Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(4): 32-37

Received: 13-05-2019
Accepted: 15-06-2019

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# Response of mung (*Vigna radiata)* and mash (*Vigna mungo)* genotypes against *Callosobruchus maculatus* F. during storage

**Zahid Iqbal, Shahid Hussain, Mhammad Ayub, Ishtiaq Hussain and Hasil Khan**

**Abstract**
Studies were conducted for the screening of mung and mash genotypes against *Callosobruchus maculatus* under laboratory conditions at NARC Islamabad during the year 2014. For this purpose No-choice and Free-choice tests were used. The parameters viz. adult emergence, damage to grains, weight losses, development period, per adult weight and number of eggs laid were recorded. Physiochemical analysis of grains was also done. In case of Mash, maximum damage and weight losses were 23.86 and 31.79% under No-choice test, and 23.45and 19.53% under Free-choice test were recorded. In case of mung grains, maximum damage and weight losses were 31.41 and 50.97%, respectively in No-choice test and those of 17.96 and 29.80%, respectively in Free-choice test. Different genotypes of mash and mung showed response differently under No-Choice and Free-Choice techniques. In case of mash, NARC-Mash-1 had the highest rating for all parameters under Free-choice test but lower under No-choice test. NCH-7-5 showed higher rating to all parameters in No-choice test but medium performance under Free-choice test. NCH-10-1 ranked on lower side for all parameters under Free-choice test but medium under No-choice tests. NCH-3-4 performed well under both types of tests. In case of mung, the response of different genotypes of mung was different for different parameters. The only genotype NCM-257-2 performed well on the basis of damage, weight losses, adult emergence and adult weight. The results of the present investigations revealed that none of the mash and mung genotype was completely resistant to *C. maculatus*. Size of the grains showed mix trend. However, the majority of the bold grains had more damage and eggs in both types of tests. In both, mash and mung, protein contents are negatively correlated with damage and adult emergence but positively correlated with developmental period. Fats have positive correlation with damage but the negative correlation with adult emergence and developmental period. Carbohydrate has a significant positive correlation with damage and adult emergence. Moisture has a positive correlation with damage and adult emergence in mash grains but the negative relation in mung. It has a negative effect on developmental period in both, mash and mung grains.

**Keywords:** Response, mung, genotypes and screening

## Introduction

Pulses play a vital role in the food of a majority of the people living in developing countries because these have 20-30% protein, three times more than present in cereals (Doharey *et al*., 1983) [1]. Globally, total pulses are cultivated on an area of 80.75 million hectare with 73.01 million tons production and 904 kg/ha yield. In Pakistan, total pulses are grown on 1.48 million hectares with production of 1.071 million tons In Pakistan, commonly grown pulses are chickpea, lentil, mung, mash and khesari (Haqqani *et al.*, 2007) [6]. These are usually grown on marginal lands in Pakistan. Mung area, production and yield in Pakistan are 0.131 million hectares, 0.093 million tons and 708 kg/ha, respectively whereas Mash is cultivated on 0.021 million hectares with 0.010 million tons production and 476 kg/ha yield. In Pakistan, generally pesticides are used for insect control during storage for fumigation and direct spray inside the stores. Insecticides are the most effective and quick methods of insect control) but have several adverse effects like environmental pollution and biohazard to human beings. The insecticides leave effects in the products. Due to regular spray, insect pests may develop resistance against certain insecticides
The development, population build-up and rate of influx caused by this pest rely on sort of food.

Unluckily, very little consideration has been given to this aspect. The present research was carried out with a vision to find out the appropriateness of various genotypes of mung and mash in the expansion of this pest and level of damage by studying its biological parameters.

### Objectives
The present studies were conducted to fulfill the following objective

- To find out relative susceptibility/resistance of mung and mash genotypes against *Callosobruchus maculatus* F.
- To investigate physiochemical factors responsible for susceptibility of pulses genotypes against *Callosobruchus maculatus* F.

