Biological control of bruchid *Callosobruchus maculatus* (F.) in blackgram

R.P. Soundararajan[1], N. Chitra, S. Geetha and J. Poorani[*]

ABSTRACT

Pulse beetle, *Callosobruchus maculatus* (F.) (Bruchidae: Coleoptera) is a major pest of stored blackgram, greengram, cowpea and other pulse grains. Nnatural incidence of bruchid parasitoid *Dinarmus* sp. (Pteromalidae: Hymenoptera) have been recorded in the stored blackgram seeds and also at field level. 500 blackgram seeds were released with 2 pairs of fresh bruchid adults in 5 different sets (A to E) with three replications. Two pairs of freshly emerged adult parasitoids were released at 5, 10, 15 and 20 days (A to D) after bruchid inoculation. A set of control (E) was maintained with no parasitoid release. Among the treatments, parasitoid released on 5^{th} and 10^{th} day had more adult parasitoid emergence (9.0 and 11.0) in the first generation and bruchid adult emergence was low (3.0 and 2.0) in the treatments. The parasitoid and bruchids were allowed up to four generations in the same set of seeds. The adult parasitoid emergence was the highest in second generation and in subsequent generation the emergence of parasitoid and bruchid was the least. After second generation the seeds were totally damaged in the control. The mass culturing techniques of the parasitoid and the feasibility for large scale release to control bruchids to be studied in future.

Key words: *Callosobruchus maculatus*, *Dinarmus* sp., emergence, field incidence, parasitoid

INTRODUCTION

Pulse beetle, *Callosobruchus* spp. causes a potential loss in legume by feeding on the protein content of the grain and their damage ranges from 12-30 per cent in developing countries (Tsedeke, 1985; FAO, 1994). Field infestation of pulse crops by *Callosobruchus* sp. appears to be very common (Raina, 1970; Mohan and Subbarao, 2000). Infestation of *C.maculatus* starts in the field and continues in storage (Messina, 1984). This field infestation though occurs at a very low level, acts as a potential source of initiation of population buildup during post-harvest period in stores causing heavy losses (Khavilkar and Dalvi, 1984). Gujar and Yadav (1978) recorded 55 to 60 per cent loss in seed weight and 45.50 to 66.30 per cent loss in protein content due to the damage by the pulse weevil. Three to six month later the initial infestation 90 per cent of the bean becomes infested and the weight loss ranges between 30 to 60 per cent (Caswell, 1981). The control of *C. maculatus* by chemical means or by radiation is not very appropriate for resource poor farmers. Few attempts have been made on biological control of the stored product pests in particular to bruchids in India.

In the present study, attempts have been made to know about the occurrence of bruchid parasitoid *Dinarmus* sp. and some biological studies of the parasitoid on the bruchids in blackgram.

MATERIALS AND METHODS

Blackgram crop is raised throughout the year in the National Pulses Research Centre, Tamil Nadu Agricultural University, Vamban, Pudukottai for seed production and research trials. Incidence of *C. maculatus* and their parasitoid were observed during May 2009 to February 2011. The harvested seeds of blackgram were periodically sampled and stored for a period of 45 days for the emergence of bruchids and their parasitoids. Samples of 250 gm seeds were collected in unprotected plots only in five different places in the field and stored for further observations. The parasitoid collected in the blackgram seeds were identified at National Bureau of Agriculturally Important Insect Pests (ICAR), Bangalore.

The pulse beetle, *C.maculatus* was continuously mass cultured in the laboratory on blackgram seeds. Five hundred blackgram seeds (var. VBN 3) were taken in a plastic container and released with 2 pairs of fresh bruchid adults *C. maculatus* in 5 different sets (as treatments from A to E) in three replications. The freshly emerged parasitoid, *Dinarmus* sp. from blackgram seeds in the storage laboratory were used for the experiments. Two pairs of adult parasitoid were released in the containers of A, B, C, D on 5^{th}, 10^{th},15^{th} and 20^{th} day respectively. The treatment E served as control without any parasitoid release. The treatment set up was observed for the development and emergence of adult parasitoid as well as the bruchids. The experiment set up was continuously monitored upto four generations. The seed damage in each treatment was calculated after four generations and expressed in per cent seed damage. The data on the laboratory studies was analysed in Completely Randomized Design.

