Bioefficacy of coccinellid predators on major tea pests

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ABSTRACT

Twenty species of coccinellid predators were observed in Sub-Himalayan tea plantation of North Bengal during 2004 to 2006. Of these, *Micraspis discolor* (F) was dominant (42.5%) in the conventionally managed tea plantations. The abundance of *M. discolor* populations was positively correlated with the abundance of red spider mites (*Oligonychus coffeae* Neitner, Acarina: Tetranychidae) (R^2=0.705) and tea aphid (*Toxoptera aurantii* Boyer de Fons, Homoptera: Aphidae) (R^2 = 0.893). Both the pests and their predator (*M. discolor*) populations showed similar patterns of abundance that reached peaks during January to March. In choice test, the mixed population the grub and adult of *M. discolor* showed a clear choice for the tea aphid. The life cycle studies also suggested that the tea aphid was the preferred prey for *M. discolors*, but the predator can survive on red spider mite also. The studies on feeding potential indicated that the grubs of *M. discolor* consumed on an average 280.30 red spider mites and 188.66 tea aphids during its larval period of development, which were 24.10 $\pm$ 0.77 and 21.70 $\pm$ 0.72 days, respectively. The regression between the age of grub and rate of consumption showed that the consumption by the predator at larval stage is highly correlated to its age. An adult predator consumed on an average of 20.32 $\pm$ 11.79 red spider mites per day and 35.9 $\pm$ 4.95 tea aphids per day. In both case, male individual consumed significantly less number of aphids as compared to the female.

Keywords: Coccinellid predators, bioefficacy, tea pests, crop protection

INTRODUCTION

Tea,*Camellia sinensis* (L.) *O. Kuntze* is grown as a major cash crop in India. The tea industry is one of the oldest organized industries in India. The coccinellid beetles known as ladybird beetles, have nearly 5000 species (Imms, 1977). They are of great economic importance as majority of them are predatory in nature. Their capacity to search and feed voraciously in both larval and adult stages on various crop pests namely aphids, mites and other soft bodied arthropods make them effective biocontrol agents (Kotwal *et al.*, 1984; Kim-Kyuchin *et al.*, 2000; Ara Begum *et al.*, 2002; Taleb and Sardar, 2007). So far pest control in tea is mainly achieved by the use of synthetic pesticides; but sole reliance on chemical protection has many limitations. Their prolonged and extensive use cause destruction of beneficial organism including natural predators, parasitoids and pollinators. It may further lead to development of resistance in insect pests, phytotoxicity, residue in tea dust and last but not the least the environ mental pollution (Luckman and Metcalf, 1975; Hazarika *et al.*, 2009). Various international organizations like the Environmental Protection Agency (EPA), Codex Alimentarius Commission, Commission of European Comm unities (CEC), and Food and Agricultural Organization (FAO) have established the Maximum Residue Limits (MRL) for different pesticides on tea (Muraleedharan *et al.*, 2001, Gurusubramanian *et al.*, 2008a). So, from export point of view, international regulations of pesticide residues need to be complied with and that in turn would help to take care of the environmental and health hazards due to pesticidal pollution. The importance of insect natural enemies (predators and parasitoids) as biocontrol agents are much appreciated since they control many crop pests by keeping the pest population at low levels. In recent times, naturally occurring biocontrol agents are more preferred than introduction of exotic predators and parasitoids for better efficacy and to avoid ecological problems (Brader, 1980).

In this regard, the predacious Ladybird beetles are of great help in effecting biological control of the tea pest as many of them feed on different tea pests (Muraleedharan *et al.* 2001). Before planning to conserve and use the predatory coccinellid beetles in an agero-ecosystem, it is essential to have a through knowledge of the number of available species, relative abundance in relation to crop age and seasons. The present work aime to recorded the richness, life cycle and reproductive traits of the dominant coccinellid predator, *Micraspis discolor* (F) on red spider mite, *Oligonychus coffeae* Neitner (Acarina:

Tetranychidae) and tea aphid, *Toxoptera aurantii* Boyer de Fons (Homoptera: Aphidae).

