-1 had smooth surface and small seed size which was found more suitable for oviposition preference and seed damage while BWUC 5-1-17-1-1-1-7 and BWUC 6-1-1-Plant were least preferred for percent seed infestation.

The present findings are in accordance with Rajendra Prasad *et al.*, (2013) [16] who studied the twenty eight *Dolichos* bean. GL 77 recorded the lowest seed damage (13.4%), followed by GL 233 (14.69%) and GL 63 (18.34%) and these entries were grouped as least susceptible. The highest seed damage was observed in GL 46 (97%) and at par with GL 67 (44%), GL 127 (42.75%) and grouped as highly susceptible. None of the entries were completely free from bruchid damage. Similarly findings are in accordance with of Shaheen *et al.*, (2006) [23] who evaluated the resistance of fifteen chickpea cultivars against pulse beetle. The minimum grain damage (24.35%) was recorded in Bittle-98, while the maximum of 54.46% damage was noticed in Flip 97-192C.

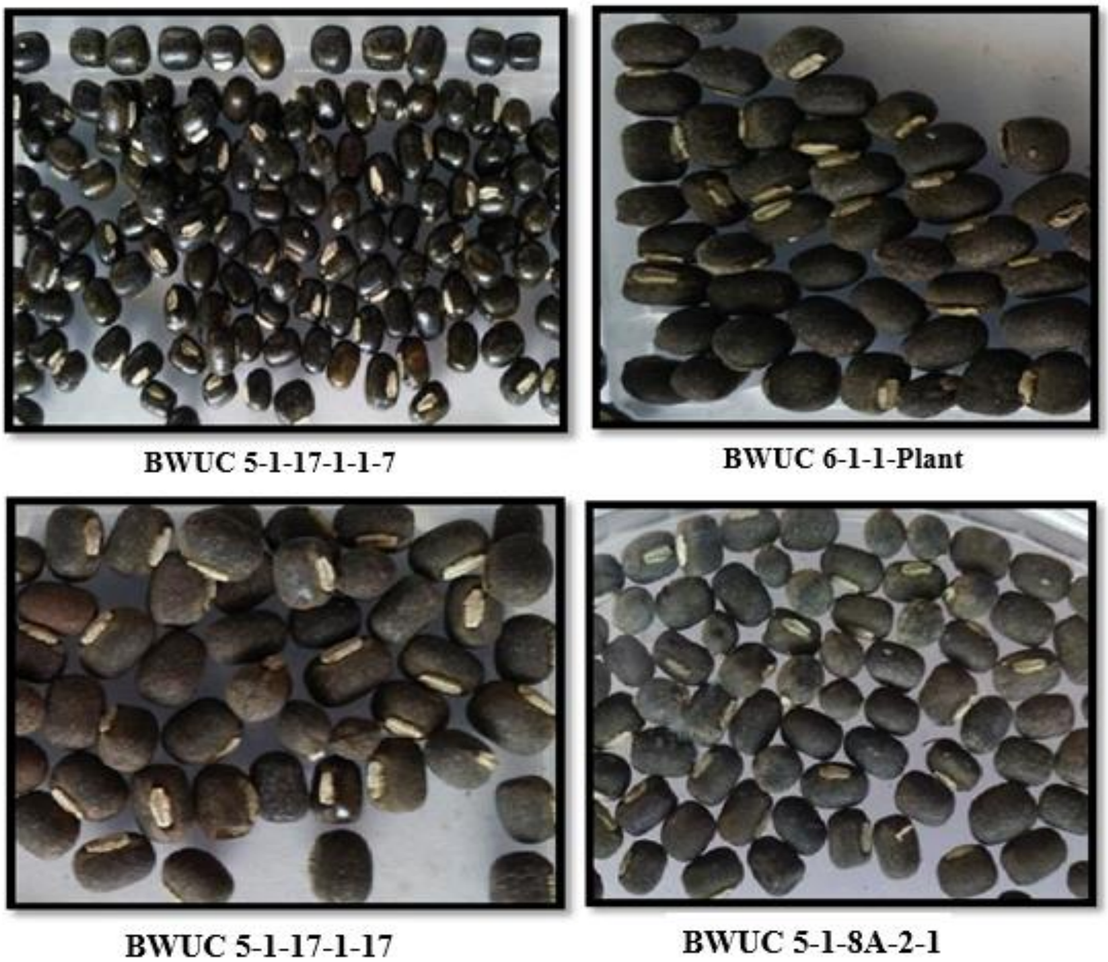

Plate 2: Tolerance interspecific progenies of mungbean against pulse beetle

BWUC 71-5-1-3-1

BWUC 22-1-6-1-1

BWUC 4

BWUC-3

Check - BM 2003-2

Plate 3: Susceptible interspecific progenies of mungbean against pulse beetle

4.8 Percent weight loss

The data presented in Table 3 showed that interspecific progenies of mungbean were significantly different for percent weight loss due to pulse beetle *C. chinensis*. Percent weight loss per 10 seeds of mungbean among different progenies ranged from 20.39 to 59.47 percent. Significantly minimum percent weight losses (20.39 percent) were observed in interspecific progenies BWUC 5-1-17-1-1-7 which was found