RESULTS AND DISCUSSION

Field incidence of bruchid parasitoid

The blackgram seeds harvested at different period during the year 2009-2011 were monitored for the emergence of parasitoids under storage conditions. The parasitoid emergence was noticed in the blackgram seeds harvested during November, December 2009 and January 2010 and also during the subsequent year (3 months period only). The hymenoptera parasitoid was identified as *Dinarmus* sp. Very few studies were available on *Dinarmus* sp. and its potential against *Callosobruchus* sp. It is a solitary parasitoid attacks larval, pre-pupal and pupal stages of *Callosobruchus* sp. (Islam and Kabir, 1985). This parasitoid has potential to suppress population of pulse beetle (Monge and Huignard, 1991). The hymenopteran *Dinarmus basalis* is an ectoparasitoid larvophagous species, which is also present in the granaries and represents 80-90 per cent of the bruchid larvophagous parasitoid in the cowpea fields and the storage (Ouedraogo *et al*., 1996).

In the present study, the highest mean adult parasitoid emergence was 5.0 per 250 gm sample during December 2010 (Fig. 1). The damage by bruchid in the field collected seeds of blackgram was maximum during July 2010 (4.5%) and related to the weather parameters. The maximum temperature during the three months period in 2009-2010 was 33.4 - 34.9°C and in 2010-11 it was 34.04 – 35.3°C. During both the years the temperature was not exceed 35.3°C. The temperature during the remaining period ranged between 36–39°C. The low temperature during the period might have favoured the development of the parasitoid in the field population of bruchid in blackgram seeds. Emergence of *D.basalis* was observed in rearing vials in the bruchid culture of soybean in Brazil with the laboratory temperature of 27° C and 70 % relative humidity with natural photoperiod (Costa *et al*., 2007).

Biological studies

In the experiment on different inoculum period of adult *Dinarmus* sp. on the bruchid attacked blackgram seeds, 5th and 10th day released treatments (A and B) recorded more emergence of first generation adult parasitoids. The stage of bruchid larva is important for the larval-pupal parasitoid. Early stage larva of bruchid might be favourable for the development of parasitoid. In the same treatment, the emergence of bruchid adults were low as it indicated the immature stage of bruchids attacked by the parasitoids. In the control where there was no parasitoid released, the adult bruchid emergence was maximum (Table 1). Illoba and Umoetok (2007) concluded that there was a two-phased relationship between *D. basalis* and *C. maculatus*. The first is from the 6-18 DAO (day after inoculation) when mortality of *C.maculatus* was high and this time corresponds to the larval stage of *C.maculatus* while from 21–30 DAO the pests had reached adult stage hence were no more susceptible to the larvophagous parasitoid. In the present study also the parasitoid release at 5th and 10th day was highly susceptible to bruchids and more adult parasitoids emerged from the treatments.

The experiment was allowed upto fourth generation of bruchid as well as parasitoid development. During the second generation the adult parasitoid emergence was more in the 5th and 10th day inoculated treatment. However, in the third generation the parasitoid emergence was very low and there was no parasitoid emergence in the fourth generation. The bruchid emergence was low from the second generation onwards and the parasitoid might have had no host to develop. Bruchid emergence was also nil at fourth generation in the treatments. In control, no bruchid emergence from third generation onwards as the seeds were completely damaged by the beetles. In case of the treatment A, B, C and D the seed damage in the fourth generation was 12, 18, 49 and 60 per cent respectively. The results clearly indicate that the parasitoid hampered the development of bruchids and subsequent bruchid population. The parasitoid prefers young immature stages of the parasitoid and early release of the parasitoid

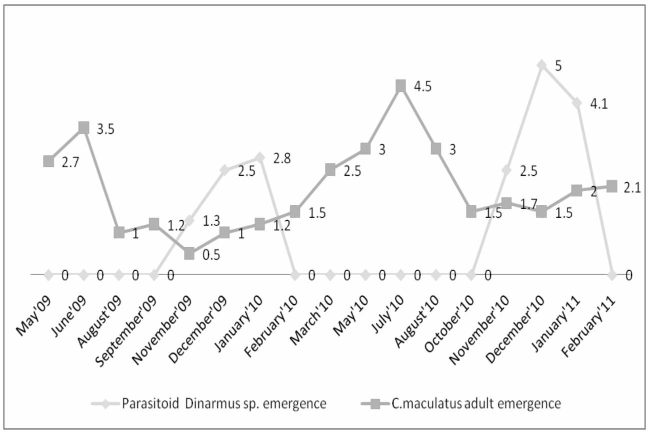

Figure 1. Field incidence of bruchid *C. maculatus* and its parasitoid *D. basalis* in blackgram

