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Tobacco cultivar and type mediated effects on the population of aphid parasitoid, *Aphidius* sp. (Hymenoptera: Aphidiinae) and predator, *Cheilomenes sexmaculata* (Fabricius) (Coleoptera: Coccinellidae)

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ABSTRACT: During 1998-2002, three experiments were conducted under net house conditions to determine the tritrophic interactions involving certain tobacco varieties, aphid, *Myzus nicotianae* and the aphidophagous species, *Aphidius* sp. and *Cheilomenes sexmaculata*. The results revealed that *C. sexmaculata* population on tobacco cultivars, CM-12 with dark cast leaf character and VT-1158 with open type leaf character, was higher than in Gouthami with semi-erect and light cast leaf character and Jayasri (erect type). Among the tobacco types, *Lanka* special (cheroot) followed by Kumkumadri (beedi) were more attractive to the beetle than Badami local (*rustica*) and Samsun (Aromatic). Highest amount of leaf surface waxes detrimental to movement of coccinellids was observed in *rustica* tobacco (225$\mu g/cm^2$) and the lowest in *Lanka* special (42$\mu g/cm^2$). It was also observed that nutritional status of aphids fed on *Lanka* tobacco was superior to those fed on least preferred varieties. In the case of *Aphidius* sp. parasitization involving different tobacco types, significant differences were not observed at top leaf position. In the middle leaf position, highest percent parasitization (80.40) was noticed in variety Kanchan followed by Samsun (70.00) and DR-1 Lanka (69.54). