Table 1. Yield of moringa

Treatment	Average weight of moringa (in g)	Yield of moringa (Nos./tree)	Weight of moringa (t/ha)
T1	63.15	254	28.85
T2	71.75	290	33.36
T3	64.32	250	25.86
T4	58.80	225	21.39
T5	55.17	212	17.99
T6	41.02	102	7.69
SEd	2.31	11.48	
CD	4.93	24.45	

T1 : 16 litres/day/tree by basin method of irrigation
T2 : 16 litres/day/tree by drip method of irrigation
T3 : 12 litres/day/tree by drip method of irrigation
T4 : 8 litres/day/tree by drip method of irrigation
T5 : 4 litres/day/tree by drip method of irrigation
T6 : Rainfed (No irrigation)

The experiment was designed in randomised blocks design with four replications.

RESULTS AND DISCUSSION

It was revealed that the treatment T2 recorded the highest weight and largest number of annual moringa. When the quantity of irrigation water increased from 4 l to 16 l, the weight of fruit was significantly more. In the case of number of moringa fruits the treatments T1 to T5 are on par and superior over the treatment T6. Annual moringa is responding to irrigation and the yield can be doubled in weight (vegetable moringa fruit) by drip irrigation compared to rainfed crop.

Table 2. WUE of annual moringa

Treatment	weight of moringa (t/ha)	Irrigation water (m^3/ha)	WUE (kg/m^3/ha)
T1	28.85	2595.3	9.50
T2	33.36	2595.3	12.05
T3	25.86	1946.5	12.71
T4	21.39	1297.5	17.16
T5	17.99	648.8	30.58
T6	7.69	-	-

It was observed (Table 2) that though the production (i.e. yield of moringa) was the highest in the treatment T2 (i.e. drip irrigation with 16 l/day/tree), the water use efficiency was the highest (30.58 kg/m^3/ha) in the treatment T5 (i.e. drip irrigation with 4 l/day/tree). When comparing the rainfed method of cultivation with the minimum water application of 4 l/day/tree through drip irrigation, there is on increase in yield of 57 per cent under drip method. With the same quantity of water used in basin irrigation, four times of area can be irrigated under drip irrigation with 4 l/day/tree and the yield can be increased three folds. Or (1991) also reported that drip irrigation gave better results than flood irrigation and helps to increase area by 80 to 83 per cent.

REFERENCES

ANONYMOUS, 1991. Completion report of the Government of India- Central Board of Irrigation and Power Scheme. Agricultural Research Station, Bhavanisagar.

OR, V. 1991. Drip irrigation - a case study of transfer technology to traditional Arab vegetable growers. In:**Irrigation and Drainage abstracts 17 (1) : 71.**

Madras Agric. J., 81(12): 679-684 December, 1994

https://doi.org/10.29321/MAJ.10.A01615

EVALUATION OF PIGEONPEA ACCESSIONS FOR RESISTANCE TO *Callosobruchus maculatus* (F)

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ABSTRACT

Two hundred and eight pigeonpea accessions were screened for their resistance to *Callosobruchus maculatus* (F) by free choice test. The number of eggs laid ranged from 4 to 60 and the number adults emerged varied from 0 to 35. Hundred per cent surviaI of *C.maculatus* was observed in six accessions (PR 5326 UQ-50, PR-5492, PR-5300, PR-5576 and PR-6035) where as it failed to develop on PRN-270. Oviposition was not influenced by the level of resistance in the seed and the rate of development was faster in susceptible accessions. Based on the suitability index, seven accessions were classified as resistant, 26 as moderately resistant, 84 as susceptible and 91 as highly susceptible to *C.maculatus*.