### Materials and Methods
The genotypes of mash and mung used in the experiments were:

| Mung Genotypes | Mash Genotypes |
|---|---|
| 1) NCM-257-2 | 1) NCH-9-9 |
| 2) NCM-11-4 | 2) NCH-3-4 |
| 3) NCM-11-3 | 3) NARC-MASH-3 |
| 4) CHAKWAL-6 | 4) CHAKWAL-MASH-97 |
| 5) NCM-11-2 | 5) NCH-7-5 |
| 6) NM-06 | 6) MASH-UROOJ |
| 7) NCM-11-6 | 7) NARC-MASH-1 |
| 8) NCM-11-8 | 8) NCH-10-1 |

### Stock Culture of *Callosobruchus maculatus*
The culture of *C. maculatus* was maintained on chickpea at 28±2 $^0$C and 60±5% R.H. with12:12 hr light: dark cycle for a number of generations in the laboratory to make it homogenous. Grains containing a single egg were isolated from the stock culture and placed in glass vials separately and plugged with cotton to get individual virgin adults in captivity. After the emergence of adults from these eggs adults were identified as male and female on the basis of body size, shape, and colour.

### Experiments Conducted
Four experiments were conducted, 2 (No-Choice and Free-Choice) for mung and 2 (No-Choice and Free-Choice) for mash genotypes. Methodologies were same for mung and mash.

### No-Choice Test
In the No choice test, 20 grams each of eight mung bean and mash genotypes were placed in separate glass jars (10×5cm). The trial was conducted with 8 treatments (8 genotypes) under Completely Randomized Design with three replications separately for mung and mash. In this test, adults were confined to oviposit and develop on all genotypes separately. Five pairs of newly emerged adults from homogenous culture were collected within 24 hours and released in glass jars (5 x 10 cm) containing 20 gram of mung and mash genotypes. Jars were covered with muslin cloth. The rim of the lid was held tightly on the jar so as to avoid the escape of pulse beetle and provide sufficient air. The experiments were conducted under controlled conditions in growth chamber at 28±2 ºC and 65± 5% relative humidity.

### Free-Choice Test
In free-choice test, all genotypes were subjected to the attack of the pulse beetle freely as described by and In this way**,** complete choice was given to the pulse beetle to oviposit on mung and mash genotypes. For this purpose, Free Choice Testing Apparatus measuring 36 x 24 x 6.8 cm$^3$ having 30 equal sections of 2.5 cm$^3$ each. These were used separately for mung and mash. Five grams each of eight genotypes were placed in small sections randomly arranged in the completely Randomized design. Thirty pairs of newly emerged adults of *C. maculatus* were released in each main chamber which was covered with muslin cloth. The experiments were conducted under controlled conditions in growth chamber at 28±2 ºC and 65± 5% relative humidity.

**Damaged grains**: The damaged grains were separated from sound grains. These grains were counted in each sample and recorded and converted to percent damaged grain as given below:

$$\text{Damaged Grains (\%)} = \frac{\text{Damaged grains}}{\text{Total grains}} \times 100$$

The damage occurred was also categorized as 0.0% = Highly resistant, 1-10 = Resistant, 11-20% = Moderately resistant, 21-40% = Moderately susceptible, 41-60% = Susceptible, 61-100% = Highly susceptible.

**Weight loss**: After emergence of adults, weight of grains was measured in grams. On the basis of initial and final weight of grains, weight losses were computed. The following formula was used for this purpose.

$$\text{Weight Loss (\%)} = \frac{\text{Initial grains weight} - \text{Final grains weight}}{\text{Initial grains weight}} \times 100$$

**Developmental period:** For developmental period (egg to adult), the number of days between the oviposition for F1 generation by the released adults and the adult emergence for F2 generation were counted.