significantly superior over the other progenies. The next moderate promising interspecific progenies recorded in BWUC 6-1-1-Plant (29.88 percent) followed by BWUC 5-1-17-1-17 (32.33 percent), BWUC 5-1-8 A-2-1 (34.39 percent), BWUC-5 (38.48 percent) and BWUC 22-1-1-2-1-1 (40.50 percent) respectively.

Significantly maximum percent weight loss was recorded on BM 2003-2 (59.47 percent) followed by BWUC 71-5-1-3-1 (58.37 percent), BWUC 22-1-6-1 -1 Good plant (54.99 percent) and BWUC-4 (52.50 percent) and BWUC-3 (49.84 percent) respectively.

The present findings are in accordance with Sumia *et al.*, (2015) [25] 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 Km-12-5 recorded the lowest percent weight loss (5.61 percent). The present findings are confirmed with Tripathi *et al*., (2012) [28] 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) [10] who studied the preferential behavior of *C. maculates* on twelve fodder cowpea genotypes, 10.39 to 56.53 percent losses in seed weight were observed in different cowpea genotypes.

5. Conclusion

Out of twenty one interspecific progenies *viz.*, BWUC 5-1-17-1-1-7, BWUC 6-1-1-Plant, BWUC 5-1-17-1-17, BWUC 5-1-

8A-2-1 and BWUC-5 progenies were found to be tolerance against pulse beetle in respect of low ovipositional preference, lowest developmental period, minimum survival and seed infestation. While, the progenies *viz.*, BWUC 71-5-1-3-1, BWUC 22-1-6-1-1,BWUC-4, BWUC-3 and check- BM 2003-2 were highly susceptible to pulse beetle in respect of above parameters.

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Table 1: Morphological characteristics of interspecific progenies of mungbean seeds