Ranking from backyard crop to a major field crop, pigeonpea, *Cajanus cajan* (L) Millsp is grown by subsistence farmer in the tropics. In India, where about 90 per cent of the crops, global growing area

Table 1. Evaluation of pigeonpea accessions for resistance to *C. maculatus* resistant and moderately resistant accessions

Accession	Eggs laid (No)	Adults emerged (No)	Survival (%)	Mean development period (days)	Suitability index
PRN 270	25	0	0.00	-	-
FAVA LARGE	18	2	1.11	41.00	0.0255
PR 6370	33	4	12.12	42.00	0.0258
P-3857	49	5	10.20	38.00	0.0265
DSLR 55	33	4	12.12	37.00	0.0293
P-537-32-1	58	11	18.97	38.00	0.0336
RBH-1	18	4	22.22	40.00	0.0337
PR 6474	25	5	20.00	36.00	0.0361
PR 6476	25	5	20.00	36.00	0.0361
LJR 100	25	4	16.00	33.00	0.0365
T-28	26	4	15.38	32.00	0.0371
PI-395100	25	5	20.00	35.00	0.0372
DUNGARPUR-9	60	9	15.00	31.00	0.0379
PR-6311	25	4	16.00	32.00	0.0376
NQ 83-2	23	5	21.74	35.00	0.0382
P-1136-50-1	25	5	20.00	34.00	0.0383
PR 6406	30	7	23.33	35.00	0.0391
RAM-45	42	11	26.19	36.00	0.0394
JM 4078	16	4	25.00	35.00	0.0399
PRN-64	16	4	25.00	35.00	0.0399
PR 6680	21	5	23.81	34.00	0.0405
CODE NO : 18	37	7	18.92	31.00	0.0412
ANM 436	18	4	22.22	32.00	0.0421
RBH 264	33	9	27.27	34.00	0.0422
CILINDRICO	19	4	21.05	31.00	0.0427
LINCCH 117	18	5	27.78	34.00	0.0425
PR 6685	21	4	19.05	30.00	0.0427
P-3340	23	5	21.74	31.00	0.0431
PR 6701	25	5	20.00	30.00	0.0434
PR 5186	33	9	27.27	33.00	0.0435
P-3888	19	14	21.05	30.00	0.0441
PS 66	14	7	50.00	38.00	0.0447
EC 107642	25	5	20.00	29.00	0.0449

(2.9 million ha) is located, it is the second most important pulse crop, with an annual production of 2 million tonnes (ICRISAT, 1990). Pigeonpea seeds are susceptible to attack by brunchids resulting in serious loss during storage and *callosobrunchus maculatus* (F) (Brunchidae; Colcpotera) is the most destructive bruchid in India causing losses upto 33 per cent (Gupta and Bhaduri, 1984). The pigeonpea cultivars vary in their susceptibility to the attack by *G. maculatus*. The development and use of less susceptible cultivars may offer suitable protection during storage and reduce the use of pesticides. Hence, two hundred and eight pigeonpea accessions were evaluated for their resistance to the pest in the laboratory at the Agricultural College and Research Institute, Madurai.

MATERIALS AND METHODS

Two hundred and eight pigeonpea accessions received from the International Crop Research Institute for Semi-Arid Tropics (ICRISAT) were screened by free choice test for their resistance to *C. maculatus* in the laboratory employing the method of Gibson and Raina (1972), with slight modifications. Fifteen circular discs of 3 cm dia were arranged along the circumference of desiccators (15 cm dia). In each disc, 10 seeds of an accession were taken. Fifteen pairs of 0-12h old *C. maculatus* adults were released at the bottom of the desiccator and were allowed for free choice oviposition in the seed. The desiccator was covered with the lid and paper strips were provided between the lid and the rim for aeration. After five days, seeds with eggs were transferred to polythene bags and observed daily for adult emergence.

$$\text{Survival (\%)} = \frac{\text{Number of adults emerged}}{\text{Number of eggs laid}}$$

Mean development period = Time taken for 50 percent of the adults to emerge.

$$\text{Index of suitability} = \frac{\text{Logrithm of per cent survival}}{\text{Development period}}$$

were calculated (Howe, 1971). Based on the index of suitability (SI) (Edward and Gunathilagaraj, 1990), the accessions were classified into resistant (SI<0.035), moderately resistant (SI:0.035-0.045), susceptible (SI:0.045-0.060) and highly susceptible (SI>0.060)

RESULTS AND DISCUSSION

The number of eggs laid by *C. maculatus* ranged from 14 to 60 in different accessions tested.

