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Assessment of population and damage of pulse beetle, *Callosobruchus chinensis* L. on different pulse grains

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ABSTRACT: Population development and grain damage by C. *chinensis* was assessed on eight different host-grains *viz.,* greengram (*Vigna radiata* L.), blackgram (*Vigna mungo* L.), Bengalgram (*Cicer arietinum* L.), redgram (*Cajanus cajan* L.), cowpea (*Vigna sinensis* L.), soybean (*Glycine max* L.), pea (*Pisum sativum* L.) and pillipesara (*Phaseolus trilobus* L.) were estimated. Among all the host-grains, maximum oviposition was recorded in blackgram (7.75 eggs/ 5 g grain). Survival was highest in bengalgram (86.43) and mean developmental period was shortest in greengram (28.47 days) which were on par with that in pillipesara (28.77 days) whereas index of susceptibility was highest in greengram (6.09) and was followed by pillipesara (6.03). The damage in terms of percentage of grains damaged and weight loss of grains increased with increase in storage period. Among all the host-grains bengalgram recorded significantly maximum percentage of grain damage (90.65%) and weight loss of grains (58.55%).

KEYWORDS: *C. chinensis*, green gram, black gram, bengalgram, redgram, cowpea, soybean, pillipesara and pea

INTRODUCTION

Pulses are the "wonderful gift of nature" plays an important role both in Indian economy and diet. Pulses are important as they are rich source of protein, several amino acids, minerals and certain vitamins. India is the largest producer of pulses in the world, in 23.63 million hectares area; India produces 14.76 metric ton pulses (Anonymous, 2007-2008). One of the major constraints in production of pulses is the insect pests which inflict severe losses both in the field and storage. The world storage losses for all grains caused by insect pests of stored products have been estimated about 10% of the annual production which in quantitative terms is over 100 million tons (Anthony and Service, 1983).

According to Raina (1970) among five species of *Callosobruchus*, mainly three species of pulse beetle *viz*., *Callosobruchus chinensis* L., *C. analis* F. and *C. maculatus* F. (Bruchidae: Coleoptera) have been reported to cause damage in different kinds of pulses in India. Among these species, *C. chinensis* is considered to be the most destructive in India and causing severe damage to the extent of 93.33% in different pulse crops (Parsai *et al*., 1989). The first record of adults of the bruchid, *C. chinensis* was reported from stored grains of *Vicia faba* in India.

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MATERIAL AND METHODS

The studies on population development and damage of *C. chinensis* in different host-grains was carried out during the year 2013-2014 in the Department of Entomology, Agricultural College, Bapatla, Guntur district and Andhra Pradesh. The initial adult cultures of the test insect, *C. chinensis* was collected from the Post-harvest technology centre, Agricultural College, Bapatla and were maintained further in the laboratory on the greengram. One pair of freshly emerged adult beetles of similar age were introduced in one plastic jar (45x15 cm) with perforated lids containing 100 g of each host-grain and covered with muslin cloth. The beetles were removed after seven days and the jars containing the host- grains along with eggs were left for further development. The data on population development and damage of *C. chinensis* in different host-grains were analyzed by using one-way analysis of variance (ANOVA).

Assessment of Population Development

Ovipositional Preference: The eggs laid on different host- grains were counted and recorded at seven days after release of the adults by using magnifying lens.

Survival: The survival of the test insect was calculated by the formula suggested by Howe (1971),

$$\text{Survival} = \frac{\text{No. of adults emerged}}{\text{No. of eggs laid}} \times 100$$

Mean developmental period: Mean development period (MDP) is the time taken for 50 percentages of adults to emerge. The developmental period (time to adult emergence) was calculated based on the total number of bruchid that emerged on a given day. It was estimated using the following formulae (Howe, 1971).

$$\text{Mean developmental period} = \frac{d_1a_1 + d_2a_2 + d_3a_3 + \text{————} + d_na_n}{\text{Total number of adults emerged}}$$

