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Relative Susceptibility of Horse Gram (*Macrotyloma uniflorum*) Accessions to the Attack of *Callosobruchus chinensis* L. (Fab.) (Coleoptera: Bruchidae)

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A total of 50 horse gram accessions were screened for their relative resistance / susceptibility to *Callosobruchus chinensis* at Seed Research and Technology Centre, ANGRAU, Rajendranagar, Hyderabad, Andhra Pradesh during the year 2011-12. Based on mean developmental period, Palem-2, Palem-1, AK-21 and NSB-27 were categorized as resistant, NS/05/42 and NSJ/NAIP/ BD-ADB-35-1 were found to be susceptible. On the basis of Howe susceptibility index, Palem-2, KSAS/06/391, Palem-1, AK-21, NSB-27, NSJ/NAIP/140-239 and NDS-259 were categorized as resistant, while NS-74, RJR-94, PSRJ-13089, NS/05/113, NSM-125 and PSRJ-13089-1 were grouped as moderately resistant. NSJ/NAIP/031-130, BAR-231-1, NSJ/NAIP/006-105, PSRJ-13030, NS/05/94 and NS/05/87 were classified as highly susceptible to bruchid infestation.

Key words: *Callosobruchus chinensis*, horse gram, Howe susceptibility index, mean developmental period

Pulses (grain legumes) are the second most important group of crops worldwide. Pulses are excellent sources of proteins (20-40%), carbohydrates (50-60%) and are fairly good sources of thiamin, niacin, calcium and iron. One of the major constraints in production of pulses is the insect pests that inflict severe losses both in the field and storage. Horse gram [*Macrotyloma uniflorum* (Lam) Verdc] is a dry land legume crop grown mainly on marginal soils. It is an important unexploited legume suitable for tropical and sub-tropical dry land agriculture. Seeds are rich in proteins (23%).The highest losses of grain legumes during storage are due to bruchids. About 12 species of bruchids are serious pests in the field and about six species are very serious pests during storage (Mphuru, 1981). In the field and storage, bruchids especially *Callosobruchus chinensis* (F.) causes exceedingly high levels of infestation even when they pass only one or two generations on the host plant. The larvae of the bruchids feed on the pulse seed contents reducing their degree of usefulness and making them unfit either for planting or for human consumption (Ali *et al.,* 2004). In spite of using various management methods, use of bruchid-resistant cultivars has considerable potential for minimising the losses in storage (Dongre *et al*., 1996). Hence, the present investigations were undertaken to identify the horsegram genotypes resistant to bruchid attack.

Materials and Methods

Field study was carried out at the National Bureau of Plant Genetic Resources (NBPGR), Regional Station, Rajendranagar, Hyderabad and the seed storability studies at Seed Research and Technology Centre, ANGRAU, Rajendranagar, Hyderabad, Andhra Pradesh during 2011-12.

The pulse beetle, *C. chinensis* was used as the test insect. One hundred healthy, sound and disinfested seeds of 50 horse gram accessions were placed in plastic containers (7.5 x 1.5 cm capacity) separately. Each accession was replicated three times. Five pairs of freshly emerged and sixed pulse beetles were released into each container for oviposition. The containers were secured with muslin cloth, fastened with rubber bands and beetles were allowed to multiply at room temperature. The following observations were recorded.

Fecundity

Three days after release of adult insects, the numbers of eggs laid on the surface of the seeds were counted with the help of hand lens and the mean number of eggs laid was calculated.

Adult emergence

The F_1 progenies emerged from each treatment 60 days after release (DAR) were counted and adult beetles were discarded daily to avoid further mating and egg laying. The process was continued till they completely ceased to emerge. The mean adult emergence was worked out by pooling the data.

Mean developmental period

The mean developmental period of pulse beetle in test varieties was calculated from the data on the number of adults emerged on each day and the number of days required for adult emergence from each treatment based on the formula suggested by Howe (1971).

$$D = \frac{\Sigma (A \times B)}{C}$$

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where,

A = Number of adults emerged on n_{th} day

B = 'n' days required for their emergence

C = Total number of adults emerged during experimental period

D = Mean developmental period (days)

Susceptibility index was calculated by using the formula suggested by Howe (1971).

$$I = \frac{\text{Log}_e F}{D} \times 100$$

where,

F = Total number of adults emerged

D = Mean developmental period (days)

I = Index of susceptibility

Categorization of horse gram accessions

The test varieties were classified into five categories based on the index of susceptibility (Mensah, 1986).

