J. Biol. Control, 22(1): 155-161, 2008

Tobacco type mediated effects on the development of pink aphid, *Myzus nicotianae* Blackman and its predator, *Chrysoperla carnea* (Stephen) (Neuroptera: Chrysopidae)

S. GUNNESWARA RAO, P. VENKATESWARLU, J. V. PRASAD, K. SIVA RAJU, S. P. SINGH and P. K. NAIK

Central Tobacco Research Institute, Rajahmundry – 533105, Andhra Pradesh, India.

E-mail: gunneswararaos@yahoo.co.in

ABSTRACT: The present study revealed that fecundity of tobacco aphid, *Myzus nicotianae* Blackman was highest on *Lanka* type (37.8 ± 7.5) and lowest on *Nicotiana rustica* (7.0±2.5). *Chrysoperla carnea* consumed 71.20 aphids / larva on Flue cured Virginia tobacco and 58 aphids on Burley type. Highest per cent pupation was observed on *Beedi* type (88%). Fecundity of *Chrysoperla* was the highest when it fed on aphids on cigar wrapper tobacco (291 eggs / female), followed by *Lanka* (287 eggs / female). The fecundity was lowest (114 eggs) when aphids on aromatic tobacco were consumed. Fecundity when fed on *Corcyra* eggs was least (220 eggs). FCV tobacco was most favored for oviposition by *Chrysoperla* (25 eggs / plant) and *beedi* and aromatic types were least preferred. On all tobacco types, when the larvae of the predator were released 63 to 92% reduction in aphid population was achieved. The nutritional profile of the aphids on the most favored tobacco type, *Lanka*, revealed that sugars and proteins / 100g dry weight of aphids were 3.6 and 7.20 compared to 2.88 and 6.20, respectively, on aphids on aromatic types, which were less suitable as food. Prospects of utilizing host plant genetic diversity in tritrophic interactions for effective management of sucking pests are discussed.

KEY WORDS: *Chrysoperla carnea*, *Myzus nicotianae*, tobacco type

INTRODUCTION

The pink aphid, *Myzus nicotianae* Blackman, is resistant to many insecticides, and the resistance mechanism is presumed to be permanent (Harlow and Lampert, 1990). In India, *Brinckochrysa scelestes* (Banks) and *Mallada boninensis* (Okamoto) were recorded as predators of tobacco aphids (Rao *et al.*, 1981; Rao and Chandra, 1984). *Chrysoperla scelestes* was utilized in augmentative biocontrol experiments against *M. persicae* (Rao and Chandra, 1984) and *Chrysoperla carnea* on *M. nicotianae* (Gunneswara Rao and Rao, 1995) in tobacco. The physical and chemical characters of tobacco leaves affect the amount of predation and parasitization of tobacco pests (Obrycki, 1986) and the nutritional quality of insect food may also affect the entomophagous insects that feed on it (Price, 1986). Keeping these aspects in mind, the present study was conducted in laboratory and net house conditions under ICAR *ad-hoc* scheme during 1998-2002 with an objective of determining the tritrophic relations involving tobacco types, tobacco aphid (*M. nicotianae)* and its predator, *C. carnea*. The study aims to understand the biology of the predator, *C. carnea* when reared on *M. nicotianae*

infesting different tobacco types and also to understand the ovipositional response and foraging ability of *C. carnea* on aphids infesting different tobacco types.

MATERIALS AND METHODS

Myzus nicotianae was initially maintained on *Lanka* tobacco (var. DR-1), a highly susceptible tobacco type, in pot culture. The aphids were inoculated on different types of tobacco plants in net house and were utilized for the experiments. The tobacco types tested in the experiment were *N. rustica* (Badami local), Burley (Banket A1), Cigar wrapper (Dixie shade), *Lanka* (DR-1), DWFC (dark western fire cured tobacco), *Beedi* (GT-4), Flue cured Virginia (J-6), Flue cured Virginia (Kanchan), *Beedi* (Kumkumadri), Burley (Lonibow), and Aromatic (Samsun). *Corcyra cephalonica* eggs were used as control.

