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Impact of bio-chemical parameters on pigeonpea varieties against egg laying, fecundity and viability of pulse beetle, *Callosobruchus chinensis* (Linn.)

B.S. Chandel, D.S. Bhadauria

Abstract
Investigation were carried out to determined the impact of Bio-chemical characters of promising varieties of pigeonpea, *Cajanus cajan* Linn. against Callosobruchus chinensis Linn. The promising genotypes viz. PUSA–84, PRABHAT, MANAK, AMAR, PUSA-33, ICPL-151, UPAS-120, JAGARTI, TYPE-7, PUSA-9, BAHAR, and TYPE-21 of pigeonpea were obtained from IIPR, Kalyanpur, Kanpur. The egg laying was observed minimum (132.71 eggs) on MANAK, closely followed by BAHAR (146.65 eggs) and ICPL-151 (183.60 eggs) and higher number of eggs were 270.60 on TYPE-21, 251.54 on PRABHAT, 233.78 on JAGARTI at 5 days, which were significantly different among themselves. Similar trend of egg lying was persisted even at 10 days after the release of the insects.

Keywords: Callosobruchus chinensis, genotypes, BAHAR, PUSA-9, fecundity and viability

1. Introduction

Legume being a good source of nutrition and food energy specially proteins, carbohydrates, lipids, vitamins and minerals (vvvv). In India, there are more than two hundred species of pest insects which cause damage to stored grains and grain products in storage (Bellows 1982, Kulkarni *et al*. 1985, Anonymous, 1991 and Ching and Shwu, 2005). Among these, *Callosobruchus chinensis* is widely distributed throughout the tropical and sub-tropical regions of the world. It is one of the most destructive pests of stored pulses, which are a major source of protein in many countries. (Howe and Currie, 1964, Edward and Gunathilagarj 1994, Horng, 1997,). The serious damage is done in the store where the insects spread from seed to seed and considerable losses of quality and market value are caused. (Giga and Smith 1983, Roche *et al*. 1985, Bhattacharya and Banerjee, 2001).

2. Materials and Methods

A large number of adults of pulse beetle, *C. chinensis* (Linn.) were collected from the local godowns and identified properly to maintain the purity of culture. The adults of this species were about 4 mm. long and can be recognized. The mass breeding of selected individuals was carried out on pigeonpea variety T-21 in glass jar of three kg capacity with their mouth tied with muslin cloth and rubber band under control temperature of 27$\pm$ 2 ^{0}C and 75$\pm$ 5 per cent relative humidity in the departmental research laboratory. The culture jars were replaced at each generation to multiply the culture, so as to get desired number of individuals for all the experiments.

(a) **Egg laying:** For obtaining the fresh adult of *C. chinensis* of known age, large number of pigeon pea seeds, laid with eggs was placed in fresh jars. The jars were examined daily for the emergence of adults on a particular date and were collected for the experimental purpose.

(b) **Fecundity**: The beetles generally mate soon after their emergence and lay their eggs continuously during day and night for about 10 days. At the time of egg lying, the female becomes very active and moving here and there for selecting a suitable surface for the oviposition and stopped moving before oviposition. A small quantity of clear viscuss fluid is secreted and the eggs are laid in this fluid, which firmly glue them to the surface of the grain. The eggs are oval Plano convax and translucent. The eggs were whitish, which turned yellow with age (Rajak and Pandey, 1965).
The observation on the number of eggs laid was recorded at 5 days and 10 days of the release of five pairs of adults in each tube. The number of eggs laid per female was

recorded on the basis on total number of eggs laid by five females. Percentage of grains having eggs after five and ten days of release was also recorded. The adult's beetles were removed after ten days from each tube, so as to avoid any further egg lying and their counting with freshly emerged adults in each case (Manohar and Yadav, 1990).

(c) **Development and emergence of beetles**: The first instar grub bears spines. These spines help the larvae in getting a hole on the eggs shell, while it uses the mandibles to cut through the seed coat. Fross produced by the larvae fill the eggshell and gave it the white appearance. This was an indication of larva's successful penetration in the seed. The full-grown larva is white and fleshy with wrinkled body surface. It lives in the grain is curved condition. The larva under goes four moulds before pupation. Before pupation, it cuts a circular hole near the seed coat till only a thin layer of testa in left intact this gives the appearance of a "window" dark spot. At this time the larva laid with its mandible facing the "window" and the prepupal and pupal stages were passed in this position (Howe and Currie, 1964 and Swaroop, *et al*. 2001). For recording the developmental period the total number of eggs laid by five female in the fourth replication with in twelve hrs. of their release on hundred grains in fourth replication were kept in separate vials. The period from the exposure of beetles till the initiation of the adult emergence was considered as the developmental period. To obtain more accurate information, the adults emerged out till another fifteen days in the fourth replication only were taken into account and the developmental period was calculated on the basis of weight mean by using following formula:

Weighed mean = WX / W
Where, X= value of an observation in days.
W= weight of x (emergence of adult)

The methodology of Gupta (1989) was adopted for recording the adult emergence. Complete development from egg to adult was recorded by the counting the total number of adult emerged of the beetle after setting the experiment. The freshly emerged beetles were counted and removed daily for another fifteen days so as to avoid the chances of their recounting and to confirm that the total emergence is over. The percent adult emergence was recorded on the basis of total number of eggs laid/ sample and the total number of adults emerged.

3. Results and discussion

Results obtained from the data as recorded from the present investigation as under:

(a) Egg Laying: The data recorded on the total number of eggs laid by all the females in each sample and percentage of grains having eggs at 5 and 10 days after their exposure, indicated that there was a significant different in the number of eggs laid on different varieties of pigeonpea at both 5 and 10 days. The egg laying was minimum (132.71 eggs) on MANAK, closely followed by BAHAR (146.65 eggs) and ICPL-151 (183.60 eggs) and higher number of eggs were 270.60 on TYPE-21, 251.54 on PRABHAT, 233.78 on JAGARTI at 5 days, which were significantly different among themselves (Table- 1and Figure-1). Similar trend of egg lying was persisted even at 10 days after the release of the insects. The numbers of eggs were minimum 202.20 on BAHAR followed by 230.43 on MANAK, 262.11 on PUSA-9 against maximum number of eggs 359.48 on TYPE-21, 326.52 on PRABHAT, 305.90 on PUSA-84 and 302.06 on JAGARTI (Table-2 and Figure-2). It is also obvious from the data that the preference of the variety for egg laying was not varying much even up to 10 days after initiation of egg lying.

The data on the percentage of grains having eggs, have shown different type of the trend, as it was not linked with the number of eggs laid on a particular variety, as egg laying on 40.29 per cent grains of variety MANAK having minimum number of eggs and 82.93 per cent in case of TYPE-21 having maximum number of eggs at 5 days, but the trend was varying for BAHAR, having eggs on 50.17 per cent of its seeds with a lesser of 146.65 eggs. The percentage of grain having eggs was maximum 82.93 per cent on TYPE-21, closely followed by AMAR 70.18 per cent without significant difference from 69.86 per cent on PUSA-33, which had 203.92 and 203.35 eggs upto 5 days of release of the beetles, respectively. The percentage of grains having eggs, was found to be increased up to extent of 96.98 per cent on TYPE-7, 96.92 on PUSA-33, 96.42 on IPCL-151, 95.61 on JAGARTI, 95.53 on TYPE-21, 95.39 on AMAR and 93.65 on PUSA-9 without any significant difference among themselves. The mean percentage of the grains having eggs was 88.49 against minimum 67.05 per cent on BAHAR and 71.13 per cent on MANAK. It can be inferred from the data that varieties having more number of eggs in its sample were also having higher percentage of grains having eggs, through the trend was not uniform for all the varieties because the percentage of eggs laying on the grains was more or less similar in almost in all the varieties having more/less number of eggs.

Table 1: Egg Laying of *C. chinensis* on different varieties of *C.cajan* upto 5 days.

Name of Variety	UPTO 5 day			
	Total No. of eggs laid		Percentage of grains having Eggs	
	√ X values	Transformed Back values	Angular values	Transformed Back values
AMAR -**V1**	**14.28**	**203.92**	**56.92**	**70.18**
BAHAR -**V2**	**12.11**	**146.65**	**45.14**	**50.17**
IPCL-151 -**V3**	**13.55**	**183.60**	**52.84**	**63.43**
JAGRATI -**V4**	**15.29**	**233.78**	**52.85**	**63.43**
MANAK -**V5**	**11.52**	**132.71**	**39.37**	**40.29**
PRABHAT -**V6**	**15.86**	**251.54**	**54.57**	**63.43**
PUSA-9 -**V7**	**14.95**	**223.20**	**54.15**	**65.62**
PUSA-33 -**V8**	**14.26**	**203.35**	**56.75**	**69.86**
PUSA-84 -**V9**	**14.41**	**207.65**	**51.92**	**61.93**
TYPE-7 -**V10**	13.25	**175.30**	**49.72**	**58.17**
T YPE-21 -**V11**	16.45	**270.60**	**65.58**	**82.93**
UPAS-120 -**V12**	13.81	**190.72**	**48.22**	**55.57**
Mean	**201.92**		**62.33**	
SE ±	**0.148**		**0.539**	
CD at 5%	**0.306**		**1.113**	