Where,

d_1 = Day at which the adults started emerging (First day)

a_1 = Number of adults emerged on d_1^{th} day

Index of susceptibility: It was calculated by the formula given by Dobie (1974) as follows,

$$\text{Index of susceptibility (I)} = \text{Log}_e Y \times 100\ t$$

Where,

Y = Total number of emerged adults

t = Average developmental period of the progeny

Assessment of Damage

Percentage of grains damage: From each host-grain, a representative sample of five grams was taken; the damaged *i.e.* grains with characteristic holes and the total numbers of grains were counted and were subjected to the formula,

$$\text{Grains damage (\%)} = \frac{\text{No. of damaged grains}}{\text{Total no. of grains}} \times 100$$

Percentage weight loss of the grains: Weight loss assessment was conducted from five gram sample in each jar. The grains were separated into damaged and undamaged portions. The grains in each portion were then counted and weighed. This parameter was calculated by the formula given by Adams and Schulten (1978) as follows,

$$\text{Weight loss of grains (\%)} = \frac{(U\,Nd) - (D\,Nu)}{U\,(Nd + Nu)} \times 100$$

Where,

U = Weight of undamaged grains

Nu = Number of undamaged grains

D = Weight of damaged grains

Nd = Number of damaged grains

Moisture content (%): The moisture content in five gram sample of each host-grain was estimated using electronic moisture balance. (M/s Shimadzu Corporation, Analytical and measuring instruments division, Kyoto 604-8511, Japan).

RESULTS AND DISCUSSION

Population development of *C. chinensis* in Different Host- grains

The ovipositional preference of *C. chinensis* was maximum in blackgram (7.75) followed by cowpea (7.50), greengram (7.25), redgram (7.00), pillipesara (6.50) and pea (6.00). While the minimum (5.25) number of eggs laid on bengalgram and soybean which were on par with each other and significantly different from other host- grains. In the similar lines, Wijenayake and Karunarathe (1999) reported that the ovipositional preference of the *C. chinensis* varied with different pulses, except for chickpea, all the other pulses were utilized by the females for egg laying. The number of eggs laid per 40 seeds was observed highest in mungbean (35.1) followed by soybean (32.3) and white (25) and black (27.2) varieties of cowpea. The lowest numbers of eggs (6.9) were deposited on green pea. Oviposition was not observed on chickpea (Table 1).

The per cent survival of *C. chininesis* was significantly different on different host- grains on which it was grown (Table 1). The highest per cent survival was observed in bengalgram (86.43) which was significantly different from other treatments followed by pillipesara (84.78), redgram (83.65), greengram (83.51), blackgram (76.78) and pea (50.34). Redgram and greengram were on par with each other and lowest per cent survival was noticed in soybean (47.64).

The mean developmental period of *C. chinensis* was shortest in greengram (28.47 days) which were on par with pillipesara (28.77 days). The longest developmental period was on soybean (41.65 days) and followed by pea (38.72 days), blackgram (35.82 days), redgram (33.41 days), cowpea (31.26 days) and bengalgram (32.64 days) (Table 1).

Index of susceptibility of *C. chinensis* was highest in greengram (6.09) followed by pillipesara (6.03), cowpea (5.31) and bengalgram (5.07) and lowest in soybean (3.16) followed by pea (3.56), blackgram

Table 1. Population development of *Callosobruchus chinensis* in different host- grains

Treatment No.	Host-grains	Mean no. of eggs/5g *	Per cent survival of the insects**	Mean developmental period (days)	Index of susceptibility
1	Greengram	7.25(2.69)^{ab}	83.51(66.07)^{b}	28.47^{f}	6.11^{a}
2	Blackgram	7.75(2.78)^{a}	80.49(63.82)^{c}	35.82^{c}	4.78^{d}
3	Bengalgram	5.25(2.28)^{c}	86.43(68.40)^{a}	32.64^{d}	5.07^{bc}
4	Redgram	7.00(2.64)^{ab}	83.65(66.16)^{b}	33.41^{d}	4.93^{cd}
5	Cowpea	7.50(2.74)^{a}	76.78(61.19)^{d}	31.26^{e}	5.31^{b}
6	Soybean	5.25(2.29)^{c}	47.64(43.65)^{f}	41.65^{a}	3.16^{e}
7	Pea	6.00(2.45)^{bc}	50.34(45.48)^{e}	38.72^{b}	3.27^{e}
8	Pillipesara	6.50(2.54)^{abc}	84.78(67.04)^{ab}	28.55^{f}	6.03^{a}
SEm (±)		0.10	0.52	0.28	-
CD (P=0.05)		0.28	1.50	0.82	-