Development of *M. nicotianae*

Development of *M. nicotianae* was observed by rearing a fully developed adult aphid on a bit of tobacco leaf kept in ventilated plastic boxes for progeny production in a BOD incubator at 27 ± 5°C and 70% R.H. with 11: 13LD phase by auto illumination. Total number of aphids laid by each adult in its lifetime was recorded for each treatment by counting the number of nymphs produced each day and replacing the tobacco leaf material as and when necessary. Three sets of each tobacco type were maintained.

Biology of *C. carnea*

The aphids were collected from colonies maintained in the net house on different types of tobacco and utilized for rearing of *C. carnea* obtained from laboratory culture. Neonate larvae were reared on *C. cephalonica* eggs for one day and from second day onwards the larvae were offered aphids. Larvae were reared individually in homeopathy glass vials and plastic louvers. Five replications were maintained with five larvae for each replication.

Ovipositional response and foraging efficiency of *C. carnea* on aphid infested tobacco types

Two plants of each tobacco type per pot were transplanted in three sets and 50 days later, *M. nicotianae* @ 50 adults per plant were released on top leaves. Two weeks later, when the aphid infestation spread downwards and secretion of honeydew was noticed, *C. carnea* adults previously reared on *M. nicotianae* for one generation were released (20 pairs) into a nylon net that covered the plants. Twenty-four hours after the release of *C. carnea* adults, observations were recorded daily on number of eggs per plant on the top, middle and bottom leaves.

The tobacco types selected for ovipositional response were grown in pots as a separate set and when they were 50 days old, *M. nicotianae* were released on the top leaves @ 50 apterous adult aphids per plant. Eight days later, all the aphids on each plant were physically counted and *C. carnea* (late second instar) @ 5 larvae per plant were released on the top leaves and confined in nylon mesh. Ten days later, number of aphids and number of cocoons of *C. carnea* recovered were recorded.

RESULTS AND DISCUSSION

The aphids that fed on *Lanka* (DR-1) tobacco produced the highest number of nymphs, followed by those that fed on *Beedi* (GT-4, Kumkumadri) and FCV (Kanchan). On the FCV variety J-6, cigar wrapper (Dixie shade) and Burley (Banket A1 and Lonibow), the aphid fecundity was much lower. The lowest fecundity was noticed on *N. rustica* (Badami local) followed by aromatic (Samsun) and DWFC (Table. 1).

Feeding potential of *C. carnea* was affected by type of tobacco. Feeding was highest on aphids derived from FCV variety, J-6 (71.20 aphids/day), followed by those obtained from *N. rustica* (69.40/day), DWFC (65.80 / day) and *Lanka* (62.20 / day) with no significant differences among them. The consumption by *C. carnea* was inferior when aphids from aromatic and burley types were offered. Aphids from all the tobacco types were preferred to *Corcyra* eggs (Table 2). Larval period of *C.*

Table 1. Mean number of *Myzus nicotianae* produced on different types of tobacco

Tobacco types	Mean number of nymphs produced
N.rustica (Badami local)	2.80 (7.00)
Beedi (Kumkumadri)	3.85 (14.30)
DWFC	4.07 (16.73)
Beedi (GT4)	6.20 (37.80)
FCV (Kanchan)	3.16 (10.00)
Cigar wrapper (Dixie shade)	5.38 (28.00)
Burley (Lonibow)	4.28 (17.51)
Burley (Blanket A1)	4.87 (22.99)
Aromatic (Samsun)	5.07 (25.33)
FCV (J6)	3.19 (10.00)
Lanka (DR1)	3.53 (11.64)
CV%	17.17
SEM±	0.4186
LSD (P = 0.05)	1.23

* Figures in parentheses are original treatment means

carnea was longer on *Corcyra* eggs (8.56 days) and on aphids obtained from FCV variety Kanchan (8.20 days) while it was shortest (7.32 days) on aromatic type (Samsun) aphids. Significantly shorter larval period (7.64 to 8.00 days) was observed when the predator fed on aphids from *N.rustica* (Badami local), cigar wrapper (Dixie shade), *Lanka* (DR 1) and DWFC. Highest % pupation was observed when *C. carnea* was fed aphids from *Beedi* variety Kumkumadri (88.0) and lowest on aphids from the FCV variety J 6 (56.0). Pupal period was longest on *C. cephalonica* eggs (7.56 days). Pupal period was significantly longer when reared on aphids from FCV (Kanchan), *Beedi* (GT 4), DWFC and *N. rustica* (Badami local). Significantly shorter pupal period was observed when *C. carnea* was reared on aphids from rest of the tobacco types and it ranged from 5.40 to 5.88 days. Lowest pupal period was observed on DWFC and *Beedi type* (Kumkumadri). The per cent adult emergence was affected when *C. carnea* was reared on FCV (J 6 and Kanchan) and Aromatic (Samsun) tobacco types. The fecundity of *C. carnea* was highest (291 eggs) when it fed on aphids from cigar wrapper type (Dixie shade), followed by aphids on *Lanka* (DR 1 and Kumkumadri). The fecundity ranged from 203 to 226 eggs when aphids from *Beedi* (GT 4), DWFC and FCV (Kanchan) types were consumed. Much lower number of eggs were laid by the predator when it developed on aphids from *N. rustica* (Badami local), Aromatic (Samsun) and Burley (Lonibow) (114 to 151).