Susceptibility index	Category
0–2.5	Resistant
2.6 – 5.0	Moderately Resistant
5.1 – 7.5	Moderately Susceptible
7.6 – 10.0	Susceptible
More than 10.0	Highly Susceptible

Results and Discussion

Mean developmental period (days)

Mean development period of the *C. chinensis* ranged from 0.00 to 30.00 days (Table 1). Shortest mean development period of 8.67 days was recorded in the accessions KSAS/06/391, NSM-125, NS/04/57, PSRJ-13030, HG-35, NS/05/87, NS/05/94, NSJ/NAIP/006-105 followed by RJR-94 (9.00 days), NS/05/84 (9.00 days), NSM-147 (9.00 days), BAR-231-1(9.00 days), NS/05/136 (9.00 days), NSJ/NAIP/140-239 (9.00 days), NSJ/NAIP/031-130 (9.00 days), NS-74 (9.33 days) and NS/05/113 (9.33 days) and were found to be on par with each other.

Longest mean developmental period of the bruchid was observed in NS/05/105 (30.00 days) and is significantly different from NSB-10 (28.67 days), PSRJ-12997 (28.33 days) PSRJ-13089 (27.67 days), SK-28 (27.33 days), NS/05/13 (26.67 days), NS/05/14 (26.67 days), NS/04/107 (26.33 days), NS/05/116 (26.00 days), NS/05/97 (26.00 days), NSJ/NAIP/BD/ADB-35-1 (26.00 days) and NS/05/42 (26.00 days).

Comparison of horse gram accessions on the basis of mean developmental period and oviposition revealed that the least preferred varieties for oviposition such as NS/05/105 and NSB-10 were also not suitable for the development of the bruchid and resulted in prolonged developmental period (30.00 and 28.67 days, respectively) while in the preferred varieties *i.e.,* NSJ/NAIP/031-130, NS/05/94 and NSJ/NAIP/006-105 that recorded more number of eggs (82.00, 40.00 and 40.67 respectively), the development period was less (9.00, 8.67 and 8.67 days, respectively).

The results are in agreement with the findings of Khokhar and Singh (1987) who reported that in the pigeonpea variety ICPL-289 which was more preferred for egg laying, it took less time for development while in ICPL-148 which was least preferred by the beetle for oviposition, it took more time for its development. Arpitha and Sagar (2011) revealed that among all the nine cultivars of pea, IPFD 6-5 and Pant P-5 were more preferred by bruchids for their development while Prakash, Green local and Yellow local were least preferred. Shivanna *et al*., (2011) reported the least mean developmental period in cowpea variety KBC-1 (26.00 days) followed by local variety (26.67 days), C-152 (27.67 days) and TVX-44 (28.33 days). Significantly maximum developmental period was noticed in CP-17 (34.67 days) followed by IT- 38956 (31.00 days), KM -5 (30.67 days) and KBC -2 (28.67 days) varieties of cowpea.

Howe's susceptibility index

Index of susceptibility is the direct measure of resistance/susceptibility of the host to the pest (Painter, 1951). In the present study, based on index of susceptibility (SI), categorization of varieties was made as given by Mensah (1986). The mean index of susceptibility ranged from 0.00 to 28.50 days. Out of 50 horse gram accessions, seven accessions were resistant while six accessions were moderately resistant, five accessions were moderately susceptible, 10 accessions were susceptible and 22 were highly susceptible. Palem-2, KSAS/06/391, Palem-1, AK-21, NSB-27 and NSJ/NAIP/140-239 recorded 0.00 index of susceptibility, which were significantly superior over other accessions (Table 1). Significantly the lowest index was observed in NDS-259 (2.51), NS-74 (3.08), RJR-94 (3.20) that were statistically on par with each other but significantly different from PSRJ-13089 (4.35), NS/05/113 (4.39), NSM-125 (4.68) and PSRJ-13089-1 (4.80).

The accessions Palem-2, KSAS/06/391, Palem-1, AK-21, NSB-27 and NSJ/NAIP/140-239 with 0.00 index of susceptibility and NDS-259 with 2.51 index of susceptibility were classified as resistant (0-2.5).

NS-74 (3.08), RJR-94 (3.20), PSRJ-13089 (4.35), NS/05/113 (4.39), NSM-125 (4.68) and PSRJ-13089-1 (4.80) were categorized as moderately resistant.

The highest susceptibility was recorded in NSJ/NAIP/031-130 (28.50) which was significantly different from BAR-231-1 (25.21), NSJ/NAIP/006-105 (24.46), PSRJ-13030 (21.30), NS/05/94 (21.30) and NS/05/87 (20.01) and grouped as highly susceptible (Table 2). The Howe index of susceptibility in other horse gram accessions ranged from 5.32 to 18.01.