Table 2. Evaluation of pigeonpea accessions for resistance to *C. maculatus* : susceptible accessions

Accession	Eggs laid (No)	Adults emerged (No)	Survival (%)	Mean development period (days)	Suitability index
ANM 189	25	11	44.00	36.00	0.0457
PR 5436	25	9	36.00	34.00	0.0458
PR 6139-3	25	9	36.00	34.00	0.0458
P-3683	25	5	20.00	28.00	0.0465
GANDHI NAGAR-1	23	11	47.83	36.00	0.0467
PR 5558	16	5	31.25	32.00	0.0467
PR 5265	48	11	22.92	29.00	0.0469
PRN 130	39	16	41.03	34.00	0.0474
PR 6503	37	19	51.35	36.00	0.0475
P-15-3-3	21	7	33.33	32.00	0.0476
PI-394860	18	5	27.78	30.00	0.0481
NSUKKA-D	25	7	28.00	30.00	0.0482
RAM 5	18	7	38.89	33.00	0.0482
RG-0222	19	7	36.84	32.00	0.0489
PANT A-3	23	11	47.83	34.00	0.0494
BDN-1	25	12	48.00	34.00	0.0494
NP(WR) - 15	28	14	50.00	34.00	0.0500
QPL-19	37	21	56.76	35.00	0.0501
GUMA	19	7	36.84	31.00	0.0505
LJR 57	19	16	84.21	38.00	0.0507
P-4685/1	40	19	47.50	33.00	0.0508
ROYES	42	18	42.86	32.00	0.0510
JM 2477	26	12	46.15	32.00	0.0520
JA-277	37	12	32.43	29.00	0.0521
ICPL-269	48	23	47.92	32.00	0.0525
BANSARA-12	19	5	26.32	27.00	0.0526
PDM-1	37	16	43.24	31.00	0.0528
CODE NO : 19	25	11	44.00	31.00	0.0530
PONTE ALANTE	19	12	63.16	34.00	0.0530
PR 6237	18	7	38.89	30.00	0.0530
DSLR-38	25	16	64.00	34.00	0.0531
MUKTA	23	9	39.13	30.00	0.0531
PR 6156	42	21	50.00	32.00	0.0531
LJR 59	23	19	82.61	36.00	0.0533
PR 6712	30	12	40.00	30.00	0.0534
PR 5347	25	21	84.00	36.00	0.0535
PR 6254	21	14	66.67	34.00	0.0536
PR 5491	23	12	52.17	32.00	0.0537
ANM 457B	51	21	41.18	30.00	0.0538
PR 5321	37	12	32.43	28.00	0.0540
PR 6171	14	11	78.57	35.00	0.0542
PR 6519	42	23	54.76	32.00	0.0543

Table 2. (Contd.,)