Ovipositional response

In a choice test when *C. carnea* adults were exposed to aphid infested tobacco types, the differences in oviposition were significant. Highest numbers of 25.44 eggs per plant were laid on FCV (J 6), which was significantly superior to the rest of the types screened. On Burley (Lonibow) and *Lanka* (DR 1), 10.26 and 5.57 eggs were laid, respectively, which significantly differed but inferior to FCV (J-6). Burley type variety Banket A1 and cigar wrapper (Dixie shade), though not differing in their ovipositional attractiveness, were inferior to *Lanka* (DR 1). *Beedi* variety GT 4

and DWFC similarly attracted *C. carnea* oviposition, but were much inferior to burley (Banket A 1) and cigar wrapper (Dixie shade). *N. rustica* (Badami local) was least preferred by the predator. FCV variety Jayasree and Aromatic type (Samsun) were totally rejected for oviposition (Table 3).

In caged condition, foraging ability of *C.carnea* larvae was not affected by tobacco types.

Table 2. Biology of *C. carnea* on *M. nicotianae* from different tobacco types

Tobacco types	No. of aphids consumed	Larval period (Days)	Pupal period (Days)	Per cent Pupation	Per cent emergence	Fecundity Per female
Badami local	69.40	8.00	6.00	60.00	84.32	148.40
Kumkumadri	60.60	7.52	5.40	88.00	88.00	262.60
DWFC	65.80	7.88	5.40	44.00	100.0	203.00
GT4	57.80	7.52	6.28	76.00	100.0	222.60
DR1	62.20	7.92	5.44	80.00	82.00	287.00
Kanchan	52.00	8.20	6.36	72.00	64.64	226.00
Dixieshade	57.80	8.00	5.84	76.00	96.00	291.00
Samsun	60.00	7.32	5.88	64.00	65.32	124.80
Lonibow	58.00	7.52	5.56	72.00	91.00	114.80
J6	71.20	7.64	5.56	56,00	76.64	151.80
Corcyra	44.60	8.56	7.56	80.00	79.32	220.20
SEM±	3.69	0.13	0.12	11.54	7.72	18.55
LSD (P = 0.05)	10.23	0.36	0.35	0.00	21.40	51.41

Table 3. Oviposition response of *C. carnea* on different tobacco types

Tobacco types	Number of eggs laid / plant / female
Burley (Banket A1)	5.00 (4.64)
DWFC	2.33 (2.31)
Cigar wrapper (Dixie shade)	4.33 (4.17)
Burley (Lonibow)	10.33 (10.26)
FCV (J6)	25.66 (25.44)
Beedi (GT4)	2.00 (2.00)
Aromatic (Samsun)	0.00 (0.00)
FCV (Kanchan)	0.66 (0.54)
*N.*rustica (Badami local)	0.66 (0.54)
FCV (Jayasri)	0.00 (0.00)
Lanka (*Lanka* special)	6.00 (5.57)
SEM±	0.256
LSD (P = 0.05)	0.74

* Figures in parentheses are transformed values.