*Values in parentheses are square root transformed values
**Values in parentheses are angular transformed values

Table 2. Number of grains damaged (%) in different pulse grains by the infestation of *C. chinensis*

Treatment No.	Host-grains	Number of grains damaged (%) after the release of insects			
		30 DAR	60 DAR	90 DAR	120 DAR
1	Greengram	7.30(15.67)^{c}	22.09(28.03)^{c}	45.38(42.34)^{c}	81.82(64.78)^{b}
2	Blackgram	1.15(6.07)^{f}	4.83(12.68)^{e}	21.44(27.55)^{d}	60.50(51.06)^{d}
3	Bengalgram	12.57(20.77)^{a}	26.83(31.19)^{b}	65.17(53.85)^{a}	90.65(72.40)^{a}
4	Redgram	9.68(18.12)^{b}	15.51(23.19)^{d}	61.70(51.77)^{a}	78.49(62.38)^{c}
5	Cowpea	5.74(13.85)^{d}	40.80(39.70)^{a}	44.62(41.91)^{c}	82.63(65.78)^{b}
6	Soybean	0.00(0.00)^{g}	2.76(9.43)^{f}	14.63(22.48)^{e}	42.47(40.67)^{e}
7	Pea	5.77(13.90)^{d}	17.41(24.58)^{d}	24.39(29.59)^{d}	27.59(31.69)^{f}
8	Pillipesara	1.61(7.25)^{e}	2.60(9.13)^{f}	50.85(45.49)^{b}	77.91(62/02)^{c}
SEm (±)		0.35	0.78	0.91	0.81
CD (P=0.05)		1.02	2.28	2.65	2.37

DAR- Days After Release
Values in parentheses are angular transformed values
In each column values with similar alphabet do not vary significantly at P=0.0

Table 3. Weight loss of grains (%) in different pulse grains by the infestation of *C. chinensis*

Treatment No.	Host-grains	Weight loss of grains (%) after the release of insects			
		30 DAR	60 DAR	90 DAR	120 DAR
1	Greengram	2.94(9.86)^{a}	6.93(15.26)^{b}	28.54(32.29)^{b}	48.94(44.39)^{b}
2	Blackgram	0.21(2.63)^{d}	6.81(15.12)^{b}	13.96(21.93)^{d}	35.41(36.53)^{d}
3	Bengalgram	3.10(10.14)^{a}	4.89(12.78)^{c}	21.45(27.58)^{c}	58.55(49.92)^{a}
4	Redgram	0.50(4.05)^{c}	2.69(9.42)^{d}	22.84(28.55)^{c}	55.79(48.33)^{a}
5	Cowpea	0.56(4.30)^{c}	9.34(17.79)^{a}	33.21(35.19)^{a}	35.43(36.53)^{d}
6	Soybean	0.00(0.00)^{e}	1.24(6.40)^{f}	5.76(13.86)^{e}	18.19(25.21)^{f}
7	Pea	0.52(4.14)^{c}	2.16(8.40)^{e}	4.74(12.56)^{f}	21.22(27.41)^{e}
8	Pillipesara	1.09(5.99)^{b}	2.78(9.59)^{d}	29.94(33.17)^{b}	44.39(41.78)^{c}
SEm (±)		0.16	0.32	0.42	0.57
CD (P=0.05)		0.46	0.93	1.23	1.66

DAR- Days After Release
Values in parentheses are angular transformed values
In each column values with similar alphabet do not vary significantly at P=0.05

