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Original Research

Biology of Pulse Beetle (*Callosobruchus chinensis*) and Its Management through Plant Products on Black Gram (*Vigna mungo)*

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Abstract

Laboratory studies on the biology of the pulse beetle *Callosobruchus chinensis* (Linn.) (Coleoptera: Bruchidae) on the stored black gram revealed that the insect completed six generations from April to October. Total developmental period of bruchid was 31 days during July – August while it was 38.3 days during April – May. On an average the incubation, larval, pupal and total developmental period (egg to adult) was of 8.0, 18.39, 8.11 and 34.5 days respectively. Five plant powders viz., neem (*Azadirachta indica* A. Juss) leaf, black pepper *(Piper nigrum* L) fruit, aonla (*Emblica officinalis* L) fruit, five leaved chaste tree(*Vitex negundo* L) leaf, curry leaf tree (*Murraya koenigii* (L.) leaf, at 50g/ kg grains and two oils, viz., mustard(*Brassica juncea* L) and neem seed kernel oil used at 7.5 ml/kg grains were tested for their efficacy as grain protectants against the pulse beetle infesting black gram(*Vigna mungo*(L) Hepper). The results revealed that black pepper fruit powder, neem oil and mustard oil caused 100 percent mortality following 7 days exposure, thereby minimizing the weight loss of seeds as a result of pest infestation at 0, 0.22 and 0.45 per cent respectively as against 38.33 percent in the untreated control.

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INTRODUCTION

Pulse beetle (*Callosobruchus chinensis* Linn. Coleoptera: Bruchidae) is a major pest of leguminous stored seeds. In the hills, it is a serious pest of stored pulses with annual loss of nearly 0.21 million tones amounting to Rs 315 million (Rathore and Sharma 2002).The insect causes substantial loss to stored black gram *(Vigna mungo* (L.) Hepper) and the infested seeds become unfit for either sowing or human consumption. The beetle exhibits a high degree of specificity for its growth and development towards various legumes. Earlier, the biology of the bruchid has been studied by many workers on different pulses (Howe and Curie 1964; Raina 1970; Kumari *et al*., 1991; Pandey and Singh 1997; Singh and Kumari, 2000; Singh and Borah 2001; Meghwal and Singh, 2005; Suchitra and Amitawa, 2006). Keeping in view the high cost of treatment with recommended insecticides and harmful residues, several alternatives have been evaluated including the use of plant products. Encouraging results have been reported against the beetle infesting different pulses (Lakhanpal *et al*., 1993, Mansour, 1997; Gautam *et al*., 2000, Misra, 2000, Bhatnagar, *et al*., 2001; Bhargava and Meena, 2002; Singh, 2003; Singh *et al*., 2006, Sathyaseelan *et al*., 2008). The present studies were, carried out not only to study the biology of the pest insect on black gram seeds but also to evaluate the efficacy of some indigenous plant products against *C. chinensis* infesting black gram.

MATERIALS AND METHODS

Experiments were conducted in the laboratory of Department of Entomology, College of Agriculture, CSKHPKV, Palampur, Himachal Pradesh, India, during April-October, 2008. The test insect was obtained from the separate culture raised from a single pair of *C. chinensis* on green gram seeds. For conducting studies on biology of the insect, three plastic containers (5 x 5 cm) containing 100 gm seeds were taken in with freshly emerged single pair of *C. chinensis* which was released in each of the three containers. Identification of the sexes was made by employing the method of Raina (1970). Mouth of the containers was covered by muslin cloth and secured with rubber bands and later maintained in ambient laboratory conditions. Adults were removed from these containers after death and total number of eggs laid by a single female on host grains was recorded. Eggs laid each day were kept in separate containers covered with muslin cloth and observations were recorded on incubation, developmental (larval and pupal) and total developmental period. Observations on incubation, larval and pupal period inside the grain were recorded by breaking the whole grain with the help of the needle and observing the stage of insect with the help of magnifying glass. The rearing of beetles was continued till the completion of sixth generation and adult longevity was recorded in respect of each generation. Data thus obtained were analyzed statistically in completely randomized design.

In separate studies on the evaluation of plant products against the test insect, plant parts used in the study as powders (Table 2) were collected locally, shade dried for one week and processed into fine powders in a heavy duty grinder. The two oils used in the study were procured from the local market. The powders were used at 5 g/Kg seed while the oils were used at 7.5 ml/Kg seed. The sample size was 25 gm seed per treatment and each treatment was replicated three times including the untreated control. The treated samples were held in 5 x 5 cm plastic containers, each shaken vigorously in order to have an even coating of the test material on the seed surface. Five pairs of freshly emerged (0-24 hr) adults of *C. chinensis* were released in each container including that of control. The mortality data were recorded after 7 days of exposure and all adults were removed from the containers thereafter. The average number of eggs laid per 100 randomly chosen seeds in each treatment was counted. Later, the number of adults emerging from each treatment was also counted and removed regularly to avoid further breeding. After five months of storage, seed damage and weight loss was ascertained as per methods of Adams and Schulten (1978). The data was analyzed statistically following completely randomized design.

RESULTS AND DISCUSSION

It is evident from Table 1 that the number of eggs laid/ female ranged from 85.33 to 99 with an average of 93.89 eggs per female. Egg laying was maximum (99 eggs / female) during July – August. Incubation period of eggs ranged from 6.33 to 10.33 days with an average of 8 days. The egg stage was shorter (6.33 days) during July to August and longer (10.33 days) during April-May. The larval period of *C. chinensis* on black gram grains ranged from 17.33 to 19 days with an average of 18.39 days. Pupal period of the beetle during different generations ranged from 7-9.33 days with an average of 8.11 days. This period was shorter (7 days) during August-September and longer (9.33 days) during April-May. Total developmental period (egg-adult) of *C. chinensis* varied from 31-38.33 days with an average of 34.50 days during different generations (Table 1). In the present investigations it was found that the fecundity was maximum (99 egg/ female), incubation period(6.33 days), larval period (17.33 days) as well as total developmental period (31 days) which was shorter during July-August while during April-May , the beetle took longer time (38.33 days) to complete its life cycle.