Table 4. Foraging efficiency of *C. carnea* larvae on different tobacco types

Treatments	Mean no. of aphids at *Chrysoperla* inoculation	Mean no. of aphids 8 days after inoculation	% reduction of aphids
Kanchan	9.24 (84.55)	5.46 (28.88)	54.24 (65.87)
Dixie shade	8.25 (67.21)	5.06 (24.77)	52.52 (62.92)
DR1	11.15 (123.44)	3.55 (11.77)	72.10 (90.41)
DWFC	8.52 (71.66)	5.29 (27.21)	51.86 (61.77)
GT4	8.32 (68.33)	4.91 (23.44)	54.38 (66.03)
J6	9.62 (91.77)	5.88 (33.88)	52.75 (63.38)
Jayasri	9.56 (90.66)	5.45 (28.89)	55.65 (68.19)
Kanchan	9.22 (84.33)	5.46 (28.88)	53.91 (65.32)
Kumkumadri	8.82 (76.89)	5.72 (31.89)	49.99 (58.69)
Lonibow	8.76 (75.77)	5.16 (25.89)	54.35 (66.07)
Samsun	6.61 (42.89)	4.08 (15.88)	52.75 (63.41)
SEM±	0.214	0.19	1.496
LSD (P = 0.05)	0.634	0.564	4.415
CV%	4.17	6.50	4.72

* Figures in parentheses are transformed values.

Highest reduction of aphid population (92%) 15 days after release of the larvae was noticed on *Lanka* special. On other tobacco types, the reduction ranged from 63 to 69%. Cocoons of *C. carnea* were also successfully recovered from all the tobacco types (Table 4). Biochemical analysis of aphids on certain tobacco types revealed that aphids on *Lanka* tobacco contained 3.60mg of sugars and 7.20mg of proteins per 100g dry weight. Aphids on *Rustica* or Aromatic types (Samsun) contained 2.88 and 6.20mg of sugars and proteins per 100 g dry weight, respectively.

The results of our study when viewed from the perspective of fitness of the prey developed on different types of tobacco revealed that aphids developed on Dixie shade, DR 1 and Kumkumadri were highly suitable. The aphids that developed on DWFC, GT 4 and Kanchan were moderately suitable and those that developed on J 6, Badami local, Samsun and Lonibow were least suitable for *C. carnea* reproduction. The tobacco types involved in the experiment are diverse in their physical (trichome density, plant architecture and size) and chemical attributes (toxins, nicotine and reducing sugars), which might have a bearing on the performance of the predator.

The differences in aphid fecundity in tobacco types involved in our study may not be due to nicotine levels but certain other plant attributes might be responsible. Mittler (1967) determined that both sugar and amino acids are necessary for prolonged feeding by *M. persicae* and the phloem of tobacco contains such a mixture. Aphids feeding on tobacco are affected by the nutritional quality of the plant as well. Michel and Chouteau (1963) found higher fecundities in aphids feeding on plants with increased potassium levels whereas increased nitrogen levels lowered fecundity. Tobacco types differ both in potassium uptake and aphid infestation. The infestation of aphids on DWFC line (Virginia 309) was found to be lower compared to Flue Cured Virginia (FCV) types (Semtner, 2005). The performance of tobacco aphids on certain oriental tobaccos was better than on FCV types and trichome density and level of reducing sugars were significantly negatively correlated with time of development and intrinsic rate of increase of tobacco aphids (Goundoudaki *et al.*, 2003).

Consumption of aphids by *C.carnea* was related to the protein and sugar content of the aphids that fed on these types than on nicotine content of the host plant as it was not found in aphids.

The ovipositional behaviour of adult insects can have a major impact on the survival of their offspring. In the present study, *C. carnea* oviposited heavily on aphid infested J 6. The chemical composition of honeydew from aphids feeding on tobacco has not been determined (Jackson, 1989). Artificial honeydew attractive to *C. carnea* oviposition was a tryptophan degradation product and indole acetaldehyde (Hagen *et al.*, 1976). Airborne olfactory cues from *Nicotiana noctiflora* seemed to have an arresting influence on *Cardiochiles nigriceps* Viereck as they were observed in large numbers in a typical resting position on this plant in the absence of any host (Jackson *et al.*, 1989). On *Rustica* tobacco, ovipostion was very poor. *Rustica* had high amount of leaf surface waxes (225mg /cm^2), which may be responsible for difficulty in gluing the stalked eggs by the predator to the leaf surface. In the rest of the tobacco types, *C. carnea* preferred *Lanka* special which contained only 42mg / cm^2 of leaf surface waxes. Foraging efficiency of *C. carnea* larvae was not impeded by leaf surface in any of the tobacco types examined and the reduction in aphid densities was remarkably high in *Lanka* special, a variety with low amount of leaf surface waxes and lesser number of glandular trichomes. The results suggest the potential importance of the host plant in mediating the insect–carnivore interactions directly or indirectly via the insect herbivore. Future research either in biological suppression or resistance breeding should not ignore those plant attributes, which are mutually beneficial for the host plant and the third trophic level, the predator or parasitoid.