will help in reducing the bruchid incidence. Islam (1994) demonstrated that the development time for the parasitoid *Dinarmus basalis* was shorter on fourth instar larva and prepupae than on second and third instar larva of pulse beetle, *Callosobruchus chinensis*. This was primarily because of qualitative or quantitative differences between fourth instar larvae or prepupae and second and third instar larva as hosts. Release of *D. basalis* showed a reduction of 48-75 per cent bruchid population within 16 days of storage. The bests timing of parasitoid release was the simulated harvest as later releases reduced the bruchid population only by about half of this percentage. The effect of increasing the number of parasitoid strongly depends on host age and food supplement (Schmale *et al*., 2005). In West Africa, Guinean zone farmers storage system in cowpea seeds, introduction of 20 or 40 pairs of *D.basalis* adult at the beginning of storage and again 15 days later reduced the development of the bruchid population after 5 months of storage In Sudano-Sahelian zone, an introduction of 40 pairs of *D. basalis* adults at the beginning of storage and again 15 days later was effective also maintaining seed weight losses from 25 kg batches at less than 10 per cent (Amevoin *et al*., 2007). The type of bag or cover used for the rearing of the parasitoid is also important. The highest percentage of suppression and parasitism occurred in amemian bags and the lowest in polypropylene bags when a single release of 50 pairs of *D. basalis* (Islam and Kabir, 1995; Manisegaran, 2010). In the present study the experiment was carried out in transparent plastic containers with sufficient air circulation as the lid of the containers were drilled with minute holes.

From the present laboratory experiment, the parasitoid *D. basalis* showed that it suppressed the bruchid population from third generation and without parasitoids the seeds were completely damaged in control treatment. Earlier a few reports also had suggested that it had high potential in the biological control of bruchids in big storage systems.The mass production techniques for the multiplication of this parasitoid need to be standardized for large scale release in storage godowns for the management of the pulse beetle.

REFERENCES

Amevoin, K., Sanon, A., Apossaba, M. and Glitho, I. A. 2007. Biological control of bruchids infesting cowpea by the introduction of *Dinarmus basalis* (Rondani) (Hymenoptera: Pteromalidae) adults into farmers' stores in West Africa. *Journal of Stored Products Research*, **43**(3): 240-247.

Caswell, G. H. 1981. Damage to stored cowpea in the northern part of Nigeria. *Journal of Agricultural Research*, **1**: 11-19.

Costa, V. A., Guzzo, E. C., Lourecao, A. L., Tavares, M. A. G. C. and Vendramim, J. D. 2007. Occurrence of *Dinarmus basalis*

Table 1. Development and emergence pattern of *Dinarmus* sp. on *C. maculatus*

Treatment/ Period of parasitoid inoculation	I generation		II generation		III generation		IV generation
	Mean *Dinarmus* emergence (No. of adults)	Mean *C.maculatus* emergence (No. of adults)	Mean *Dinarmus* emergence (No. of adults)	Mean *C.maculatus* emergence (No. of adults)	Mean *Dinarmus* emergence (No. of adults)	Mean *C.maculatus* emergence (No. of adults)	Mean seed damage* (%)
5th day (A)	9.0	3.0	10.0	1.0	1.3	0	12.0
10th Day (B)	11.0	2.0	12.3	1.6	0.9	0	18.0
!5th day(C)	3.6	11.3	3.7	2.7	1.0	1.0	49.0
20th day (D)	2.7	13.3	4.7	4.2	0.8	1.7	60.0
Control (E)	0	32.0	0	114	0	0	100.0
SEd	0.1791	0.3207	0.1474	0.2325	0.207	0.1756	2.694
CD (p=0.05)	0.399	0.7145	0.3284	0.5181	0.4613	0.3913	6.004

- the values are added with 0.05 and square root transformed for statistical analysis
- *the values are arcsine transformed and analysed
- values are mean of three replication

in *Callosobruchus analis* in stored soybean in Sao Paulo, Brazil. *Science and Agriculture (Piracicaba, Brazil)*, **64** (3): 201-202.

Effowe, T. Q., Amevoin, K., Nuto, Y., Mondedji, D. and Glitho, I.A. 2010. Reproductive capacities and development of a seed bruchid beetle, *Acanthoscelides macrophthalmus*, a potential host for the mass rearing of the parasitoid, *Dinarmus basalis*. *Journal of Insect Science*, **10** (129):1-14.