Accession	Eggs laid (No)	Adults emerged (No)	Survival (%)	Mean development period (days)	Suitability index
FAO ACC 51-425-CIT	42	14	33.33	28.00	0.0544
T-21	37	18	48.65	31.00	0.0544
PR 5163-3	25	16	64.00	33.00	0.0547
ICPL-87	42	21	50.00	31.00	0.0548
JM 2459 A	25	11	44.00	30.00	0.0548
EC-107648	49	25	51.02	31.00	0.0551
PRN-267	21	16	76.19	34.00	0.0553
PI-395799	48	25	52.08	31.00	0.0554
PR 5413	21	11	52.38	31.00	0.0555
JM 2472	33	12	36.36	28.00	0.0557
SA-1	48	33	68.75	33.00	0.0557
PRN 215	26	16	61.54	34.00	0.0559
SAD-144	40	19	47.50	30.00	0.0559
P-3799	35	19	54.29	31.00	0.0560
PR 5388	25	16	64.00	32.00	0.0564
AS-71-37	28	11	39.29	28.00	0.0569
P-4787-1	19	11	57.89	31.00	0.0569
JM 3080	37	19	51.35	30.00	0.0570
PR 6453	48	32	66.67	32.00	0.0570
CAJANUS R-5	32	25	78.13	33.00	0.0574
PR 6716	39	16	41.03	28.00	0.0576
VR-1	42	23	54.76	30.00	0.0579
P-4683	25	18	72.00	32.00	0.0580
PR 6328	42	35	83.33	33.00	0.0582
SAD 381	39	19	48.72	29.00	0.0582
DSLR 108	21	9	42.86	28.00	0.0576
PR 5311	25	21	84.00	33.00	0.0583
PRN 233	33	28	84.85	33.00	0.0584
VR-3	40	26	65.00	31.00	0.0585
PR 5552-2	14	12	85.71	33.00	0.0586
ANM 883	23	21	91.30	33.00	0.0594
PI-396933	25	18	72.00	31.00	0.0599
EC-109887	30	14	46.67	28.00	0.0596
PR 5402	26	16	61.54	30.00	0.0596
PR 6459	37	30	81.08	32.00	0.0597
UPAS 120	37	30	81.08	32.00	0.0597
P-4608	37	23	62.16	30.00	0.0598
PRN 120	25	18	72.00	31.00	0.0599
BSR 1	40	19	47.50	28.00	0.0599
PR 6319	56	35	62.50	30.00	0.0599
PRN 195	19	18	94.74	33.00	0.0599
PR 5294	48	23	47.92	28.00	0.0600

Table 3. Evaluation of pigeonpea accessions for resistance to *C.maculatus* : highly susceptible accessions

Accession	Eggs laid (No)	Adults emerged (No)	Survival (%)	Mean development period (days)	Suitability index
P-1129	28	18	64.29	30.00	0.0603
PR 4894	35	33	65.71	30.00	0.0606
PR 5174	37	16	43.24	27.00	0.0606
PR 5358	49	28	57.14	29.00	0.0606
ANM 327	28	14	50.00	28.00	0.0607
PI-397765	42	21	50.00	28.00	0.0607
PRN 285	53	35	66.04	30.00	0.0607
P-1170	21	14	66.67	30.00	0.0608
TB 79-484	26	23	88.46	32.00	0.0608
VAR KHOBI	18	12	66.67	30.00	0.0608
PR 5523	18	16	88.89	32.00	0.0609
PRN 31	18	16	88.89	32.00	0.0609
PR 6280	39	35	89.74	32.00	0.0610
ICPL-151	32	25	78.13	31.00	0.0611
PI-283	35	21	60.00	29.00	0.0613
EC-109884	25	23	92.00	32.00	0.0614
JM 2470	21	11	52.38	28.00	0.0614
VAR.PWIRI PWIRI	21	11	52.38	28.00	0.0614
DSLR 6	26	16	61.54	29.00	0.0617
P-1176-53-1	30	16	53.33	28.00	0.0617
PR 5564-1	19	18	94.74	32.00	0.0609
PRN 143	49	35	71.43	30.00	0.0618
P-81014	25	18	72.00	30.00	0.0619
JM 4212 (A)	33	18	54.55	28.00	0.0620
JM 4230 (B)	40	19	47.50	27.00	0.0621
P-3724	19	9	47.37	27.00	0.0621
PR 6343	19	16	84.21	31.00	0.0621
PR 6294	33	28	84.85	31.00	0.0622
PR 6317	19	14	73.68	30.00	0.0622
P-81002	21	18	85.71	31.00	0.0624
CORG-12	37	18	48.65	27.00	0.0625
PR 5111	42	21	50.00	27.00	0.0629
PR 6473	21	14	66.67	29.00	0.0629
EC-109894	18	14	77.78	30.00	0.0630
PR 6338	21	19	90.48	31.00	0.0631
JM 2504	14	11	78.57	30.00	0.0632
SL-1	42	16	38.10	25.00	0.0632
PRN 147	26	18	69.23	29.00	0.0635
ANM 592	40	28	70.00	29.00	0.0636
3746	39	32	82.05	30.00	0.0638
PI-396916	35	16	45.71	26.00	0.0638
JM 4133	30	16	53.33	27.00	0.0640
JM 2412	19	16	34.21	30.00	0.0642
PI-394745	30	19	63.33	28.00	0.0643
PR-5576	18	18	100.00	31.00	0.0645
PR 5442	28	18	64.29	28.00	0.0646

Table 3. (Contd.)

