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Management of *Callosobruchus chinensis* Linnaeus in Stored Chickpea Through Interspecific and Intraspecific Predation by Ants

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Abstract: Predatory efficacy of three ant species i.e. *Monomorium minimum*, *Dorylus labiatus* and *Camponotus rufipes* was checked on all stages of *Callosobruchus chinensis* Linnaeus (CCL). *D. labiatus* was found to be the most efficient larvae and pupae predatory ant species with 84.65% and 98.26% rate of mortality of CCL larvae and pupae respectively. *M. minimum* was the most efficient egg eating species with 84.85% rate of CCL egg mortality. Considerable CCL adult predation was shown by *C. rufipes*. Forest lines of most of the species were better CCL predators. It was concluded that ants could be effective management tools against CCL.

Key words: Pulses · dhora · predators · pest · tropical crops

INTRODUCTION

Pulses are important sources of proteins, fats, carbohydrates, sugars and vitamin B. Gram (*Cicer arietinum*) is among one of the most important pulse crops famous as a good source of protein. In Pakistan, an area of 1088.8 thousand hectares was cultivated under gram during the year 2003-04 with a production of 667 thousand tons [1]. *Callosobruchus chinensis* Linnaeus (CCL) (Coleoptera, Bruchidae) commonly known as "Dhora" is one of the most destructive insect pests of this crop in stored conditions. According to Qayyum and Zafar [2] the maximum loss of 90% in gram due to CCL was reported. Heavy losses have been caused by CCL in moth beans [3]. Attempts have been made by different scientists for the biological control of stored Bruchid beetles through parasitoids.

The myrmicine genus *Monomorium* is one of the most important groups of ants in terms of its diversity, morphological and biological variability and its extensive range throughout the world. Several taxa, i.e. the pharaoh ant (*Monomorium pharaonis*, the Singapore ant (*Monomorium destructor*) and *Monomorium floricola* (Jerdon) are also notable tramp species and domestic pests [4]. On a world scale, Bolton [5] listed 296 species in the genus *Monomorium.* The ants are mostly considered pests of different commodities both in the fields and urban habitats [6]. In urban populations, ants cause frequent pest problems destroying aesthetic and economic value of many products of human consumption [7, 8]. Ants also act as natural predators of many pests. Ants have been observed to be one of the most common generalized predators in tropical crops. A few species may dominate high species richness in some crops [9]. Reznikova and Panteleeva [10] observed the active hunting of ants for springtails which are inhabitants of litter-soil stratum in various natural zones and landscapes. Ants are helpful in controlling a variety of insect pests in temperate and tropical crops, such as cocoa, pears, cotton, rice etc., [11-14]. A predatory ant, *Oecophylla smaragdina* (Fabricius) is the example of earliest biological control agent used in China in 300 AD for controlling Lepidopterous and Coleopterous pests of citrus. This practice is continued till date[7, 15].

The present studies were carried out to observe the predatory efficacy of different ant species on all developmental stages of CCL and to study the intra-specific variations in predatory efficacy among lines of most efficient predatory ant belonging to different colonies inhabiting domestic and forest habitats.

MATERIALS AND METHODS

A variety CM72 of chickpea was collected from Pulses Program, National Agriculture Research Center, Islamabad. It was fumigated using Agtoxin tablets for a

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period of two weeks. The culture of CCL was multiplied and maintained in mud rearing jars. Three ant species *Monomorium minimum*, *Dorylus labiatus* and *Camponotus rufipes* were collected from urban /semi-urban colonies and forests of different localities in Rawalpindi and Islamabad. This gave three so-called "lines" of each of the three species. Each group of ants was collected from the same colonies in order to maintain genetic uniformity among same species. The ant culture was maintained on sucrose sugar and aqueous honey solution (1:1 water and honey) in 2 kg capacity plastic insect rearing jars. The experiments were carried out under laboratory conditions at 30±2°C temperature and 65±5% relative humidity. All the experiments were laid out following Completely Randomized Design (CRD) and each treatment was replicated by three times.

Experiment I: Twelve plastic insect rearing jars of 200 g capacity were taken and 20 g of chickpea were added in each jar. Ten pairs of 24 h old CCL were transferred in each rearing jar following Halstead [16]. The mouths of jars were closed with muslin cloth and incubated. After one week CCL adults were removed and number of eggs laid were counted. Ten worker ants of semi-urban habitat of each species of ants i.e. *M. minimum*, *D. labiatus* and *C. rufipes* were added in rearing jars in three replications leaving three jars without ants as control. A cotton piece soaked in aqueous honey solution (1:1 water and honey) was placed in each of all twelve jars to provide supplemental food to ants ensuring their survival. The mouths of these jars were closed with the help of muslin clothes and incubated. Ants dying naturally were replaced by the fresh ones ensuring their specified number throughout the experimental period. Number of eggs of CCL consumed by ants were counted just before hatching and compared with control. Similarly number of larvae, pupae and adults developing from the surviving eggs and consumed by ants were also counted and compared with control.