Table 1. Mean developmental period of pulse beetle (*Callosobruchus chinensis*) and Howe susceptibility index on horse gram accessions

Accession	Eggs laid/ 100 seeds (no.)*	Adult emergence (no.)*	Mean developmental period (days)*	Howe susceptibility Index
Palem-2 (Check)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.0
NS/04/124	1.00 (1.22)	1.00 (1.25)	19.33 (4.43)	9.5
SKN-88	1.33 (1.34)	1.33 (1.34)	19.00 (4.39)	8.5
KSAS/06/391	1.33 (1.34)	1.00 (1.22)	8.67 (2.97)	0.0
NSB-10	1.33 (1.34)	1.33 (1.34)	28.67 (5.39)	10.0
NS/05/103	1.60 (1.46)	1.00 (1.22)	17.33 (4.21)	18.0
NS/05/105	1.60 (1.46)	1.33 (1.34)	30.00 (5.51)	8.4
NS/05/93	1.60 (1.46)	1.00 (1.22)	19.00 (4.41)	5.8
KSAS/06/280	2.33 (1.67)	1.67 (1.46)	18.00 (4.27)	16.0
NSM-125	4.60 (2.25)	1.33 (1.34)	8.67 (2.978)	4.7
NS/05/16	5.00 (2.33)	1.67 (1.46)	17.67 (4.25)	5.5
PSRJ-13089-1	6.00 (2.54)	2.33 (1.79)	17.67 (4.25)	4.8
NS-74	7.00 (2.72)	1.33 (1.52)	9.33 (3.10)	3.0
NS/04/57	7.00 (2.72)	2.00 (1.71)	8.67 (2.97)	8.0
RJR-94	7.00 (2.72)	1.33 (1.52)	9.00 (3.06)	3.2
Palem-1 (Check)	9.33 (3.12)	0.00 (0.70)	0.00 (0.70)	0.0
AK-21 (Check)	9.67 (3.15)	0.00 (0.70)	0.00 (0.70)	0.0
NSB-27	10.00 (3.20)	0.00 (0.70)	0.00 (0.70)	0.0
NS/05/113	10.67 (3.36)	2.00 (1.559)	9.33 (3.12)	4.4
NDS-259	11.33 (3.42)	1.67 (1.61)	20.33 (4.54)	2.5
NS/05/84	11.67 (3.47)	2.67 (1.88)	9.00 (3.07)	10.9
NSM-147	12.33 (3.57)	3.33 (2.06)	9.00 (3.07)	13.4
PSRJ-13030	13.33 (3.71)	6.33 (2.68)	8.67 (3.01)	21.3
HG-15	15.33 (3.96)	3.00 (1.98)	20.67 (4.59)	5.3
NS/05/86	18.00 (4.29)	5.00 (2.40)	17.33 (4.21)	9.3
SK-73	20.33 (4.55)	3.67 (2.016)	18.00 (4.28)	6.1
NSM-201	22.00 (4.74)	4.67 (2.29)	18.00 (4.29)	8.6
NS/05/02	22.67 (4.80)	6.00 (2.62)	18.00 (4.29)	10.1
BAR-231-1	23.33 (4.83)	9.67 (3.18)	9.00 (3.06)	25.2
HG-35	23.33 (4.83)	1.33 (1.344)	8.67 (2.98)	5.9
NS/05/136	23.67 (4.88)	2.00 (1.54)	9.00 (3.05)	7.7
PSRJ-13150-2	23.67 (4.88)	5.00 (2.339)	18.33 (4.30)	11.6
PSRJ-13089	25.33 (5.06)	3.33 (2.06)	27.67 (5.30)	4.3
NSJ/ NAIP/140-239	26.33 (5.11)	1.00 (1.41)	9.00 (3.06)	0.0
SK-28	28.33 (5.36)	7.67 (2.79)	27.33 (5.27)	7.4
NS/05/87	30.67 (5.56)	5.33 (2.387)	8.67 (3.00)	20.0
NS/05/14	35.67 (6.00)	10.33 (3.32)	26.67 (5.21)	8.8
PSRJ-13006-1	35.67 (6.00)	19.00 (4.47)	17.67 (4.25)	16.7
NS/05/116	39.67 (6.33)	23.33 (4.91)	26.00 (5.14)	12.1
NS/05/94	40.00 (6.36)	10.67 (3.321)	8.67 (3.00)	21.3
NSJ/ NAIP/006-105	40.67 (6.40)	8.33 (3.03)	8.67 (3.00)	24.5
NS/05/97	41.33 (6.46)	4.33 (2.159)	26.00 (5.14)	7.7
NS/05/13	45.67 (6.79)	24.00 (4.71)	26.67 (5.21)	11.9
PSRJ-13068	47.00 (6.88)	13.00 (3.73)	17.33 (4.22)	14.8
NS/05/85	53.00 (7.31)	15.67 (4.07)	18.00 (4.28)	15.3
NS/05/101	56.00 (7.51)	20.00 (4.51)	17.33 (4.21)	17.3
NS/04/107	66.00 (8.15)	20.67 (4.41)	26.33 (5.18)	11.5
PSRJ-12997	67.33 (8.23)	20.33 (4.58)	28.33 (5.36)	10.6
NS/05/42	75.33 (8.70)	35.67 (5.97)	26.00 (5.14)	13.7
NSJ/NAIP/BD/ ADB-35-1	79.67 (8.94)	30.33 (5.51)	26.00 (5.14)	13.1
NSJ/ NAIP/031-130	82.00 (9.07)	13.00 (3.73)	9.00 (3.06)	28.5
SEm±	0.22	0.15	0.44	0.54
CD (5%)	0.63	0.44	1.25	1.52