**Adults emerged**: After completion of F1 generation, numbers of adults emerged were counted after time period of 65 days. On the basis of initial eggs and adults emerged, percent adult emergence was calculated as follow:

$$\text{Adult emergence (\%)} = \frac{\text{Numbers of adults emerged}}{\text{Total numbers of eggs laid}} \times 100$$

## Results

**Table 1:** Response of Mash (*Vigna mungo*) Genotypes against *Callosobruchus maculatus* in No-Choice Test

| Genotypes | Damaged Grains Mean± SD (%) | Weight Loss Mean± SD (%) | Total Eggs Mean± SD (No.) | Adult Emerged Mean± SD (%) | Per Adult Weight Mean± SD (mg) | Development Period Mean± SD (days) |
|---|---|---|---|---|---|---|
| NCH-9-9 | 22.74± 2.34 | 22.81± 4.75 | 142± 18.18 | 65.68± 12.40 | 1.97± 0.26 | 30.77± 1.53 |
| NCH-3-4 | 18.27± 2.07 | 24.9± 4.19 | 131.77±19.01 | 61.87± 14.86 | 1.17± 0.11 | 31.00± 1.00 |
| NARC-Mash-3 | 21.23± 3.18 | 31.48± 5.80 | 122.33±35.53 | 72.02± 22.27 | 1.11± 0.08 | 29.77± 1.53 |
| Chakwal-Mash-97 | 21.34± 1.52 | 31.79± 12.16 | 155.77± 15.57 | 59.76± 9.17 | 1.89± 0.23 | 30.00± 1.83 |
| NCH-7-5 | 23.86± 0.70 | 31.70± 4.59 | 174.77± 8.33 | 55.15± 1.13 | 1.19± 0.00 | 30.33± 0.58 |
| Mash-Urooj | 18.43± 2.28 | 20.41± 7.12 | 147.66± 25.81 | 50.04± 3.91 | 1.16± 0.10 | 31.33± 0.15 |
| NARC-Mash-1 | 17.82± 3.36 | 23.79± 10.77 | 137.00± 19.10 | 56.99± 11.94 | 1.12± 0.17 | 30.00± 1.73 |
| NCH-10-1 | 21.84± 2.05 | 27.7± 7.77 | 171.00± 8.00 | 53.21± 6.13 | 1.83± 0.13 | 29.77± 1.15 |
| CV (%) | 11.25 | 27.31 | 13.88 | 20.26 | 8.18 | 4.46 |
| LSD (0.05) | 4.026 | 12.64 | 35.48 | 20.92 | 0.26 | 2.34 |

**Table 2:** Response of Mash (*Vigna mungo*) Genotypes against *Callosobruchus maculatus* in Free-Choice

| Genotypes | Damaged Grains Mean± SD (%) | Weight Loss Mean± SD (%) | Total Eggs Mean± SD (No.) | Adult Emerged Mean± SD (%) | Per Adult Weight Mean± SD (mg) | Development Period Mean± SD (days) |
|---|---|---|---|---|---|---|
| NCH-9-9 | 22.88± 3.57 | 19.53± 6.77 | 30.77± 8.50 | 77.27± 12.93 | 1.14± 0.36 | 31.00± 1.00 |
| NCH-3-4 | 14.06± 3.22 | 6.77± 3.21 | 24.00±8.91 | 68.15± 18.76 | 1.62± 0.18 | 31.00± 1.00 |
| NARC-Mash-3 | 13.70± 5.44 | 31.48± 4.85 | 20.00±1.00 | 66.46± 23.71 | 1.45± 0.21 | 29.00± 1.73 |
| Chakwal-Mash-97 | 19.72± 5.94 | 13.13± 12.23 | 28.00± 4.59 | 73.17± 9.71 | 1.62± 0.25 | 30.00± 1.73 |
| NCH-7-5 | 20.30± 2.88 | 14.83± 3.10 | 25.00± 5.29 | 86.03± 4.19 | 1.12± 0.30 | 29.00± 0.58 |
| Mash-Urooj | 17.33± 2.24 | 13.70± 2.27 | 22.33± 4.04 | 72.11± 14.38 | 1.45± 0.21 | 29.00± 1.53 |
| NARC-Mash-1 | 23.45± 6.16 | 15.33± 8.45 | 25.77± 6.91 | 95.58± 4.10 | 1.92± 0.14 | 30.00± 1.53 |
| NCH-10-1 | 12.29± 4.04 | 8.77± 6.02 | 15.00± 6.67 | 87.99± 11.91 | 1.31± 0.10 | 29.00± 0.58 |
| CV (%) | 24.20 | 37.03 | 25.99 | 17.82 | 15.45 | 4.30 |
| LSD (0.05) | 7.51 | 8.15 | 10.82 | 24.23 | 0.40 | 2.23 |