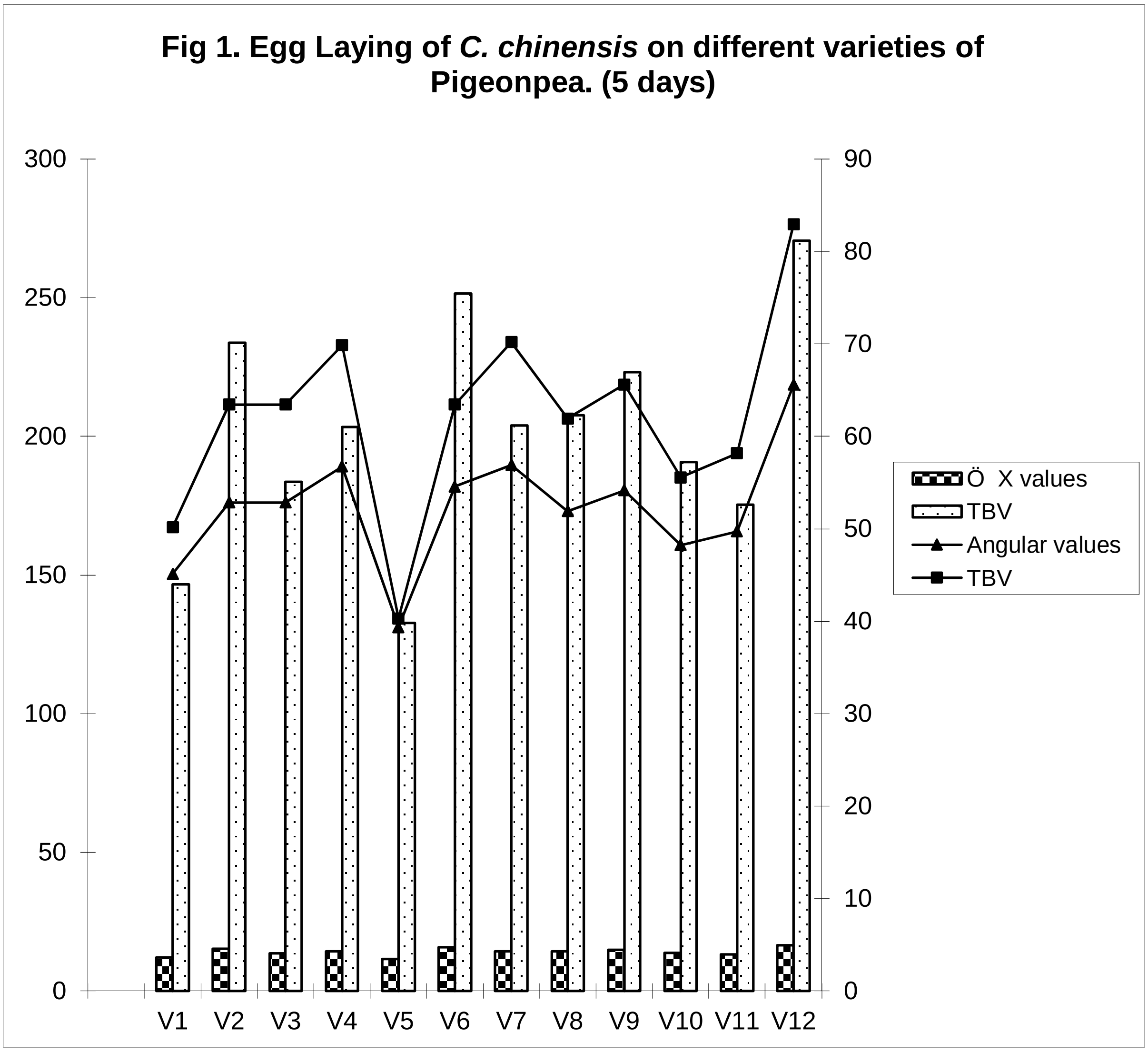
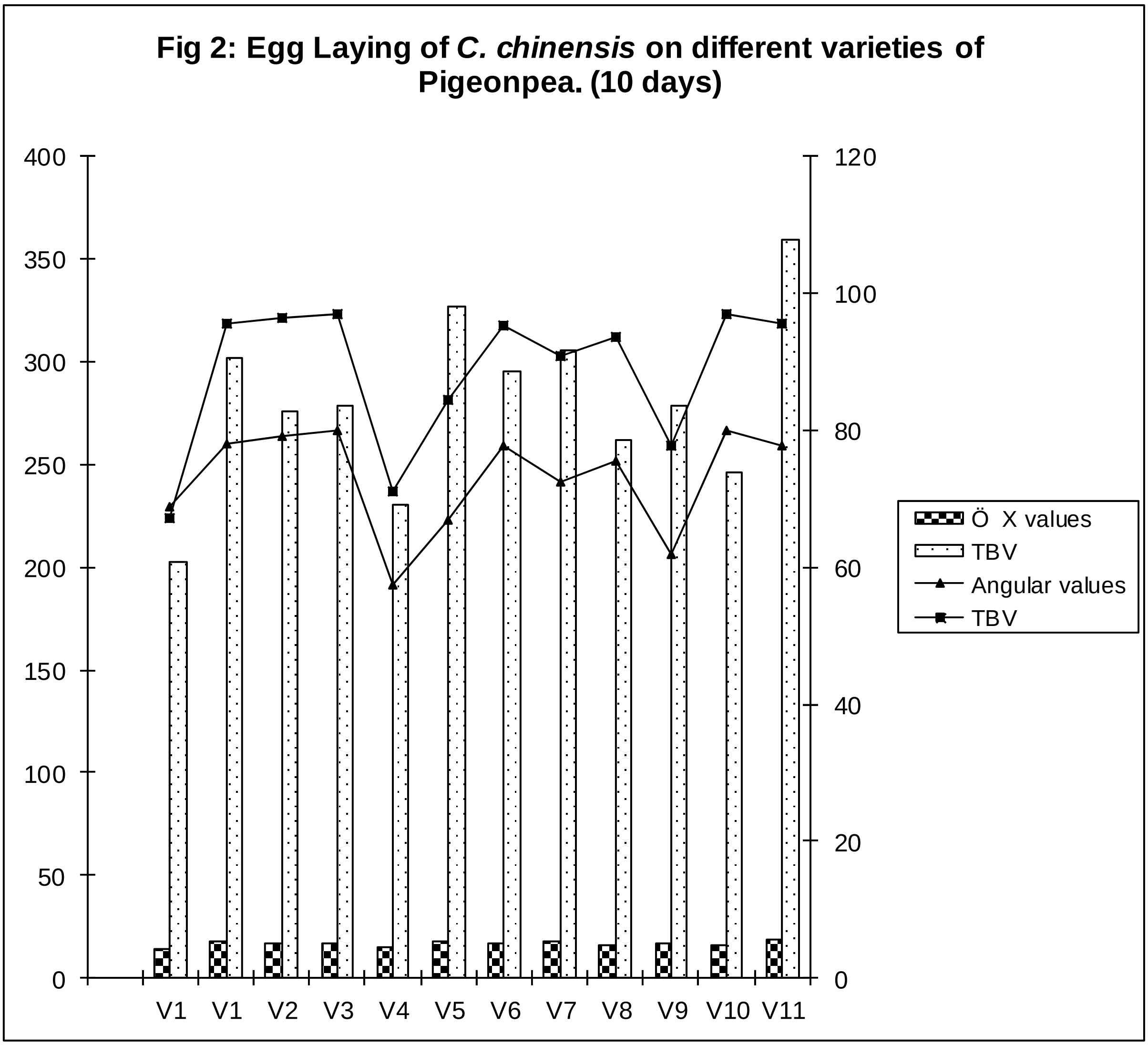