MATERIALS AND METHODS

Species richness of Coccinellid predators

The detailed study on the documentation of coccinellid predators in the tea ecosystems in the Darjeeling foothills and plains of Sub Himalayan North Bengal region was conducted for two years from 2004-2006. For this purpose, five tea estates were selected from three different sites located in the Dooars, Terai and Darjeeling hills. The survey was conducted twice in a month. Block of the size 50 x 50 ft in three replications was marked in all the selected tea estates for random sampling. The crops were maintained following the recommended agronomic practice except insecticidal application either on foliage or in soil. The coccinellids were sampled by using D- Vac suction sampler (for 10 minutes duration in each block) and the collected specimens were preserved in 70% alcohol and got identified. The data pertaining to grubs were pooled, while separate counts of adults of common species were made but pooled for those occurring less frequently. The relative abundance in percentage of different coccinellids on tea was determined by following the method of Ambasht (1990).

Relation between red spider mite and tea aphid population

Three separate sections each measuring (10m x 10m) were considered as three replications. The experimental area was kept free from any chemical plant protection measure. Fortnightly samples of most dominant species of *Micrapis discolor* was done randomly along with the population of *O. coffeae* and *T. aurantii* following methods of Das (1959) and Irwin (1980). The relationship between these two pests and the predator was determined separately by using simple regression equation.

Predatory potential and feeding preference of *M. discolor*

Studies on feeding capacity and life cycle traits of the dominant coccinellid predator *M. discolor* were estimated in laboratory condition (25-30 ^{0}C and 70- 80% RH) by following Ara Begam *et al.* (2002) method. Freshly hatched individual grubs and adult of *M. discolor* were provided with known number of preys (either red spider mite or aphids) daily on fresh tea shoots/ leaves in plastic jar (6x6 cm) with perforated lids fitted with small piece of cloth. There were at least five replications per prey. The number of preys consumed by each instar and adult was recorded daily to determine the predatory potentiality under conditions of abundant supply of prey. Ten individuals of the predator were observed for determining the duration of each life stage in both treatments (culture on red spider mite / aphids). Feeding of *M. discolor* was observed in choice and no choice condition following the methods of Ara Begam *et al.* (2002) using red spider mite and aphid prey together and separately.

RESULT AND DISCUSSION

Richness and abundance of Coccinellid predators and their preys

Twenty species of coccinellids namely, *Coclophora sexareata*, *Colophora unicolor*, *Les dimidiate*, *Coccinella septempunctata*, *Menochilus sexmaculatus* , *Jauravia quadrinata*, *Crytogonus quardriguttatus*, *Oenopia kirbyi*, *Oenopia luteopustulata*, *Oenopia sexareata*, *Micrapis discolor*, *Afidentula mandertiernae*, *Callineda sedecemnotata*, *Henospilachna septima*, *Stethorus gilviforn*, *Chilocorus circumdatus*, *Coccinella repanda*, *Coccinella transversalis*, *Aspidimerus circumflexa*, and *Ola* sp., were recorded from tea plantations. Among them, *M. discolor* was the most abundant species (42.5 per cent) followed by

Table 1. Developmental period (in days) and predatory rate of *M. discolor* under no choice test.

Life stages of *Micraspis discolor*	Tea aphid		Red Spider Mite	
	Duration (days)	Average no. of prey consumption	Duration (days)	Average no. of prey consumption
1st instar grub	3.40* ± 0.22	17.84 ± 0.36	3.90 ± 0.23	37.80 ± 3.23
2nd instar grub	3.30 ± 0.15	33.60 ± 1.87	4.10 ± 0.35	62.00 ± 2.76
3rd instar grub	4.20 ± 0.36	66.32 ± 4.21	5.00 ± 0.42	94.30 ± 10.33
4th instar grub	3.70 ± 0.33	70.90 ± 2.34	3.90 ± 0.31	86.20 ± 10.35
Total grub period	17.50 ± 0.65	188.66 ± 3.34	19.60 ± 0.75	280.30 ± 16.75
Pupa	4.20 ± 0.13	-	4.50 ± 0.13	-
Total development period from egg to adult	21.70 ± 0.72	188.66 ± 3.34	24.10 ± 0.77	280.30 ± 16.75
Male beetle longevity	22.70 ± 0.97	629.70 ± 31.13	21.60 ± 1.13	139.30 ± 7.25
Female beetle longevity	36.80 ± 2.80	1287.50 ± 98.33	34.80 ± 2.77	547.70 ± 36.87