Accession	Eggs laid (No)	Adults emerged (No)	Survival (%)	Mean development period (days)	Suitability index
DUNGARPUR-6	25	14	56.00	27.00	0.0647
JM 2501	25	14	56.00	27.00	0.0647
PR 6215	16	12	75.00	29.00	0.0647
PR 6205	25	14	56.00	27.00	0.0647
P-3684	32	18	56.25	27.00	0.0648
PR 5126	39	19	48.72	26.00	0.0649
PR 5191-1	37	18	48.65	26.00	0.0649
CPC-95	18	16	88.89	30.00	0.0650
PR 5461	18	16	88.89	30.00	0.0650
JM 2396	21	12	57.14	27.00	0.0651
PRN 91-1	21	19	90.48	30.00	0.0652
ANM 432	19	11	57.89	27.00	0.0653
PR 6600	33	30	90.91	30.00	0.0653
KMR 6	25	23	92.00	30.00	0.0655
PR 4904	35	18	51.43	26.00	0.0658
PASCUALUS	19	18	94.74	30.00	0.0659
C-11	23	19	82.61	29.00	0.0661
QPL 49	21	11	52.38	26.00	0.0661
PR 5300	18	18	100.00	30.00	0.0667
PR 5492	18	18	100.00	30.00	0.0667
PR 6035	18	18	100.00	30.00	0.0667
SL-6	33	18	54.55	26.00	0.0668
PR 6190	25	16	64.00	27.00	0.0669
PI-394839	25	12	48.00	25.00	0.0672
TTB 7	18	16	88.89	29.00	0.0672
QPL - 1	32	21	65.63	27.00	0.0673
ANM 243	23	21	91.30	29.00	0.0676
KMR - 1	21	14	66.67	27.00	0.0676
PI - 396862	28	19	67.86	27.00	0.0678
PI - 394848	14	7	50.00	25.00	0.0680
QPL - 38	30	21	70.00	27.00	0.0683
ANM 495	42	35	83.33	28.00	0.0686
HYB - 2	19	12	63.16	26.00	0.0692
P - 3035	37	32	86.49	28.00	0.0692
PR 4730	32	21	65.63	26.00	0.0699
UQ-19	19	11	57.89	25.00	0.0705
PR 4702	30	21	70.00	26.00	0.0710
PR 5455	25	18	72.00	26.00	0.0714
LRG 30	19	14	73.68	26.00	0.0718
P-3798	37	33	89.19	27.00	0.0722
PR 6177	18	16	88.89	27.00	0.0722
PRABHAT	18	16	88.89	26.00	0.0750
UQ-50	16	16	100.00	26.00	0.0769
GSS 4	19	18	94.74	25.00	0.0791
PR 5326	18	18	100.00	25.00	0.0800

It was 18 in Fava large and RBH 1 to 58 in P-537-32-1 among the resistant accessions (Table 1) and 14 to 56 among the susceptible accessions (Table 2) and 14 to 53 among the highly susceptible accessions (Table 3). The accession Dungarpur-9 which received the maximum number of eggs (60) was found moderately resistant to *C. maculatus*. Salunkhe and Jadhav (1982) recorded 827.67 times more egg in bengal gram accession L-550 than in sel-436. The possible reason for this behaviour may be due to the difference in seed coat surface as the preference for oviposition was determined by smoothness of the surfaces of the seed coat (Girish *et al.*, 1974).

The number of adults emerged ranged from 0 to 14 among the accessions categorised as resistant/moderately resistant where as it ranged from 9 to 35 among the highly susceptible accessions. Maximum number of adults emerged from ANM -495, PRN-143, PR 6280, PRN 285 AND PR-6319 (Table 2 and 3). Dharne *et al.*, (1985) also observed more adult emergence from susceptible accession of red gram. No adult emergence was observed in the accession PRN-270. Dissection of seeds along the path of the larval bore showed that the larva died in early instars. It died just before or as it entered cotyledons. Therefore, it is clear that the larva experienced difficulties in boring the seed coat. Nwanze and Horber (1976) observed that the first instar larva was unable to penetrate the seed coat in rough seeds. The macrosclerieds of smooth seeds were laid down in loose, longitudinal ridges arranged vertically, where as in rough varieties they were modified into susceptible helical cells. This major difference appeared to affect larval penetration.