Table 2: Egg Laying of *C. chinensis* on different varieties of *C.cajan* upto 10 days.

Name of Varieties	UPTO 10 day.			
	Total No. of eggs laid		%age of grains having Eggs	
	√ X values	**TBV**	**Angular values**	**TBV**
AMAR -V_1	14.28	295.75	56.92	95.39
BAHAR -V_2	12.11	202.20	45.14	67.04
IPCL-151 -V_3	13.55	275.56	52.84	96.42
JAGRATI -V_4	15.29	302.06	52.85	95.61
MANAK -V_5	11.52	230.43	39.37	71.12
PRABHAT -V_6	15.86	326.52	54.57	84.48
PUSA-9 -V_7	14.95	262.11	54.15	93.65
PUSA-33 -V_8	14.26	278.89	56.75	96.92
PUSA-84 -V_9	14.41	305.90	51.92	90.96
TYPE-7 -V_{10}	13.25	245.86	49.72	96.98
T YPE-21 -V_{11}	16.45	359.48	65.58	95.53
UPAS-120 -V_{12}	13.81	278.56	48.22	77.81
Mean	280.03		88.49	
SE ±	0.159		2.448	
CD at 5%	0.328		5.053	



The effect of bio-chemical characteristics on grains having eggs was found to be non-significant (Table-3a, b, c). The individual and multiple regressors of seed characters with percentage of grains having eggs have also shown their little impact, as moisture content contributed to the extent of only 5.0 per cent (R^2 = 0.5) in enhancing the percentage of grains having eggs of pulse beetle (Table- 3a, b, c). The consideration of any one or more factor like test weight, hardness, number of grains per sample and protein content with moisture content could contribute to a negligible level of 8.0 per cent (R^2 = 0.08).

