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Rearing and release of the pulse weevil parasitoid *Dinarmus basalis* (Rond.) (Hymenoptera:Pteromalidae)

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ABSTRACT

Mass rearing technique of *Dinarmus basalis* and release of this parasitoid in an experimental room to determine its potential as a biological control agent, against a solitary larval-pupal parasitoid of the pulse weevil, *Callosobruchus maculatus* is described. One thousand parasitoids were capable of producing more than 35000 parasitoids per week. The parasitoid suppressed about 85% population of *C. maculatus* at the introduction levels of 40 or 50 pairs and about 45% at the introduction levels of 5 pairs only. Progeny produced when introducing 50 pairs was 9.01 per female and it was 35.5 per female with 5 pairs.

Key words: Biological control, *Callosobruchus maculatus*, *Dinarmus basalis*, pulse weevil.

INTRODUCTION

The pulse weevil, *Callosobruchus maculatus* (F.) (Bruchidae) is a major cosmopolitan pest of stored pulses causing severe loss in storage. This pest multiplies rapidly under warm humid conditions and inflicts serious damage within a short time (Cotton 1963). Gujar and Yadav (1978) recorded 55 to 60% loss in seed weight and 45.50 to 66.30% loss in protein content due to damage by the pulse weevil. Three to six months after the initial infestation, 90% of the beans become infested and the weight loss ranges between 30 and 60% (Caswell 1981). The control of *C. maculatus* by chemical means or by radiation is not very appropriate for resource-poor farmers. Therefore, more simple and indigenous methods of control are sought, such as the use of ashes, repellents, pesticidal plants or plant-derived oils (van Huis 1991). There has been little relevant research for control of stored product pests in general, and on parasitic Hymenoptera in particular (Haines 1984). This method is environmentally innocuous, long-lasting, self renewing and relatively inexpensive (Rabb *et al.* 1984).

The solitary pteromalid, *Dinarmus basalis* (Rond.) parasitized the larval, pre-pupal and pupal stages of *C. maculatus* (Southgate 1979; Islam *et al.* 1985). This parasitoid has potential to suppress populations of the pulse weevil (Monge and Huignard 1991). Besides *D. basalis,* some other parasitoids, viz. *Anisopteromatus calandrae* How. (Southgate 1979) and *Eupelmus vuilleti* (Cwf.) (van Alebeek 1991) of *C. maculatus* have been recorded. Studies on the bionomics of *D. basalis* have been conducted by Gomez-Alvarez (1980) and Islam (1985). However, to our knowledge, there are no reports on mass culture and release of *D. basalis* on *C. maculatus*. The objective of the present study was to develop a mass culture technique and to produce and release *D. basalis* in the pulse debris.

MATERIALS AND METHODS

Five hundred newly emerged mated females of *C. maculatus* were allowed to oviposit on mash seeds during 2-3 h in separate Petri dishes (11.5 cm diam.). After removing the female beetles, the petri dishes were placed in an incubator (30 ± 1^{0}C) for development. The process was continued for getting 20-23-days-old infested seeds daily. The infested seeds were identified by the presence of empty egg-shells and damaged seed-coat.

Newly emerged adult *D. basalis* were collected from a 7 years old laboratory culture just after emergence. Subsequent mating was assured by observation. To obtain many mature eggs, the females were supplied with honey solution in wads of cotton. Each female was offered 50 infested 20-30-days-old seeds in different Petri dishes (8.5 cm diam), each seed containing one host. Every 24 h, the ovipositing females were transferred to other Petri dishes containing 20-30-days-old infested seeds. The parasitized seeds were placed in an incubator in separate glass tubes for rearing. The tubes were covered with muslin. The process was continued until the ovipositing female dies.

Seven to eight days later, the empty seeds and adult beetles emerging form non-parasitized seeds

were removed from the Petri dishes and again all the tubes were placed in an incubator until parasitoid emergence. After 11-14 days the males and females of *D. basalis* emerged from the parasitized seeds.

Mass culture of *D. basalis* in the laboratory

Five hundred mated females of *C. maculatus* were placed in one tray with 10,000 mash seeds during 3-4 h for egg-laying. Each tray was covered with another tray and placed in the incubator for rearing after removing all the beetles. This process was continued for five days to obtain more 20-23-days-old infested seeds.