Sr. No	Name of progenies	Width of seed (mm)	Length of seed (mm)	Character of seed& color	Moisture Percent
1	BWUC 22-1-2-2-1	2.78	3.47	Small, oval shape and rough surface black	11.11
2	BWUC 1	3.54	4.16	Medium, oval and smooth surface, green	10.43
3	BWUC 5 -1- 17- 1-1-7	3.22	3.96	Small, oval shape and smooth surface, dark black	9.49
4	BWUC 22-1-2-27	3.70	4.77	Medium, oval shape and rough surface, black	11.29
5	BWUC 22- 1- 6 -1 –1	2.69	4.07	Small, oval shape and rough surface, black	10.53
6	BWUC – 3	3.37	3.93	Medium, round and smooth surface, light green	12.01
7	BWUC 25 -1-1-1-1-1	3.08	4.69	Medium, oval, smooth surface, light black	11.60
8	BWUC 71-5-1-3-1	4.32	5.08	Bold, oval and smooth surface, green	12.78
9	BWUC 5-1-1	3.33	4.58	Medium. oval and rough surface, black	11.77
10	BWUC 22-1-1-2-1-1	3.69	4.01	Small, oval shape and rough surface, black	11.94
11	BWUC 22-1-6-1-1	3.64	5.06	Bold, oval shape and rough surface, light black	12.47
12	BWUC 23-1-37-1	3.42	3.58	Small, oval shape and rough surface, black	10.94
13	BWUC 4	4.28	5.06	Bold, oval shape and smooth surface, green	12.24
14	BWUC 23-1-1-2-27	3.57	4.98	Medium, oval and smooth surface, dark black	11.79
15	BWUC 5-1-17-1-17	3.23	4.62	Medium, oval and rough surface, black	9.87
16	BWUC 23-1-3-5-1-1	3.29	4.79	Medium. oval and rough surface, light black	11.90
17	BWUC 23-1-2-17	3.55	5.48	Bold, oval and smooth surface, light black	10.83
18	BWUC 5	2.97	3.31	Small, round and smooth surface, dull green	10.00
19	BWUC 6-1-1	3.97	4.57	Medium, oval and smooth surface, black	9.68
20	BWUC 5-1-8A-2-1	3.50	4.02	Small, rough surface, black	9.93
21	Check - BM 2003-2	4.02	5.06	Bold, oval shape and smooth surface, dark green	12.82

Table 2: Oviposition preference and adult emergence of *C. chinensis.* L. on different interspecific progenies of mungbean

r. No.	Name of progenies	No of eggs laid/ 100 Seeds *	Percent adult emergence/10 Seeds**	Total developmental period / 10 seed (*)	Percent adult survival / 10 seed (**)
1	BWUC 22-1-2-2-1	33.50 (5.83)	50.00 (45.00)	24.80 (5.03)	50.00 (45.00)
2	BWUC 1	24.50 (5.00)	45.0 (42.13)	25.75 (5.12)	45.00 (42.13)
3	BWUC 5 -1- 17- 1-1-7	12.50 (3.60)	15.0 (22.78)	23.72 (4.92)	15.00 (22.78)
4	BWUC 22-1-2-27	23.50 (4.85)	45.0 (42.13)	24.49 (4.99)	45.00 (42.13)
5	BWUC 22- 1- 6 -1 – 1	26.50 (5.24)	35.0 (36.22)	25.12 (5.06)	35.00 (36.27)
6	BWUC – 3	64.00 (8.03)	55.0 (47.87)	25.70 (5.11)	55.00 (47.87)
7	BWUC 25 -1-1-1-1-1	35.50 (6.04)	45.0 (42.13)	25.16 (5.06)	45.00 (42.13)
8	BWUC 71-5-1-3-1	65.50 (8.12)	65.0 (53.77)	26.30 (5.17)	65.00 (53.72)
9	BWUC 5-1-1	25.50 (5.09)	45.0 (42.11)	24.58 (5.00)	45.00 (42.13)
10	BWUC 22-1-1-2-1-1	40.50 (6.40)	45.0 (42.13)	25.70 (5.11)	45.00 (42.13)
11	BWUC 22-1-6-1-1	64.50 (8.06)	60.0 (50.76)	26.25 (5.17)	60.00 (50.76)
12	BWUC 23-1-37-1	40.50 (6.40)	50.0 (45.00)	25.10 (5.06)	50.00 (45.00)
13	BWUC 4	64.50 (8.06)	55.0 (47.88)	26.29 (5.17)	55.00 (47.88)
14	BWUC 23-1-1-2-27	27.50 (5.29)	45.0 (42.13)	25.75 (5.12)	50.00 (45.00)
15	BWUC 5-1-17-1-17	13.50 (3.74)	20.0 (26.56)	24.58 (5.00)	20.00 (26.56)
16	BWUC 23-1-3-5-1-1	38.50 (6.24)	50.0 (45.00)	25.79 (5.12)	50.00 (45.00)
17	BWUC 23-1-2-17	62.50 (7.93)	50.0 (45.00)	25.50 (5.09)	50.00 (45.00)
18	BWUC 5	15.50 (4.00)	30.0 (33.21)	24.75 (5.02)	30.00 (33.21)
19	BWUC 6-1-1	13.00 (3.67)	15.0 (22.78)	24.17 (4.96)	15.00 (22.78)
20	BWUC 5-1-8A-2-1	14.00 (3.87)	25.0 (30.00)	24.29 (4.97)	25.00 (30.00)
21	Check - BM 2003-2	78.50 (8.88)	75.0 (60.00)	26.33 (5.18)	75.00 (60.11)
	SE m ±	0.07	1.28	0.04	0.96
	CD at 5%	0.21	3.67	0.12	2.74
	CV %	1.82	4.41	1.18	3.29