Table 3: Effect of Physico-chemical characteristic of *C. cajan* on percent grain having eggs of *C. chinensis.*

Table (a): Correlation Cofficient:

Sl. No.	Seed Character (X)	Particular of Seed Character	Correlation Coefficient (r)
1.	X_1	Test weight	0.05
2.	X_2	Grains/Sample	0.02
3.	X_3	Hardness	0.07
4.	X_4	Moisture	0.23
5.	X_5	Protein	0.04

Table (b): Individual regressors

Sl. No.	Regression Equation	Seed Character
1.	Y= 85.72 + 0.03	X_1
2.	Y= 00.54 + 7.10	X_4
3.	Y= 91.05 + 0.19	X_3
4.	Y= 84.00 + 0.19	X_5
5.	Y= 89.83 + 0.01	X_2

Table (c): Multiple regressors of seed character with percentage grain having eggs.

Sl. No.	Regression Equation	Coefficient of Regression (R^2)
1.	$Y= 0.05 + 7.10 X_4$	0.05
2.	$Y= 46.74 + 8.99 X_4 – 0.70 X_3$	0.08
3.	$Y = -21.88 – 0.03 X_1 + 9.61 X_4 – 0.65 X_3$	0.08
4.	$Y = -16.38 – 0.06 X_1 +9.63 X_4 –0.70 X_3 – 0.01 X_2$	0.08
5.	$Y = -16.09 – 0.06 X_1 +9.64 X_4 -0.70 X_3 - 0.01 X5 – 0.01 X_2$	0.08

Fecundity

The fecundity of pulse beetle, *C. chinensis* was recorded upto 10 days on different varieties of pigeonpea (Table- 4 and Figure-3). The mean number of eggs laid by each female, was 40.34 uto 5 days, which increased to 56.04 upto 10 days of initiation of egg lying. It indicated that the female laid 75% of its eggs within 5 days. There were maximum of 38.07 eggs on Type-21, closely followed by 35.05on UPAS-120 and 44.62 on PUSA-9, while there were only 26.52 and 29.27 eggs on MANAK and BAHAR, respectively, with significant differences between themselves after 5 days of release of beetles. The total number of eggs laid by a single female was significantly high on Type-21 (55.80), closely followed by UPAS-120 (49.14), PUSA-84 (61.15). The fecundity was significantly less (40.45) on BAHAR, followed by 46.10 on MANAK and 71.91 on TYPE-7, with significant difference with each other.

Table 4: Fecundity and viability of *C. chinensis* on different verities of *C.cajan*

Variety	**No. of eggs laid / female**				**% of Emergence**		**Developmental**
Pigeonpea	**Upto 5 Days**		**Upto 10 days**		**Angular values**	**TBV**	
	√ X values	**TBV**	**√X values**	**TBV**		**TBV**	**Period (days)**
AMAR -V_1	6.39	40.83	7.65	58.52	43.97	48.08	27.66
BAHAR -V_2	5.41	29.27	6.36	40.45	60.22	75.30	28.33
IPCL-151 -V_3	6.06	36.72	7.42	55.06	40.78	42.70	28.65
JAGRATI -V_4	6.83	46.65	7.57	57.30	40.24	41.66	28.65
MANAK -V_5	5.15	26.52	6.79	46.10	51.68	61.59	30.33
PRABHAT -V_6	6.17	38.07	7.47	55.80	44.14	48.60	27.99
PUSA-9 -V_7	6.68	44.62	7.24	52.42	52.51	45.64	30.00
PUSA-33 -V_8	6.37	40.57	7.71	59.44	40.69	42.52	29.34
PUSA-84 -V_9	6.44	41.47	7.82	61.15	42.84	45.47	29.01
TYPE-7 -V_{10}	5.92	35.05	7.01	49.14	43.36	47.21	27.34
T YPE-21 -V_{11}	7.36	54.17	8.48	71.91	47.03	53.49	27.67
UPAS-120 -V_{12}	7.09	50.27	8.08	65.29	42.61	45.82	30.32
Mean		40.34		56.04		49.84	28.77
SE $\pm$	0.122		1.212		1.027		0.122
CD at 5%	0.252		3.276		2.119		0.252