Experiment II: This experiment consisted of three sub-experiments estimating ants directly feeding on CCL. Thirty plastic rearing jars were taken. Mouth closing and incubation of jars was same as in experiment I.

Sub-experiment-1 (Number of eggs consumed): In each of 30 plastic insect rearing jars 20 g of un-infested chickpea were added along with 24 h old ten CCL adult pairs and incubated. After one week, adults were removed and number of eggs laid were counted. Thirty ants belonging to three lines of all three ant species were added in insect rearing jars each in three replications. Three jars were left as control. After three days of incubation, number of CCL eggs consumed by the ants were counted.

Table 1: Percent mortality of *Callosobruchus chinensis* L. by various ant species

	Percentage Mortality of CCL			
Ant Species	Eggs	Larvae	Pupae	Adults
Camponotus rufipes	18.325 c	5.458 c	11.658 c	23.589 a
Monomorium minimum	84.854 a	62.985 b	53.458 b	4.325 b
Dorylus labiatus	51.214 b	84.652 a	98.265 a	2.645 b
Control	17.325 c	6.548 c	7.589 c	4.650 b

Sub-experiment-2 (Number of larvae/pupae consumed): In 30 insect rearing jars, 20 g of chickpea seeds with fifty larvae/ pupae were added along with thirty worker ants of different lines of three ant species each in three replications. Three jars were left as control. After three days of incubation, number of larvae/ pupae consumed by ants were counted.

Sub-experiment-3 (Number of adults consumed): In each of thirty insect rearing jars, 20 g of un-infested chickpea seeds were added along with 50 CCL adults. Thirty worker ants of three lines of all three species were added each in three insect rearing jars while three jars were left as control. After three days, number of adults consumed by ants were counted. Computer based *SPSS 10.0* and *Minitab V11* packages were used for data analysis.

RESULTS AND DISCUSSION

The results obtained from the experiments were expressed in the form of table and figures.

Inter-specific variation in predatory efficacy of ants: All of three ant species exhibited different levels of predation of different developmental stages of CCL as shown in Table 1.

***Egg predation*:** *M. minimum* consumed maximum number of eggs of CCL with the percentage mortality of 84.85% that was statistically different from all other ant species. It was followed by *D. labiatus* (51.21%). *C. rufipes* (18.32%) was similar to control (17.32%).

***Larvae predation*:** *D. labiatus* was proved to be the most efficient predatory ant species for CCL larvae with 84.65 percent mortality followed by *M. minimum* (68.98%). Again no significant CCL predation was shown by *C. rufipes* (5.45%) which was similar to control (6.54%).

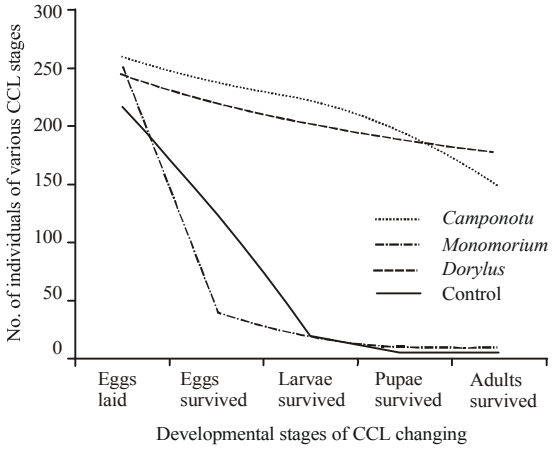

Fig. 1: Population dynamics of CCL influenced by ants

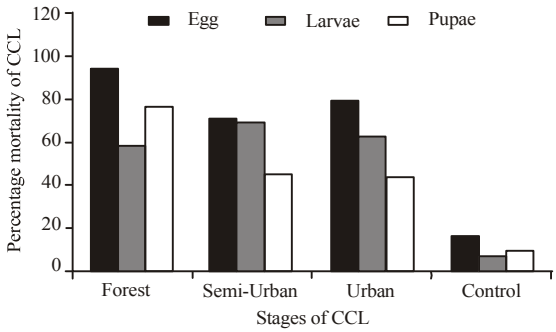

Fig. 2: Percent mortality of various developmental stages of CCL by various lines of *Monomorium minimum*

***Pupae predation*:** Maximum CCL pupae were predated by *D. labiatus* (98.26%) followed by *M. minimum* (53.54%). *C. rufipes* and control were statistically similar.

***Adult predation*:** Significant predation of adults of CCL was only shown by *C. rufipes* (23.58%). *M. minimum* (4.32%) and *D. labiatus* (2.64%) were statistically similar to control (4.65%).