D. basalis parasitized seeds were collected from the stock culture and kept in different glass beakers until adult emergence. After the emergence of adults, mating was assured by observation. Batches of one thousand mated females, collected with an aspirator, were transferred to large muslin covered containers. Fourteen thousand infested seeds (20-23-days-old) were introduced in each glass container. Again, 14000, 20-23-days-old infested seeds were introduced twice in each container at two-day intervals. In this way, a total of 42,000, 20-23-days-old infested seeds were introduced in each glass container three times a week. The experiments were conducted at constant temperature (30±1°C). Seven to ten days later, the containers were removed from the incubator and the empty seeds and the adult beetles that had emerged were removed from the containers. The remaining parasitized seeds were divided into three groups in small containers, and kept at the same temperature for the required days for the complete development of parasitoids. The total production of *D. basalis* was counted. The experiments were replicated three times.

Release of *D. basalis*

The release of *D. basalis* was conducted in two separate sealed rooms to prevent insects from entering or exiting. The average temperature in the rooms was 29.8 ± 0.47° C and the relative humidity 85.9 ± 0.9%.

For each test, two laboratory cultures of 20-23-days-old *C. maculatus* containing 1000 insects/culture were thoroughly mixed, then separated in two equal quantities. Clean grains were added until the quantity reached 500g. One 500g unit was scattered in each of the rooms to simulate infested spillage. Five pairs of *D. basalis* were added to one of the rooms while the other room remained parasitoid free.

After 8 days, the mash was removed from each room and held for 15 days. During this period, *D. basalis* were removed thrice weekly by aspirator from the infested mash that had been exposed to the parasitoids. After 15 days, mash from both the rooms was sifted to remove the *C. maculatus* and all the remaining *D. basalis*. Effectiveness of *D. basalis* was determined by comparing the *D. basalis* exposed population of *C. maculatus* with that of the non-exposed population. The procedure was repeated using 10, 20, 30, 40 and 50 pairs of parasitoids. All tests were replicated three times.

RESULTS

The total number of parasitoids emerging from the first group of parasitized seeds was 32, 712 and from the second group, it was 35,077. From the last group a total of 36,112 parasitoids emerged. The mean number of F_1 offspring produced from 1000 parasitoids was therefore 34,633 per week.

The greater the number of pairs of *D. basalis* introduced, the more the population of *C. maculatus* was reduced (Fig 1). The correlation between the number of pairs of *D. basalis* introduced and the

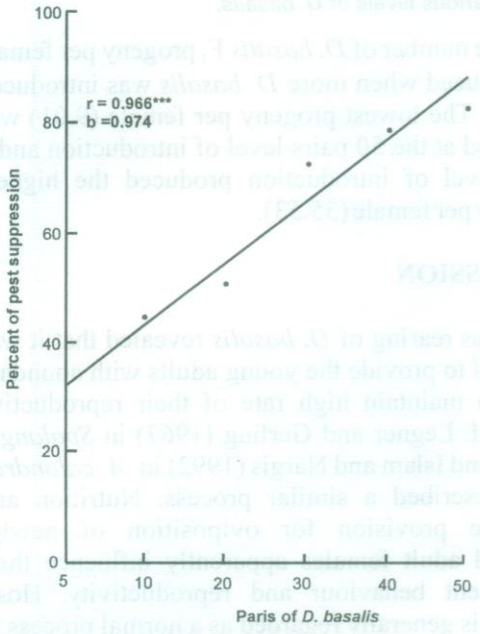

Fig1. Relationship between percentage suppression of *C. maculatus* and the number of *D. basalis* introduced

reduction of *C. maculatus* population was high and positive (r=0.97). When 5 pairs were introduced, 43.77% of the pest was controlled. The control of the pest did not exceed 75% when 20 and 30 pairs were introduced, but with 40 and 50 pairs, control of *C. maculatus* reached approximately 85% (Fig 1).

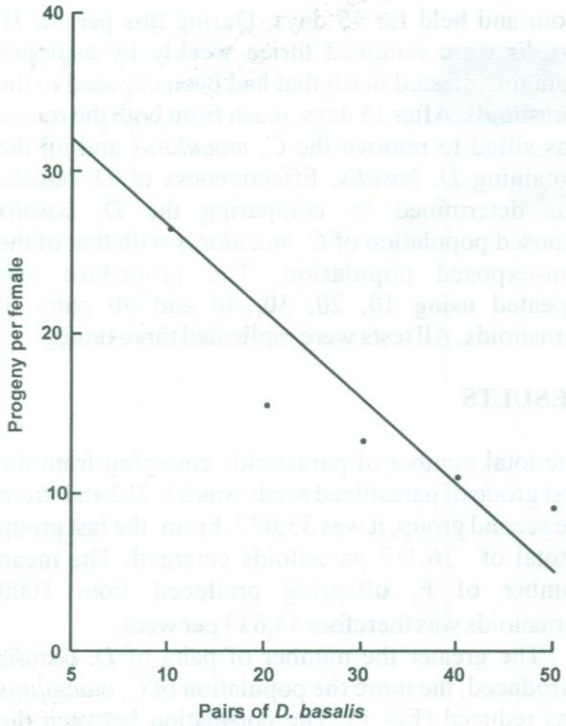

Fig 2. The number of F_1 progeny resulting from *C. macul-atus* infested mash seeds previously exposed to various levels of *D. basalis*.