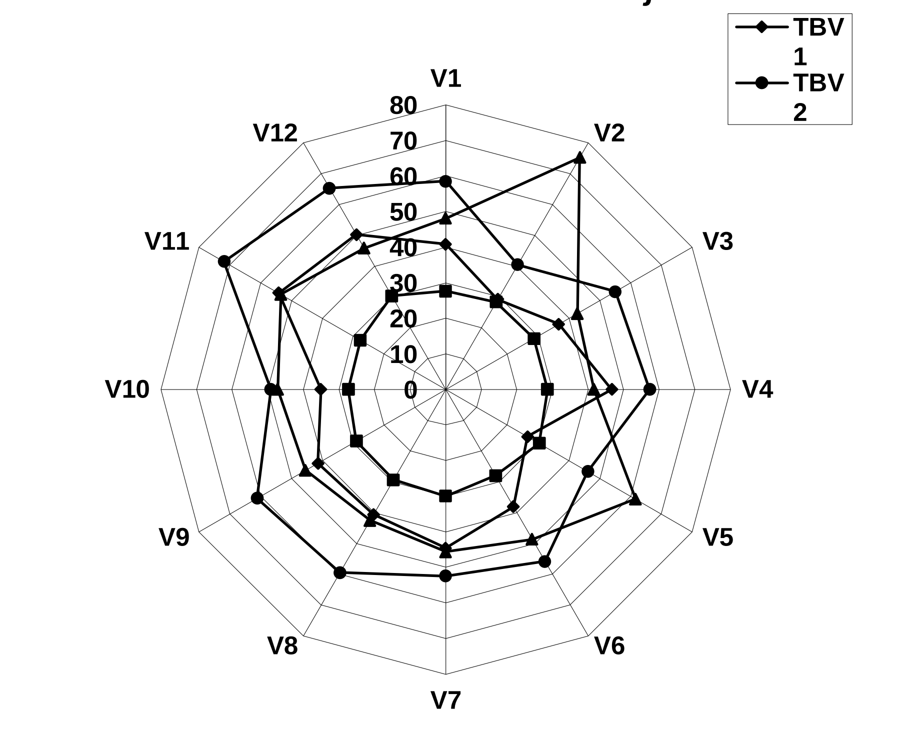


Fig 3 : Fecundity and viability of C. chinensis on different verities of *C. cajan*

The correlation coefficient values of the seed characters with fecundity of pulse beetle, *C. chinensis* was found to be negatively governed by the hardness and test weight of the varieties, while the number of grains per sample affected the egg laying positively at a 10 again confirmed the similar pattern of these variables (Table-8). Among the multiple regressions the number of grains contributed to the extent of 53 per cent (R^2 = 0.53), while addition of moisture content with number of grains responded to a limit of 64.0 per cent (R^2 = 0.64). The fecundity was found to be governed upto the extent of 67.0 per cent (R^2 = 0.67) by all the characters of the seeds under investigation. These results on more fecundity of pulse beetle TYPE-21, UPAS-120 and PUSA-84 because of their less test weight and more number of seeds and expressed the more suitability of bigger seeds for egg laying and those of Regupathy and Rathnaswamy (1970), who observed no association of seed colour, seed volume and hardness of seed Satyavir (1982) indicated no relationship of seed character of different varieties of *moth* bean with oviposition of *C. maculatus*.

Developmental Period

The development period was recorded by considering the weighted mean of beetle emergence after date of egg lying (Table-5a, b, c). There was a significant difference in the developmental period on different varieties of pigeonpea, as it was maximum 30.33 days on MANAK and 27.34 on UPAS-120 closely followed by 30 days on PUSA-9, 29.34 on PUSA-33, 29.01 days on PUSA-84, 28.65 on JAGARTI, 28.33 on BAHAR and 30.32 on PRABHAT having statistically parity with each other. The developmental period was shortest as 27.67 days on TYPE-7, 27.66 days on AMAR and 27.99 on TYPE-21, which were also at par with PRABHAT, BAHAR, ICPL-151 etc. The varieties, having less developmental period were more suitable host for the development of the pest than those prolonging the developmental period.

It is also evident from the perusal of (Table-5c) all the seed characters had their negligible effect of the development of *C. chinensis.* The moisture content of the seed was conducive, but had non-significant effect on the development of the beetles. The test weight and hardness of the seed responded negatively. The developmental period has been found to be significantly related with the food consumed by the grub (r= 0.78), but it did not effect the total weight loss caused by this pest. The effect of moisture content was also more 0.06 per cent (R^2 = 0.0606), which had been tripled (18.22 per cent, R^2 = 0.1822) with the consideration of test weight with the moisture content, but consideration of any other seed character with them could not influence the development of beetles over 19.08 per cent (R^2 = .1908).