ACKNOWLEDGEMENTS

We sincerely acknowledge the support and guidance given by Dr. V. Krishnamurthy, Acting Director, CTRI, Rajahmundry, and also the encouragement and support given by Dr. K. D. Singh, Ex. Director, CTRI. We thank Dr. C. A. Raju, Head of the Division, Crop Protection for his valuable suggestions during the course of the study.

REFERENCES

Cohen, C. and Brummett, D. L. 1997. The non-abundant nutrient (NAN) concept as a determinant of predator-prey fitness. *Entomophaga,* **42**: 85-92.

Goundaoudaki, S, Tsitsipis, J. A., Margaritopoulos, J. I., Zarpas, K. D. and Divanidis, S. 2003. Performance of the tobacco aphid *Myzus persicae* (Hemiptera: Aphididae) on Oriental and Virginia tobacco varieties. *Agriculture and Forest Entomology*, **5**: 285.

Gunneswara Rao, S. and Rao, R. S. N. 1995. Efficacy of *Chrysoperla carnea* Stephen against *Myzus nicotianae.* p.39. In: *Proceedings of Tobacco symposium, Feb.1-3, 1995.* Indian Society of Tobacco Science, Rajahmundry, India.

Guthrie, F. E., Campbell, W. V and Baron, R. L 1962. Feeding sites of green peach aphid with respect to its adaptation to tobacco. *Annals of Entomological Society of America*, **55**: 42-46.

Hagen, K. S., Greany, P., Sewall Jr. and Tassan, R. L. 1976. Tryptophan in artificial honey dew as a source of an attractant for adult *Chrysopa carnea. Environmental Entomology,* **5**: 458-463.

Harlow, L. D and Lampert, E. P. 1990. Resistant mechanism in the two color forms of tobacco aphids. *Journal of Economic Entomology*, **83**: 2130-2135.

Jackson, D. M., Severson, R. F. and Johnson, A. W. 1989. Effect of natural tobacco constituents on insect survival, development and behaviour. *Recent Advances in Tobacco Science*, **15**: 26-116.

Mittler, T. E. 1967. Effect of amino acid and sugar concentrations on the food uptake of the aphid *Myzus persicae. Entomologia Experimentalis et Applicata*, **10**: 39-51.

Obrycki, J. J. 1986. The influence of foliar pubescence on entomophagous species, pp 61-83. In: D. J. Boethel and R. D. Eikenhary (Eds.). *Interactions of plant resistance and parasitoids and predators of insects*. Ellis Horwood, West Sussex, UK.

Price, P. N. 1986. Ecological aspects of host plant resistance and biological control : Interactions among three tri-trophic levels, pp. 11-30. In: Boethel, D. J. and Eikenhary, R. D. (Eds.), *Interactions of Plant Resistance and Parasitoids and Predators of Insects.* Ellis Horwood, West Sussex, UK.

Rao, R. S. N., Satyanarayana, S. V. V. and Soundararajan, R. 1981. Note on new additions to the natural enemies of *Spodoptera litura* F. and *Myzus persicae* Sulz. on FCV tobacco in Andhra Pradesh. *Science and Culture*, **47**: 98-99.

Rao, R. S. N. and Chandra, I. J. 1984. *Brinckochrysa scelestes* Banks as a predator on *Myzus persicae* Sulz. on tobacco. *Entomophaga*, **29**: 283-285.

Reddy, G. V. P., Tabone, E. and Smith, M. J. 2004. Mediation of host selection and oviposition behaviour in the diamondback moth, *Plutella xylostella* and its predator, *Chrysoperla carnea* by chemical cues from cole crops. *Biological Control*, **29**: 270-277.

Semtner, P. J. 2005. The Virginia integrated pest management programme: IPM on tobacco (Online), 34-36, www.virginiatech.com.

University of Agricultural Sciences, Dharwad, 1995. Annual Report, pp. 192.

(Received: 15.10.2007; Revised: 06.12.2007; Accepted: 10.01.2008)