**Table 3:** Response of Mung (*Vigna radiata*) Genotypes against *Callosobruchus maculatus* in No-Choice Test

| Genotypes | Damaged Grains Mean± SD (%) | Weight Loss Mean± SD (%) | Total Eggs Mean± SD (No.) | Adult Emerged Mean± SD (%) | Per Adult Weight Mean± SD (mg) | Development Period Mean± SD (days) |
|---|---|---|---|---|---|---|
| NCM-11-4 | 28.95±3.39 | 50.06±1.28 | 325±18.08 | 44.73±3.27 | 2.263±0.14 | 29±1.00 |
| NCM-257-2 | 26.73±3.91 | 49.20±1.48 | 343±13.53 | 39.35±4.37 | 2.35±0.14 | 28.77±0.58 |
| NM-06 | 30.42±3.26 | 48.13±1.61 | 288.33±12.50 | 51.99±4.52 | 2.41±0.16 | 29.77±0.58 |
| Chakwal-06 | 30.14±1.88 | 48.93±1.79 | 323±7.02 | 49.59±4.12 | 2.35±0.08 | 29.00±1.00 |
| NCM-11-8 | 31.41±3.27 | 47.20±2.24 | 305.33±9.81 | 55.28±4.21 | 2.23±0.12 | 29.00±1.00 |
| NCM-11-3 | 29.24±3.21 | 49.60±3.33 | 343.77±21.20 | 42.55±7.14 | 2.36±0.04 | 28.77±0.58 |
| NCM-11-6 | 27.97±2.21 | 49.30±0.58 | 354.33±14.05 | 44.72±3.77 | 2.28±0.07 | 30.77±0.58 |
| NCM-11-2 | 30.84±5.41 | 50.97±0.88 | 341.00±7.15 | 39.44±6.35 | 2.26±0.13 | 29.00±0.00 |
| CV (%) | 11.78 | 3.70 | 4.20 | 10.60 | 4.99 | 2.52 |
| LSD (0.05) | 5.99 | 3.14 | 23.95 | 8.42 | 0.20 | 1.27 |

### Adult Weight
Results are statistically non-significant. After getting the weight of all emerged adults, weight of one adult was found. Average weight of adults of *C. maculatus* was almost equal with range 2.23-2.41 mg. However, the adult weight on NM-06 (2.41 mg) was highest and NCM-11-8 (2.23 mg) was lowest.

### Free-Choice Test on Mung Grains
Under Free-Choice Test for mung grains, the following results were obtained (Table 4).

### Fecundity
Results are statistically significant. Maximum eggs per female laid by released adults of *C. maculatus* were (31.33) in NCM-11-4 and minimum (15.33) in NCM-11-3. Fecundity in Chakwal-06 (27.77), NCM-11-6 (24.66), NCM-257-2 (22.33), NCM-11-8 (21.33), NCM-11-2 (19.66) and NM-06 (16.00) is statistically non-significant.

### Damaged Grains
Results are statistically non-significant. Highest damage (17.96%) to grains by *C. maculatus* was recorded in NCM-11-4 and the lowest (8.82%) in NCM-11-8. In other genotypes, damages were 15.98% (Chakwal-06), 15.59% (NCM-11-6), 11.83% (NCM-11-2), 10.30% (NCM-11-3), 9.56% (NM-06) and 9.44% (NCM-257-2). NCM-11-8 was least preferred by *C. maculatus* for feeding and NCM-11-4 was the most preferred by *C. maculatus.*

### Weight Loss
Results are statistically significant. Maximum weight losses due to the damage occurred by *C. maculatus* in different genotypes of Mung were observed in NCM-11-8 (29.80%) and minimum weight losses occurred in NCM-257-2 (3.93%). Weight losses in NCM-11-8 were significantly higher than

NCM-257-2, Chakwal-06 and NCM-11-4. While NM-06 (24.46%), NCM-11-3(24.26%), NCM-11-2(24.20%) and NCM-11-6 (24.13%) are non-significant at upper side and Chakwal-06, NCM-11-4, NCM-11-6, NCM-11-2, NCM-11-3 and NM-06 are non-significant.