Investigations on the effect of some indigenous plant products against *C. chinensis* infesting black gram revealed that following 7 days exposure, *P. nigrum* powder, neem oil and mustard oil caused 100 per cent mortality of the beetle, followed by neem leaf powder (86.67%), *V. negundo* leaf powder (73.33%) and *E. officinalis* fruit and *M. koenigii* leaf powder each causing 66.67 per cent mortality (Table 2). These results are in agreement with Misra (2000) and Singh (2003) with regard to neem oil and *Gautam et al*., (2001) with regard to black pepper. The data regarding effect of treatments on oviposition by *C. chinensis* revealed that no eggs were laid in *P. nigrum* treatment while neem oil and mustard oil reduced the average egg laying to 1.97 and 3.33/ 100 seeds respectively which was significantly lower than all other treatments, in which the egg count varied from 6.67 to 15.33/ 100 seeds and the untreated control with egg count of 76.66/ 100 seeds (Table 2). These results were in general agreement with earlier workers who reported oviposition deterrent

Table 1: Biology of *Callosobruchus chinensis* Linn. on black gram.

Generation	Period/ duration in days				
	Egg	Larva	Pupa	Total Developmental period	Average egg laying /female
(April-May)	10.33	18.67	9.33	38.33	85.33
(May-June)	8.33	19.00	9.00	36.33	89.67
(June-July)	6.67	18.67	8.67	34.00	97.33
(July-Aug)	6.33	17.33	7.33	31.00	99.00
(Aug-Sep)	7.33	18.00	7.00	32.33	98.33
(Sept-Oct)	9.00	18.67	7.33	35.00	93.67
Mean	8.00	18.39	8.11	34.50	93.89
CD (P=0.05)	**1.186**	**NS**	**1.326**	**3.302**	**8.240**

Table 2: Effect of plant products on mortality, oviposition, seed damage and weight loss of black gram seed infested with *C.chinensis.*

Treatment	Dosage g(ml)/ 100 g seed	Av. Mortality after 7 days	*Av No of eggs/ 100 seeds	Seed damage (%)	Weight loss of seeds(%
Neem leaf powder	5.0	86.67(68.69)	7.67(2.94)	5.33(13.35)	2.33(8.78)
Black pepper powder	5.0	100.00(90.0)	0.00(1.0)	0.13(2.07)	0.0(0.0)
Aonla fruit powder	5.0	66.67(4.74)	6.67(2.77)	13.99(21.96)	5.76(13.89)
5-leaf chaste tree Leaf powder	5.0	73.33(58.51)	15.33(4.04)	13.41(21.48)	3.89(11.38)
Curry leaf powder	5.0	66.67(54.74)	15.0(4.00)	20.0(26.56)	7.87(11.38)
Mustard oil	7.5	100.0(90.0)	3.33(2.08)	1.30(6.52)	0.45(3.85)
Neem oil	7.5	100.0(90.0)	1.97(1.63)	0.20(2.56)	0.22(2.69)
Control	-	0.0	76.67(8.81)	64.69(53.34)	38.33(38.2)
CD (P=0.05)		**(0.56)**	**(2.54)**	**(0.77)**	**(0.28)**

Figures in parentheses in the marked (*) column are √x+1 transformed value while in others they are angular transformed values

activity of plant products against *C. chinensis* (Gautam *et al*., 2000; Singh 2003) on different grains. The data on seed damage by *C. chinensis* after 5 months of storage, revealed that treatment with black pepper powder caused the least seed damage of 0.13 per cent, which was statistically at par with neem oil (0.20 %), both being significantly lower than mustard oil with 1.30 % seed damage . In rest of the treatments, the seed damage ranged from 5.35 to 20.0 per cent as against 64.69 per cent in control (Table2). Similarly the data on weight loss as a result of infestation by the pest during 5 months of storage revealed that while there was no weight loss in black pepper treatment, it was 0.22, 0.45, 2.33, 3.76 and 7.87 per cent in neem oil, mustard oil, leaf/ fruit powders of neem, chast tree, aonla or curry leaf tree respectively. However, there was 38.33 per cent seed weight loss as observed in untreated control (Table 2). The present results were in agreement with earlier workers (Gautam *et al*., 2000; Misra, 2000; Bhatnagar *et al*., 2001; Singh, 2003; Singh *et al*., 2006) in other pulses.

CONCLUSION

The paper presented clearly indicates that the development of all stages of the pulse beetle were clearly slower during April owing to ambient lower temperature and relative humidity while it becomes rapid during the months of July to October. These findings are in complete agreement with the findings of Kumari *et al*., (1991), Singh and Borah, (2001), Singh and Kumari, (2000) and Meghwal and Singh, (2005) on separate grains. Thus, prophylactic measures must be taken during July-August to protect the black gram seeds from the attack of pulse beetle (*C. chinensis*).

In a separate set of experiments on the efficacy of plant protectants against the bruchids,

it was clear that powder of black pepper, neem oil and mustard oil proved promising and were quite effective in providing protection to black gram seeds for upto 5 months. The farmer could, therefore, utilize these products for safe seed storage as they were not only effective against *C. chinensis* infestation but also convenient to use and easily available in the local market place. Pulses meant for human consumption could also be protected from damage by the pulse beetle by using the locally available plant products which were cheap, free from toxic residues and also environment-friendly.

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