Table 5 (a): Correlation coefficient

S. No.	Seed Character Total No of egg/ female	Correlation coefficient (r)	Biological parameter of *C. chinensis*	Correlation coefficient (r)
1.	Test weight (X_1)	- 0.62*	Total no. of eggs/ sample x	-0.57
2.	Grains/Sample (X_2)	0.72*	Emergence	
3	Hardness (X_3)	0.50	Total no. of eggs/sample	-0.08
4	Moisture (X_4)	0.06	Developmental period	-0.36
5	Protein (X_5)	0.24	Total no. of eggs/sample x	-0.09

* = Significant at 5 percent level.

Table 5 (b) Individual regressors

Sl. No.	Regression Equation	Seed Character
1.	Y= 85.23 – 0.31	X_1
2.	Y= 74.39 – 1.48	X_4
3.	Y= 69.97 – 1.57	X_3
4.	Y= 33.91 + 0.96	X_5
5.	Y= 19.56 + 0.13	X_2

Table 5 (c): Multiple regressors of seed character with percentage grain having eggs.

Sl. No.	Regression Equation	Coefficient of Regression (R^2)
1.	**$Y = 19.56 + 0.13 X_2$**	0.53
2.	**$Y = -105.71 + 9.32 X_4 + 0.17 X_2$**	0.64
3.	**$Y = -113.16 + 9.03 X_4 + 0.53 X_5 + 0.16 X_2$**	0.66
4.	**$Y = -108.13 + 9.32 X_4 – 0.41 X_3 + 0.47 X_5 + 0.15 X_2$**	0.67
5.	**$Y = -113.43 + 0.04 X_1 + 9.14 X_4 – 0.36 X_3 + 0.47 X_5 + 0.16 X_2$**	0.67

Table 6: Effect of physico-chemical characteristics of *C. cajan* on developmental period of *C. chinensis.*

Table 6 (a): Correlation coefficient

S. No.	Seed Character Total No of egg/ female	Correlation coefficient (r)	Biological parameter of *C. chinensis*	Correlation coefficient (r)
1.	Test weight (X_1)	- 0.17	Developmental period x weight loss	-0.17
2.	Grains/Sample (X_2)	0.15	Developmental period x food consumption	0.78*
3.	Hardness (X_3)	-0.01	Total no. of eggs x developmental period	-0.08
4.	Moisture (X_4)	0.25	Emergence x developmental period	-0.05
5.	Protein (X_5)	0.13		

* = Significant at 5 percent level.

Table 6 (b): Individual regressors

Sl. No.	Regression Equation	Seed Character
1.	Y= 29.78 – 0.01	X_1
2.	Y= 27.79 + 0.01	X_2
3.	Y= 28.80 – 0.01	X_3
4.	Y= 19.77 + 0.73	X_4
5.	Y= 27.28 + 0.06	X_5

Table 6 (c): Multiple regressors of seed character with percentage grain having eggs.

Sl. No	Regression Equation	Coefficient of Regression (R^2)
1.	$Y= 19.7700 + 0.7266 X_4$	0.0606
2.	$Y= 14.4769 – 0.0254 X_1 + 1.3648 X_4$	0.1822
3.	$Y = 13.7570 – 0.0246 X_1 + 1.3239 X_1 + 0.0404 X_5$	0.1887
4.	$Y = 12.9700 – 0.0213 X_1 + 0.0014 X_2 + 1.333 X_4 + 0.0394 X_5$	0.1892
5.	$Y = 12.1270 – 0.0179 X_1 + 0.0032 X_2 + 0.0226 X_3 + 1.3718 X_4 + 0.0425 X_5$	0.1909

Table 7: Effect of bio -chemical characteristics of *C. cajan* on emergence of *C. chinensis.*

Table 7 (a) Correlation coefficient

S. No.	Seed Character Total No of egg/ female	Correlation coefficient (r)	Biological parameter of *C. chinensis*	Correlation coefficient (r)
1.	Test weight (X_1)	0.24	Emergence x developmental period	-0.05
2.	Grains/Sample (X_2)	- 0.31	Emergence x total weight loss	0.79 *
3.	Hardness (X_3)	0.27	Emergence x food consumption	0.08
4.	Moisture (X_4)	0.13	Total no. of eggs x emergence	-0.57*
5.	Protein (X_5)	0.10		

* = Significant at 5 percent level

Table 7(b): Individual regressors

Sl. No.	Regression Equation	Seed Character
1.	Y= 36.90 + 0.14	X_1
2.	Y= 68.34 – 0.07	X_2
3.	Y= 41.15 + 0.98	X_3
4.	Y= 4.65 + 3.65	X_4
5.	Y= 60.91 + 0.48	X_5

Table 7 (c): Multiple regressors of seed character with percentage grain having eggs.