### Adult Emergence

Results are statistically significant. Maximum adults were emerged in NCM-11-6 (97.22%) which were significantly higher than NM-06 (57.76%), NCM-257-2 (61.91%) and NCM-11-2 (66.92%) and statistically at par with Chakwal-06 (86.90%), NCM-11-3(81.29%), NCM-11-4 (71.89%) and NCM-11-8 (69.92%). Adult emergence in NM-06 was the lowest followed by NCM-257-2 and NCM-11-2. All the entries were statistically at par with one another except NCM-11-6.

### Development Period

Results are statistically significant. *C. maculatus* took almost equal period 28.00-32.66 days from eggs to adult emergence. NCM-11-6 (32.66 days) took highest period and statistically significant from all others. NCM-11-2 (28.00 days) was with minimum period. The developmental duration of *C. maculatus* on the grains of remaining genotypes NM-06, NCM-11-8,NCM-11-3, NCM-11-4, NCM-257-2 and Chakwal-06 were 30.00, 30.00, 30.00, 29.77, 29.33 and 29.33 days, respectively.

### Adult Weight

Results are statistically non-significant. After getting the weight of all emerged adults collectively, weight of one adult was found. Average weight of adults of *C. maculatus* was statistically equal from 1.37 to 1.69 mg. Highest adult weight was on NM-06 (1.69 mg) and lowest on NCM-257-2 (1.37 mg). The remaining genotypes viz. NCM-11-6, NCM-11-4, NCM-11-8, Chakwal-06, NCM-11-3, and NCM-11-2 were with adult weights of 1.53, 1.49, 1.43, 1.42, 1.39 and 1.39 mgs, respectively.

**Table 4:** Response of Mung (*Vigna radiata*) Genotypes against *Callosobruchus maculatus* in Free-Choice Test

| Genotypes | Damaged Grains Mean± SD (%) | Weight Loss Mean± SD (%) | Total Eggs Mean± SD (No.) | Adult Emerged Mean± SD (%) | Per Adult Weight Mean± SD (mg) | Development Period Mean± SD (days) |
|---|---|---|---|---|---|---|
| NCM-11-4 | 17.96±6.77 | 20.26±10.62 | 31.33±7.09 | 71.89±22.77 | 1.49±0.09 | 29.77±1.53 |
| NCM-257-2 | 9.44±2.83 | 3.93±1.85 | 22.33±11.82 | 61.91±23.56 | 1.37±0.10 | 29.33±0.58 |
| NM-06 | 9.56±4.94 | 24.46±2.20 | 16.00±5.57 | 57.76±26.41 | 1.69±0.80 | 30.00±1.00 |
| Chakwal-06 | 15.98±5.84 | 19.13±.58 | 27.77±10.02 | 86.90±8.12 | 1.42±0.25 | 28.33±1.15 |
| NCM-11-8 | 8.82±3.73 | 29.80±.92 | 21.33±7.77 | 69.92±18.28 | 1.43±0.13 | 30.00±1.00 |
| NCM-11-3 | 10.30±4.79 | 24.26±5.69 | 15.33±6.43 | 81.29±7.04 | 1.39±0.24 | 30.00±2.00 |
| NCM-11-6 | 15.59±7.40 | 24.13±2.50 | 24.66±10.97 | 97.22±4.81 | 1.53±0.21 | 32.66±0.58 |
| NCM-11-2 | 11.83±5.42 | 24.20±3.77 | 19.66±10.21 | 66.92±7.09 | 1.39±0.25 | 28.00±1.00 |
| CV (%) | 43.10 | 21.00 | 40.29 | 22.82 | 24.26 | 4.00 |
| LSD (0.05) | 9.25 | 8.07 | 15.54 | 29.30 | 0.58 | 2.06 |