There were cent per cent survival in the accessions PR 5326, UQ-50, PR-6035, PR-5492, PR-5300 and PR-5576 and more than 90 per cent survival in 11 other accessions tested. The survival was less than 20 per cent in 11 accessions which were found to be resistant/moderately resistant (Table 1). The possible reasons for the lower survival in the resistant accession may be due to the difficulties encounted by first instar larva in penetrating the thick or rough seed coat, hard and tough layers of albumen inside the seed coat, presence of antibiotic or hallucinogenic compounds such as alkaloids, saponins, pentose sugars, L-dopa, free amino acids, phytoagglutins, low nutritional content and presence of endopeptidase inhibitors which make digestion difficult (Bridwell, 1918; Ishii and Urishibara, 1951; Applebaum, 1964; Howe and Currie, 1964; Nwanze and Horber, 1976).

The resistant accession Dungarpur-9 which received the maximum number of eggs, supported only 15 per cent survival where as the susceptible accession UQ-50 which supported cent per cent survival received only 16 eggs. Edward and Gunathilagaraj (1993) also observed cent per cent survival of *C. maculatus* in RFG-30 bengal gram which was least prefarred for oviposition among the 200 accessions tested. The oviposition preference was not related to the susceptibility of a particular accession for further development (Sachdeva and Sehgal, 1984; Sehgal and Sachdeva, 1985). The secondary plant substances often quite unrelated to the nutritive value of the plant for the larva may provide the necessary token stimuli for the female to oviposit. Indeed, these token stimuli may be toxic to the developing larva (Hinton, 1981). Presence of such stimulus in the form of saponin was onbserved in Applebaum *et al.*, (1985). They found that saponin faction C. an ovipositional attractant of *Callosobruchus* adult was highly deterimental to its larvae.

The mean development period was as high as 42 days in the resistant accession PR 603 (Table 1) and as low as 25 days in the highly susceptible accessions CSS 4, PI-394839, PI-394848, PR 5326, SL-1 and UQ-19 (Table 3). The development was completed between 28 and 36 days in the susceptible accessions (Table 2). Development period can be extended by hard textured accessions that are difficult to ingest or digest; accession partially tocix to developing larvae; accession that are nutritionally inadequate for the development of the pest (Dobie, 1984). The prolonged development period in resistant accessions might be due to the accumulation of toxins in the developing larva and/or nitrogenous compounds that slowed the development of bruchid larvae (Applebaum *et al.*, 1965; Janzen, 1969). Dick and Credland (1986) observed that the development of IITA strain of *C.*

maculatus was extended up to 29.1 days in TVu 2027, a resistant cowpea.

The index of suitability which is a combined criteria of survival and development period was found to vary from 0.0255 (Fava large) and 0.0800 (PR 5326). Suitability index ranged from 0.0170 to 0.0741 among 200 bangal gram varieties tested by Edward and Gunathilagaraj (1993). Among the 208 varieties screened, there were 7 resistant, 26 moderately resistant, 84 susceptible and 91 highly susceptible varieties based on the suitability index.

From the observations it was infered that anitbiosis was involved in conferring resistance to *C. maculatus* as reflected in the varied level of adult emergence and prolonged development period in the resistant accession. However, the oviposition behaviour was not found to be associated with the level of resistance. The accession which received minimum number of eggs supported cent per cent survival indicating that the oviposition was not associated with resistance.