***CCL population dynamics*:** The population dynamics of CCL influenced by the presence of various ant species is shown in Fig. 1. It was observed that *D. labiatus* and *M. minimum* decreased CCL population consuming different developmental stages at various levels of predation. *D. labiatus* killed maximum CCL at larvae and pupae level with 15 and 2% rate of survival respectively while *M. minimium* reduced pest pressure at the early egg stage where only 15% eggs survived. *C. rufipes* was similar to control only with the exception of notable adult predation where rate of adult survival was 76%. These results were similar to the conclusion of Adams *et al.*, [9] that the presence of few ant species reduced the pest pressure being common predators of various crop pests.

Intra-specific variation in predatory efficacy of ants: *M. minimum* and *D. labiatus* did not show any significant adult predation of CCL so they were only analyzed for their egg, larvae and pupae predation in intra-specific studies.

***Predatory efficacy of Monomorium minimum*:** The results obtained were expressed in Fig. 2.

- **Egg predation:** Maximum CCL egg predation was shown by forest line of *M. minimum* (95.35%) that was statistically different from other two lines. Semi-urban (71.25%) and urban (79.25%) lines showed similar levels of CCL egg predation. Minimum egg mortality (15.35%) was observed in case of control.

- **Larvae predation:** Maximum CCL larvae predation was shown by semi-urban line (69.65%) but it was statistically similar to forest (58.32%) and urban (63.45%) lines while all three lines were different from control (6.57%).

- **Pupae predation:** Forest line of *M. minimum* exhibited maximum CCL pupae predation (77.154%) which was statistically different from semi-urban (45.65%) and urban (43.54%) lines. Control (9.71%) was different from all.

***Predatory efficacy of Dorylus labiatus*:** The results were shown in Fig. 3.

- **Egg predation:** Maximum number of eggs of CCL were predated by semi-urban line (47.21%) which was statistically different from other two lines. Urban (39.58%) was similar to forest line (34.25%). Control was different from all (18.26%).

- **Larvae predation:** Maximum larvae predation (92.47%) was shown by forest line of *D. labiatus* followed by urban line with 71.65% CCL larvae mortality. Semi-urban line (44.65%) was statistically different from both of first lines and control (8.29%).

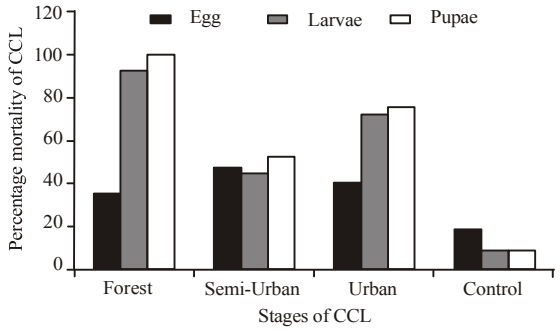

Fig. 3: Percent mortality of various developmental stages of CCL by various lines of *Dorylus labiatus*

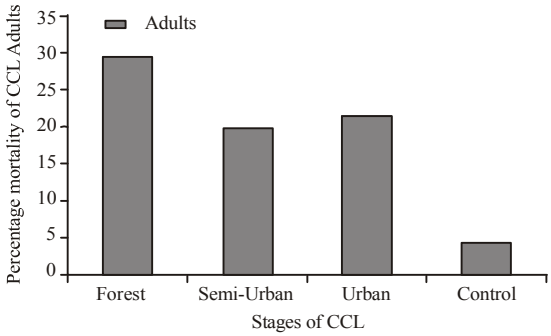

Fig. 4: Percent mortality of CCL adults by various lines of *Camponotus rufipes*

- **Pupae predation:** Hundred percent predation of pupae of CCL was shown by forest lines of *D. labiatus*. It was followed by urban line (75.25%) which was statistically different from semi-urban line (52.65%). Control was different from all (8.64%).

***Predatory efficacy of Camponotus rufipes*:** The results were shown in Fig. 4.

- **Adult predation:** Forest line of *C. rufipes* showed maximum predation of adults (29.21%) of CCL. Urban line (21.54%) and semi-urban line (19.85%). No significant egg, larvae or pupae predation of CCL was shown by *C. rufipes*.

It is obvious from the results that the ant species especially forest lines are potentially efficient predators of CCL as shown by various other field studies [10]. These ants can be used for the management of all stages of CCL especially eggs, larvae and pupae just like those ant species that have been used as natural predators of a variety of insect pests of temperate and tropical crops like cotton, pears, cocoa and rice [11-14]. If the storage buildings for chickpea are constructed in forest habitat these ants rather than becoming a pest, would benefit the farmers by eliminating CCL which is an economic insect pest of chickpea.

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