**Table 5:** Physical Features of Mash grains

| Genotypes | Size | Tex6ture | Surface | 100 seed Weight (gm) |
|---|---|---|---|---|
| NCH-9-9 | Medium | Rough | Dull | 4.71 |
| NCH-3-4 | Medium | Rough | Dull | 4.45 |
| NARC-Mash-3 | Bold | Rough | Dull | 4.72 |
| Chakwal-Mash-97 | Bold | Smooth | Dull | 4.41 |
| NCH-7-5 | Bold | Rough | Dull | 4.48 |
| Mash-Urooj | Medium | Rough | Dull | 4.81 |
| NARC-MASH-1 | Bold | Rough | Dull | 4.64 |
| NCH-10-1 | Bold | Smooth | Dull | 4.50 |

**Table 6:** Chemical Composition of Mash grains

| Genotypes | Protein (%) | Moisture (%) | Ash (%) | Fat (%) | Fiber (%) | Carbohydrate (%) |
|---|---|---|---|---|---|---|
| NCH-9-9 | 25.40 | 8.34 | 3.19 | 1.04 | 3.21 | 58.82 |
| NCH-3-4 | 26.38 | 8.08 | 3.31 | 1.11 | 3.10 | 58.02 |
| NARC-Mash-3 | 25.28 | 8.56 | 2.88 | 1.12 | 3.05 | 59.11 |
| Chakwal-Mash-97 | 26.18 | 8.18 | 3.22 | 1.04 | 3.25 | 58.13 |
| NCH-7-5 | 25.60 | 8.45 | 3.15 | 1.09 | 3.96 | 57.75 |
| Mash-Urooj | 25.81 | 8.37 | 3.07 | 1.05 | 3.94 | 57.76 |
| NARC-Mash-1 | 25.20 | 8.29 | 3.15 | 1.08 | 3.00 | 59.28 |
| NCH-10-1 | 25.34 | 8.41 | 3.24 | 1.19 | 3.03 | 58.79 |

## Discussion

In case of Mash, maximum damage and weight losses were 23.86 and 31.79% under No-Choice test, and 23.45 and 19.53% under Free-Choice test. According to damage, three genotypes were moderately resistant and 5 were moderately susceptible in No-Choice test but in Free-Choice test, 6 were moderately resistant and 2 were moderately susceptible. Srinivasan and Durairaj (2007) [14] studied different pulses and reported 30-40% losses. The results of the present investigations revealed that none of the mash genotype was completely resistant to *C. maculatus*. Damage is positively correlated with number of eggs, weight loss and adult emergence but negatively correlated with Developmental period and 100 grain weight. Physical appearance of the grains plays important role for damage. Different genotypes showed response differently under No-Choice and Free-Choice techniques. In current study, majority of the bold grains had more damage and eggs in both type of tests. NARC-Mash-1 had highest rating for all parameters under Free-Choice test but lower under No-choice test. NCH-7-5 showed higher rating to all parameters in No-Choice test but medium performance under Free-Choice test. It is because of its bold size grains which had highest number of eggs. On the other side, NCH-10-1 ranked on lower side for all parameters under Free-choice test but medium under No-Choice tests. NCH-3-4 performed well under both types of tests. However, Tomooka *et al.* (2000) [17] found no correlation between seed size and levels of resistance. In current studies, the correlation is positive but weak. The parameters of chemical composition have non-significant correlation with damage, adult emergence, developmental period and 100 grain weight. Protein contents are negatively correlated with damage and adult emergence but positively correlated with developmental period which shows protein protect the grains and prolonged the developmental period of the insects. Moisture contents in the grains have positive correlation with damage, adult emergence and 100 grain weight but have negative relation with developmental period. It reveals that moisture in the grains slow down the development of insects which resulted in more damage and adult emergence. Fibers have positive correlation with damage and developmental period but negative correlation with adult emergence. More the fibers in the grains more the damage to grains due to insect and prolonged the developmental period but reduced the adult emergence. Ash contents have negative correlation with damaged grains, adult emergence and 100 grain weight but positive with developmental period. These relationships show that ash contents in the grains create problem for insects in feeding and so the damage, adult emergence and grain weight reduces during this test but increase the developmental duration. Fats showed no effect on damaged grains and adult emergence but its contents reduced the developmental duration of *C. maculatus* as fats have almost no relation with damaged grains and adult emergence but negatively correlated with developmental period (-0.502) and positively correlated with 100 grain weight (0.370). Carbohydrate had negative effect on developmental period but positive with adult emergence and 100 grain weight. Its correlation shows negligible relation with damaged grains. The results of the present investigations revealed that none of the mash genotype completely resistant to *Callosobruchus maculatus*. Physiochemical analysis is in close conformity with Khattak *et al.*, (1987) [8].