C. septempunctata and *M. sexmaculatus*. A overwhelming diversity of lady bird beetles in tea ecosystem may be due to the complex and stable ecosystem of tea plantations. Tea plants are perennial and evergreen with leaves stratified in 2-3 layers. The bush below the plucking surface is very important as a refuge for natural enemies (Muraleedharan *et al.,* 2001) because of very low quantity of spraying chemical reaching this tier. The abundance of coccinellid population in the tea plantations may possibly be due to variety/stages and abundance of prey/pest species. Therefore, the biodiversity plays a major role in sustainability and healthy functioning of the ecosystem (Speight *et al.,* 1999), through prey-predator interactions. Population abundance of both pests (red spider mite and aphid) and the predators (*Micraspis discolor*) reached peak during the month of January to March. During April to October, these three populations were lowest in the tea plantation of Darjeeling foothills and plains (Fig.1). Population abundance of red spider mite and aphid population with the population trends of *M. discolor* indicated a positive correlation with each other ($r^2 = 0.75$ and 0.89 for red spider mite and aphid, respectively. The present observation is corroborated with earlier observation of Das (1965), and Gurusubramanian *et al*. (2008b) from tea plantation of North East India. Agarwala *et al.,* (1988) also reported the population abundance of *M. discolor* in the aphid infested crop fields of North-East India. It was also added that population began to decline from February and become very low between April to June. The findings of present study are more or less in agreement with their observations on the mustard fields.

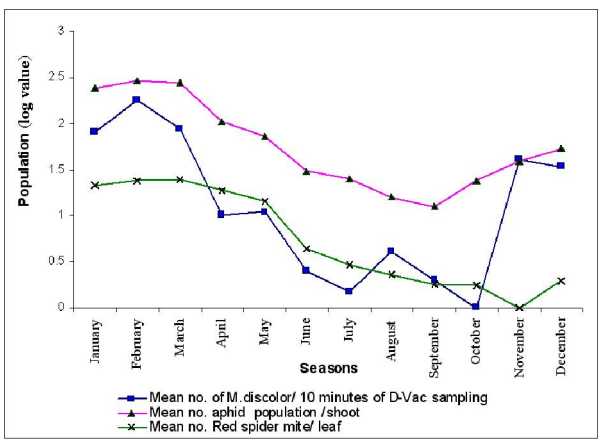

Figure 1. Populations of *Micraspis discolor*, *Oligonychus coffeae* and *Toxoptera aurantii* in tea plantation of Darjeeling foothills (Ordinate represents the log values of the populations)

Predatory potential and feeding preference of *M. discolor*

The food preference of *M.discolor* was studied by offering an equal number of both the preys. In choice test, between the mixed population, the adult (11.2 ± 1.24 and 29.2 ± 1.87 for red spider mit and aphid, respectively) and grubs (6.2 ± 1.39 and 16.6 ± 1.43 for rsm and aphid respectively) of *M. discolor* preferred aphid than red spider mite. This may be governed by the frequency of prey encountered (Hassel, 1978) as aphid colonies are more sessile than the tiny motile red spider mite (Sabelis, 1992).

In no choice test the average consumption of aphid and red spider mite separately by grubs and adult of *M. discolor* revealed that the predator voraciously ate on tea aphids. Developmental periods of different stadium showed different trends on the prey species. The life cycle studies suggested that although tea aphid was the preferred prey for *M. discolors*, the predator can survive on red spider mite also. The studies on feeding potential indicated that the grubs of *M. discolor* consumed on an average 280.30 red spider mites and 188.66 tea aphids during its larval period of development. An adult male coccinellid on an average consumed 139.30 red spider mites and 629.70 tea aphids whereas female consumed 547.70 and 1287.50 respectively. In both cases, male individual consumed significantly less number of aphids as compared to the female. Results of Islam and Nasiruddin (1978), Prodhan *et al.* (1995) and Ara Begum *et al.* (2002) supported the present observation on the biology of *M. discolor*.

Keeping in view the proportion of *M. discolor* in the field and its feeding capacity, it could be concluded that this species might be contributing largely to suppress aphid and partly red spider mite pests in tea plantation and more in the organic plantations of Darjeeling foothills and plains of North Bengal, India.

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