* Valu**e** in parenthesis are square root transformed value. ** Value in parenthesis are angular transformed value.

Table 3: Growth index and number of holes by *Callosobruchus chinensis* on different interspcific progenies of mungbean seeds.

Sr. No.	Name of progenies	Growth index / 10 seeds	No. of seed holes / 10 seeds *	Percent Seed infestation / 10 seeds **	Percent weight loss / 10 seeds **
1	BWUC 22-1-2-2-1	2.10	5.0 (2.34)	50.00 (45.00)	41.35 (40.02)
2	BWUC 1	1.79	4.0 (2.12)	40.00 (39.23)	39.67 (39.04)
3	BWUC 5 -1- 17- 1-1-7	0.57	1.0 (1.22)	10.00 (18.43)	20.39 (26.84)
4	BWUC 22-1-2-27	1.76	5.0 (2.34)	50.00 (45.00)	39.75 (39.05)
5	BWUC 22- 1- 6 -1 – 1	1.52	5.0 (2.34)	50.00 (45.00)	39.39 (38.87)
6	BWUC – 3	2.39	5.5 (2.44)	55.00 (47.88)	49.84 (44.09)
7	BWUC 25 -1-1-1-1-1	1.74	4.0 (2.12)	40.00 (39.32)	40.63 (39.59)
8	BWUC 71-5-1-3-1	2.45	7.0 (2.73)	70.00 (56.78)	58.37 (49.82)
9	BWUC 5-1-1	1.75	5.5 (2.44)	55.00 (47.88)	38.82 (38.54)
10	BWUC 22-1-1-2-1-1	1.83	4.5 (2.23)	45.00 (42.11)	38.50 (38.35)
11	BWUC 22-1-6-1-1	2.47	6.5 (2.64)	65.00 (53.77)	54.99 (47.86)
12	BWUC 23-1-37-1	1.94	5.0 (2.34)	50.00 (45.00)	39.48 (38.92)
13	BWUC 4	2.24	5.5 (2.44)	55.00 (47.88)	52.50 (46.43)
14	BWUC 23-1-1-2-27	1.78	5.0 (2.34)	50.00 (45.00)	40.21 (39.35)
15	BWUC 5-1-17-1-17	0.76	3.0 (1.87)	30.00 (33.21)	32.33 (34.65)
16	BWUC 23-1-3-5-1-1	2.06	5.5 (2.34)	55.00 (47.88)	41.09 (39.86)
17	BWUC 23-1-2-17	2.05	5.0 2.34)	50.00 (45.00)	46.39 (42.93)
18	BWUC 5	1.16	4.5 (2.23)	45.00 (42.11)	38.43 (38.31)
19	BWUC 6-1-1	0.58	2.0 (1.58)	20.00 (26.56)	29.88 (33.31)
20	BWUC 5-1-8A-2-1	0.94	3.5 (1.99)	35.00 (36.22)	34.39 (35.90)
21	Check - BM 2003-2	2.99	8.0 (2.91)	80.00 (63.43)	59.47 (50.46)
	SE m ±	0.06	0.06	1.80	0.40
	CD at 5%	0.18	0.17	5.14	1.15
	CV %	5.10	3.88	5.85	1.49

* Value in parenthesis are square root transformed value

**Value in parenthesis are angular transformed value.

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