In case of mung grains, damage and weight losses (31.41 and 50.97%, respectively) were significantly higher in No-Choice test than those of 17.96 and 29.80%, respectively in Free-Choice test. In No-Choice test, all genotypes were moderately susceptible as expressed by data. In Free-Choice test, 3 genotypes showed resistance and 5 were moderately resistant. The results of both tests contradict. Regardless type of tests 30-40% weight losses to different pulses were noted as studied by Srinivasan and Durairaj (2007) [15]. The correlation of damage with weight losses and developmental period is positive but very weak. The correlation of damage with number of eggs laid and adult emergence is significantly positive. It depicts that damage is increased with the increase of eggs and when damage increased adult emergence increased. According to Srinivasan *et al.* (2007) [14], Shivanna *et al.* (2011), Hamed *et al.* (1994) [13, 5] susceptible varieties showed more eggs, damage to grains, adult emergence and shorten developmental period. Jha *et al.* (2009) [7] and Srinivasan and Durairaj (2007) [15] observed higher damage and fast developmental period on susceptible varieties. According to Shaheen *et al.* (2006) [12] susceptible varieties had higher damage, weight losses, adult emergence and Adult weight. The size of grains showed mix effect. However, highest damage was in small grains and lowest medium size grains while weight losses were highest in medium size grains and lowest in small and shiny grains. In contrast, more weight losses in shining mung grains. These might be due to the differences in susceptibility of varieties used now and then. Overall, damage and weight losses show mix trend which means mung grains damage and weight losses don't depend upon size but either on chemical ingredients or its susceptibility. It means that fiber contents of the grains lower the damage to some extent but slightly enhance the adult emergence and developmental period. Ash contents have negative correlation with damage, adult emergence and developmental period showing that ash in the grains causes reduction in damage, adult emergence and developmental period. Fats have positive correlation with damage but negative correlation with adult emergence and developmental period. Due to the presence of higher contents of fats in the grains damage to grains slightly increased but decreases the adult emergence and developmental period. Carbohydrate has significant positive correlation with damage and adult emergence and both are statistically significant but show no relation with developmental period. It represents that the grains with high carbohydrates showed high damage and in turn higher adult emergence but not effected the developmental period. Physiochemical analysis is in close conformity with Khattak *et al.* (1987) [8].

**Conclusion and Recommendations**

On the basis of damage, three genotypes were moderately resistant and five were moderately susceptible in No-Choice test but in Free-Choice test, six were moderately resistant and two were moderately susceptible. On the basis of fecundity, damage, developmental period and adult weight, Mash genotype NCH-10-1 performed the best and showed comparatively resistance against *C. maculatus* but it showed medium weight loss and adult emergence. Mash genotype NCH-3-4 also performed well on the basis of fecundity, damage, weight losses, developmental period and adult emergence. Overall, the response of different mung genotypes was different for different parameters. In No-Choice test, all genotypes were moderately susceptible as expressed by data. In Free-Choice test, three genotypes showed resistance and five were moderately resistant. The only genotype NCM-257-2 performed well on the basis of damage, weight losses, adult emergence and adult weight.

For further investigation, chemical composition should also be determined after damage or completion of experiment to observe any change in the quantity of composition. Similar experiments should also be conducted for other insects and grains.

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