REFERENCES

APPLEBAUM, S.W. 1964. Physiological aspects of host specificity in the Bruchidae - I. General considerations of developmental compatibility. **J. Insect Physiol., 10 :** 783-788

APPLEBAUM, S.W., GESTETNER, B. and BIRK, Y. 1965. Physiological aspects of host specificity in the Bruchidae-IV. Developmental incompatibility of soybeans for *Callosobruchus*. **J. Insect Physiol., 11:** 611-616

BRIDWELL, J.C. 1918. Notes on the Bruchidae and their parasities in the Hawaiin Islands. **Proc.Hawaii ent. Soc.,** 3: 465-505

DHARNE, P.K., SALUNKHE, G.N. and AJRI, D.S. 1985. Studies on susceptibility of pigenopea (*Cajanus cajan* L.) Varieties to pulse beatle (*Callosobruchus chinensis* L) **Curr. Res, Reporter 1** : 96-98

DICK,K.M. and CREDLAND, P.F. 1986. Variation in the response of *Callosobruchus maculatus* (Coleoptera: Bruchidae) to a resistant variety of cowpea. **J.Stored Prod.Res., 22** : 227-233

DOBIE, P. 1984. Biological methods for integrated control of insects and mites in tropical stored products 1. The use of resistant varieties. **Trop.Stored Prod. Inf., 48** :4-8

EDWARD, Y.S.J.T. and GUNATHILAGARAJ,K. 1990. Evaluation of chickpea genotypes for their resistance to the pulse beetle, *Callosobruchus maculatus* (F) (Coleopera: Bruchiade). **ICN 23**:19-20

EDWARD,Y.S.J.T. and GUNATHILAGARAJ,K. 1993. Screening of bengal gram accessions for resistance to pulse beetle. **Madras Agric. J., 80** : 214-219

GIBSON,K.E. and RAINA, A.K. 1972. A simple laboratory method of determining the seed host preference of Bruchidae. **J.econ.Ent., 65** : 1189-1190

GIRISH, V.G., SINGH,K. and KRISHNAMUTHY,K. 1974. Studies on the oviposition and development of *Callosobruchus maculatus* (Fab) on various stored pulses. **Bull. Grain Technol.,12**:113-116

GUPTA,D.P. and BHADURI, N. 1984. Studies on the oviposition of *Callosobruchus maculatus*. **Curr.Sci., 53:** 392-393

HINTON, H.E. 1981. **Bilology of Insect Eggs.** Voll. New York: Pergamon press, 473 pp

HOWE,R.W. 1971. A parameter for expressing the suitability of an environment for insect development. **J.Stored Prod.Res.,** 7:63-65

HOWE,R.W. and CURRIE,J.C. 1964. Some laboratory observations on rates of development, mortality and oviposition of several species of Bruchidae in stored pulses. **Bull.ent.Res., 55**:437-477

ICRISAT 1990 **Annual Report for 1989.** International Crop Research Institute for Semi-Arid Tropics. Patancheru, Andhra Pradesh, India, 336pp

ISHII, S. and URSHIBARA,H. 1951. Studies on the host plant of cowpea weevil (*Callosobruchus chinensis*L) XII. The growth hindering substances which were contained in *Phaseolus vulgaris* for the development of larvae, and utilisation of carbohydrates by the larvae. **Oyo-Kontyu** 7:59-60

JANZEN, D.H. 1969. Seed-eaters versus seed size, number toxicity and dispersal. **Evolution 23**:1-27

NWANZE,K.F. and HORBER,E. 1976. Seed coat of cowpeas affect oviposition and larval development of *Callosobruchus maculatus* (F). **Environ.Entomol.,** 5:213-218

SACHDEVA, J.S. and SEHGAL, S.S. 1985. Ovipositional response and development of *Callosobruchus maculatus* Fabr. on some new varities of green gram. **Bull. Grain Technol., 23**:3-6

SALUNKHE,V.S. and JADHAV,L.D. 1982. Relative susceptibility of some gram(*Cicer arietinum* L) varieties to pulse beetle (*Callosobruchus maculatus*Fab) in storage **Legume Res., 5**: 45-48.

SEHGAL,S.S. and SACHDEVA,J.S.1985. Certain factors governing ovipositional behaviour and longevity of *Callosobruchus maculatus* Fabr. (Bruchidae; Coleoptera). **Bull. Grain Technol. 23**:28-133.