*values in the parenthesis are square root transformed values

Similar findings were reported by Dasbak *et al.* (2009) who classified pigeonpea varieties infested by pulse beetle on the basis of susceptibility index and the results showed that the index of susceptibility ranged from 0.9 to 4.2 and categorized three varieties *viz.,* ICPL-161 (1.6), ICPL-87 (1.8) and ICPL-85063 (2.0) as resistant and none of the them were in susceptible and highly susceptible categories. Rao and Verma (2002) observed that the loss in weight and damaged grain showed significant influence with F_1 progeny and susceptibility index indicating that an increase in fecundity, development of F_1 progeny and high index of susceptibility, will certainly increase the loss in weight and damaged grain and vice versa in pea varieties.

Table 2. Categorization of horse gram accessions based on Howe index of susceptibility

Category / Susceptibility Index	No. of accessions	Accessions
Resistant (0.0 – 2.5)	7	Palem-2 (Check), KSAS/06/391, Palem-1 (Check), AK-21 (Check), NSB-27, NSJ/NAIP/140-239, NDS-2597
Moderately resistant (2.6 – 5.0)	6	NS-74, RJR-94, PSRJ-13089, NS/05/113, NSM-125, PSRJ-13089-16
Moderately susceptible (5.1 – 7.5)	5	NS/05/16, NS/05/93, HG-35, SK-73, SK-285
Susceptible (7.6 – 10.0)	10	NS/05/136, NS/05/97, NS/04/57, NS/05/105, SKN-88, NSM-201, NS/05/14, NS/05/86, NS/04/124, NSB-1010
Highly susceptible (more than 10)	22	NS/05/02, PSRJ-12997, NS/05/84, NS/04/107, PSRJ-13150-2, NS/05/13, NS/05/116, NSJ/NAIP/BD/ADB-35-1, NSM-147, NS/05/42, PSRJ-13068, NS/05/85, KSAS/06/280, PSRJ-13006-1, NS/05/101, NS/05/103, NS/05/87, PSRJ-13030, NS/05/94, NSJ/NAIP/006-105, BAR-231-1, NSJ/ NAIP/031-13022

On the basis of mean developmental period, Palem-2, Palem-1, AK-21 and NSB-27 were found to be resistant accessions which were least preferred by pulse beetle. On the other hand, NS/05/42 and NSJ/NAIP/BD-ADB-35-1 were highly preferred for the development by pulse beetle. Based on the Howe susceptibility index, the accessions Palem-2, KSAS/06/391, Palem-1, AK-21, NSB-27, NSJ/NAIP/140-239 and NDS- 259 were categorized as resistant, while NS -74, RJR-94, PSRJ-13089, NS/05/113, NSM-125 and PSRJ-13089-1 were categorized as moderately resistant. The highly susceptible accessions were NSJ/NAIP/031-130, BAR-231-1, NSJ/NAIP/006-105, PSRJ-13030, NS/05/94 and NS/05/87.

From the overall results it was evident that the resistance in Palem-2, Palem-1, AK-21 and NSB-27 was due to less ovipositional preference, least mean developmental period and low Howe susceptibility index. Further, these accessions can be used as parents in the hybridization programmes for the development of bruchid resistant varieties.

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