The number of *D. basalis* F_1 progeny per female was reduced when more *D. basalis* was introduced (Fig 2). The lowest progeny per female (9.01) was produced at the 50 pairs level of introduction and 5 pairs level of introduction produced the highest progeny per female (35.53).

DISCUSSION

The mass rearing of *D. basalis* revealed that it was essential to provide the young adults with abundant hosts to maintain high rate of their reproductive potential. Legner and Gerling (1967) in *Spalangia endius* and Islam and Nargis (1992) in *A. calandrae* have described a similar process. Nutrition and adequate provision for oviposition of newly-emerged adult females apparently influence their subsequent behaviour and reproductivity. Host-feeding is generally regarded as a normal process in the Pteromalidae (Clausen 1962). Legner and Gerling (1967) demonstrated the importance of host-feeding on the whole life-span of different pteromalid parasitoids e.g. *Spalangia cameroni*, *Nasonia vitripennis* and *Muscidifurax raptor* of housefly, *Musca domestica*. Islam and Nargis (1992) observed the same on pteromalid parasitoid *A. calandrae* of pulse beetle, *C. chinensis*. Legner and Gerling (1967) reported that *S. endius* obtained nourishment from host pupae for optimum egg-production but Islam and Nargis (1992) reported that *A. calandrae* produced maximum number of eggs when fed on body fluid of 4th instar larvae, pre-pupae and pupae of *C. chinensis*, like *D. basalis* in the present investigation. The trend in mass-production was found to be similar to that of the parasitoid *S. endius* on the host *M. domestica* as reported by Morgan *et al.* (1975) and *A. calandrae* on host *C. chinenis* (Islam and Nargis 1992). Morgan *et al.* (1975) found large number of *S. endius* within a week by the introduction of two-day old housefly pupae three times/week. Similarly, Rutz and Axtell (1979) also reared a large number of *M. raptor* through mass-culture on the same host but Islam and Nargis (1992) found 44839 individuals of *A. calandrae* within a week by the introduction of 12-15-day-old *C. chinesis* infested seeds three times per week.

The present investigation demonstrated that *D. basalis* controlled nearly 85% of *C. maculatus* population at the introduction level of 40 and 50 pairs and nearly 50% at an introduction level of 5 pairs. The suppression of *C. chinensis* by *A. calandrae* at 5 pairs was 56% whereas at 50 pairs was 98% (Islam and Nargis 1994). The same parasitoid suppressed population of *Sitophilous oryzae* in wheat debris by 95.3% at introduction levels of 30, 40 and 50 pairs and nearly 50% at introduction level of 5 pairs (Press and Flaherty 1984).

Morgan *et al.* (1975) released *S. endius* on *M. domestica* populations achieving complete eradication of the house flies within 30 days and all house fly pupae collected within 37 days were parasitized. The same parasitoid suppressed populations 84.3% and 85% as observed in two separate experiments by Morgan (1980) and Guillermo *et al.* (1985). The population of the almond moth, *Ephestia cautella* was suppressed by the predator *Xylocoris flavipes* by about 97% as reported by Press *et al.* (1982).

The F_1 progeny per female was the lowest at the highest introduction levels and highest at the lowest introduction levels in the present investigation. This indicated that at higher levels of introduction, *D. basalis* found hosts that were already parasitized and this resulted in a high rate of super parasitism.

Islam and Nargis (1994) observed that under confined conditions with a limited host supply, *A. calandrae* often attacked the same host more than once although only rarely did more than one parasitoid develop from a host. Press *et al.* (1984) achieved a similar result and observed that at higher levels of introduction, there were lower levels of

progeny per female and at lower levels of introduction higher levels of progeny produced by *A. calandrae* on *S. oryzae*. The higher parasitoid densities would undoubtedly not have increased the suppression appreciably although a greater number of *D. basalis* would be necessary if their host searching capacity were to be taxed by either larger quantities of infested mash or if a larger warehouse space were to be utilized.

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