Sl. No	Regression Equation	Coefficient of Regression (R^2)
1.	$Y= 68.3163 – 0.0663 X_2$	0.0961
2.	$Y= 102.3891 – 0.1797 X_1 – 0.1277 X_2$	0.1109
3.	$Y = 107.9441 – 0.1770 X_1 0.2852 X_5 – 0.1250 X_2$	0.1147
4.	$Y = 95.1197 – 0.1394 X_1 + 0.2630 X_3 – 0.2529 X_5 – 0.1028 X_2$	0.1174
5.	$Y = 100.6128 – 0.1346 X_1 – 0.5026 X_4 + 0.2748 X_3 – 0.2447 X_5 – 0.1028 X_2$	0.1176

The mean developmental period of the pulse beetle was 28.77 days and was found to vary significantly from variety to variety. It was significantly at par on varieties MANAK, UPAS-120, PUSA-9, PUSA-33, PUSA-84, ICPL-151 and ranging between 28.33 to 30.33 days and was significantly less on variety TYPE-21 and AMAR, PRABHAT, being 27.66 to 30.32 days. Though there was no remarkable impact of any seed characteristics on the development of this pest, but the moisture content of the seeds was found to be conducive, and test weight and hardness were inconducive for the development of the beetles on pigeonpea seeds. There was a significant increase in the amount of food consumed by the grub with the increase in the developmental period without any significant increase in the losses.

Emergence of the Beetles

Variety BAHAR was found to have maximum emergence of 75.30 per cent with its statistical superiority over others (Table- 7). It was followed by MANAK having 61.59 per cent emergence and showed it distinct impact on the emergence of the beetles over remaining varieties. Meanwhile, JAGARTI, PUSA-33, ICPL-151, PUSA-84, UPAS-120 and TYPE-7 were having significantly poor emergence of the beetles ranging from 41.66 – 47.21 per cent.

The emergence of the adults of *C. chinensis* found to be positively governed by the test weight, hardness and moisture content of the seeds, but the effect was non-significant statistically. Meanwhile, the number of grains per sample and protein content had responded negatively i.e. the increase in the number of grains per sample and increase in protein content in the seeds had reduced the emergence, though the impact was not remarkable statistically (Table- 7a,b,c). The individual regression lines also indicated the negative figures of their slope. The effect of multiple regression was also very poor, as the number of grains per sample alone was governing upto a level of 9.6 per cent (R^2 = 0.096) of emergence, but additive effect of any two or more seed characters could not show their more than 11.70 per cent (R^2 = 0.1176) impact on their emergence (Table- 7c). Thus, it may be concluded that the emergence of the beetles was significantly high on variety BAHAR (75.30 per cent) and MANAK (61.59 per cent) and minimum on JAGARTI (41.66 per cent), closely followed by PUSA-33 (42.52 per cent) and ICPL-151(42.70 per cent) with mean infestation of 49.84 per cent irrespective of varieties. The seed characters of pigeonpea varieties was failed to govern the emergence, because their correlation coefficient values with emergence were non-significant.

4. Discussion

The results of the present laboratory study demonstrated that ovipositional preference of female *Callosobruchus chinensis* varied among different types of pulses. (Reddy and Singh 1972). Satyavir 1983 was also reported relative resistance of gram and cowpea to pulse beetle (*Callosobruchus chinensis* Linn.)

Similar, results were reported by egg production and development of pulse beetle. *C. rhodesianus* and *C. maculatus.* Giga and Smith, 1987 were also obtained resistance to pulse beetle for growth and development of *C. chinensis* (Linn.). A number of bio-chemical factors of seeds appear to be responsible for the reduction of the development of the cowpea beetle in some pusles (Singh *et al.* 1980 a and b, Rasul *et al.*, 1989, Shafique and Ahmad 2002 and Sarwar, 2012) The ability of the larva to penetrate the seed coat appears to be influenced by the physical properties of the seed coat such as thickness, hardness and roughness (Singh and Singh, 1986, Manohar and Yadava, 1990).

According to Nwanze & Hobor (l976) larval survival during penetration of the seed coat is also affected by surface texture and structure, and larval development within seeds depends on quality and compactness of seed as well as the amount of food available. (Srivastava and Bhatia 1958). Therefore, it is evident that the female C. chinensis is not able determine the most suitable oviposition site for the development of its larvae. This is in accordance with the findings of Satya Vir and Jindal 1981 and Verma et al 2005 for C.maculatus.

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