Table 4. Moisture content (%) in different pulse grains infested by *C. chinensis*

Treatment No.	Host-grains	Moisture content (%)				
		1DAR	30 DAR	60 DAR	90 DAR	120 DAR
1	Greengram	6.60(14.88)	8.37(16.82)^{a}	9.83(18.26)^{a}	11.61(19.90)^{b}	13.48(21.52)^{b}
2	Blackgram	6.28(14.49)	6.71(15.00)^{b}	7.97(16.38)^{bc}	10.03(18.46)^{d}	13.02(21.14)^{bc}
3	Bengalgram	6.88(15.19)	7.98(16.41)^{a}	9.97(18.39)^{a}	11.19(19.53)^{bc}	12.65(20.83)^{bc}
4	Redgram	6.43(14.67)	8.03(16.46)^{a}	9.78(18.22)^{a}	10.55(18.95)^{cd}	11.23(19.57)^{d}
5	Cowpea	6.78(15.07)	8.13(16.56)^{a}	8.81(17.26)^{b}	10.20(18.62)^{d}	12.10(20.35)^{cd}
6	Soybean	6.03(14.20)	6.13(14.33)^{c}	7.22(15.58)^{cd}	7.95(16.38)^{e}	9.10(17.56)^{e}
7	Pea	5.98(14.15)	5.98(14.15)^{c}	6.80(15.11)^{d}	7.56(15.96)^{e}	8.61(17.06)^{e}
8	Pillipesara	6.88(15.19)	8.23(16.67)^{a}	10.71(19.09)^{a}	13.43(21.49)^{a}	15.56(23.21)^{a}
SEm (±)		0.05	0.17	0.32	0.30	0.40
CD (P=0.05)		NS	0.49	0.93	0.86	1.17

DAR- Days After Release
Values in parentheses are angular transformed values
In each column values with similar alphabet do not vary significantly at P=0.05

(4.78), redgram (4.93). It revealed that greengram, pillipesara, cowpea and bengalgram were preferred host-grains for the development *C. chinensis* (Table 1).

Assessment of Damage

The damage caused by *C. chinensis* on different host-grains was observed in terms of percentage of grains damage and weight loss of grains was increased with increase in storage period of 120 days (Table 2). The highest percentage of grains damage was recorded in bengalgram (90.65) followed by cowpea (82.63) and greengram (81.82), whereas the least grain damage was observed in pea and soybean (27.59 and 42.47) at 120 DAR. The seed damage resulted by *C. chinensis* in different bengalgram varieties varied from 2.00 to 57.33%, being maximum in JG-12 variety (57.33%) and minimum in JG-74 variety (2.00%) (Choudhary and Pathak, 1989). The damage caused by *C. maculatus* was recorded 84% in bengalgram at six months after storage (Gupta *et al*., 1981).

The highest weight loss of grains was recorded in bengalgram (58.55) followed by redgram (55.79) and greeengram (44.39), whereas the least was recorded in soybean and pea (18.19 and 21.22) (Table 3). Thus both percentage of grains damage and weight loss of grains was highest in bengalgram at the end of the storage period. The present weight loss values were in conformity with the findings of Doharey *et al*. (1987), who reported that the significant increase in weight loss in greengram by *C. chinensis* was 0.62, 16.74 and 25.56 % at 30, 60 and 90 days after storage, respectively.

The damage caused by *C. chinensis* in terms of moisture content (%) in different host- grains was presented in the Table 4. As the storage period is increasing the moisture content was gradually and significantly increased in all the host-grains. The moisture content was maximum in pillipesara (15.56) followed by greengram (13.48), blackgram (13.02) and bengalgram (12.65). The increased moisture content in the stored grains is due to increased bruchid population, presence of their excreta and metabolic activity of the bruchid. Thus the increase

in moisture content in different host-grains were in conformity with the findings of Rawat and Srivastava (2011) who reported that the moisture content was maximum in greengram (8.27%) and followed by mothbean (8.2%) while minimum in cowpea (7.6%) after 40 days of storage period.

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