FAO (Food Agricultural Organisation), 1994. Grain storage techniques, evaluation and trends in developing countries. *FAO Agricultural Services Bulletin*, 109, Rome, Italy.

Gujar, G. T. and Yadav, T. D. 1978. Feeding of *Callosobruchus maculatus* F. (Colepotera: Bruchidae) reared on different food and temperature. *Journal of Stored Products Research*, **22**(2): 71-75.

Iloba, B. N. and Umoetok, S. B. A. 2007. Effects of *Dinarmus basalis* (Rendani) on the population density of *Callosobruchus maculatus* (Fab.) on stored cowpea (*Vigna unguiculata* Walp) seeds. *Tropical and Subtropical Agrosystems*, **7**; 59-62.

Islam, W. 1994. Effect of host age on rate of development of *Dinarmus basalis* (Rond.) (Hymenoptera: Pteromalidae). *Journal of Agricultural Entomology*, **118**: 392-398.

Islam, W. 1995. Biology of *Dinarmus basalis* (Rondani) (Hymenoptera: Pteromalidae), a larval-pupal parasitoid of *Callosobruchus chinensis* (Linnaceus). *Annals of Entomology*, **36**: 51-56.

Islam, W. and Kabir, S. M. H. 1995. Biological control potential of *Dinarmus basalis* (Rond.) (Hymenoptera: Pteromalidae), a larval-pupal ectoparasitoid of the pulse beetle, *Callosobruchus chinensis* (L.). *Crop Protection*, **14** (6): 439- 443.

Khanvilkar, S.V. and Dalvi, C. S. 1984. Carry over the pulse beetle *Callosobruchus maculatus* (F) infestation from field and its control. *Bulletin of Grain Technology*, **22**: 54-61.

Manisegaran, S. 2010. Acclimation for resistance in egg parasitoid *Trichogramma exiguum* John and Plinto. *Journal of Biopesticides*, **3**(3): 543 – 546.

Messina, F. J. 1984. Influence of cowpea and pod maturity on the oviposition choices and larval survival of a bruchid beetle *Callosobruchus maculatus*. *Entomologia Experimentalis et Applicata*, **35**: 241-248.

Mohan, S. and Subbarao, P. V. 2000. First second of *Callosobruchus maculatus* infesting blackgram and greengram under field conditions of Tamil Nadu. *Bulletin of Grain Technology*, **33** (1): 73-74.

Monge, J. P. and Huignard, J. 1991. Population fluctuation of two bruchid species *Callosobruchus maculatus* F. and *Bruchidius atrolineatus* Pic (Coleoptera: Bruchidae) and their parasitoids *Dinarmus basalis* Rondani and *Eupelmus vuilleti* Crawford (Hymenoptera: Pteromalidae: Eupelimidae) in a storage condition in Niger. *Journal of African Zoology*, **105**: 197-206.

Ouedraogo, P. A., Sou, S., Sanon, A., Monge, J. P., Huignard, J., Tran, B. and Credland, P. F. 1996. Influence of temperature and humidity on population of *Callosobruchus maculatus* (Coleptera: Bruchidae) and its parasitoid *D.basalis* (Hymeoptera: Pteromalidae) in two climatic zones of Burkina Faso. *Bulletin of Entomological Research*, **86**: 695-702.

Raina, A. K. 1970. *Callosobruchus* spp. infesting stored pulses in India and comparative study of their biology. *Indian Journal of Entomology*, **32**: 303-310.

Schmale, I., Wackers, F.L., Cardona, C. and Dorn, S. 2005. How host larval age and nutrition and density of the parasitoid *Dinarmus basalis* (Hymenoptera: Pteromalidae) influence control of *Acanthoscelides obtectus* (Coleoptera: Bruchidae). *Bulletin of Entomological Research*, **95**: 145-150.

Tsedeke, A. 1985. Evaluation of some insecticides for the control of the bean bruchids in stored haricot bean. *Ethiopian Journal of Agricultural Sciences*, **7**: 112-117.

Soundararajan, R.P.[1] Chitra, N., Geetha, S. and Poorani, J.[*]

1Corresponding author. National Pulses Research Centre, Tamil Nadu Agricultural University, Vamban Colony, Pudukottai – 622 303, Tamil Nadu, India.

[*]National Bureau of Agriculturally Important Insects, Bangalore –560 024, Karnataka, India.

*Mobile: +91 98422 89175; E-mail: sound_insect73@rediffmail.com

Received: September 07, 2011 Revised: December 22, 2011 Accepted: January 18, 2012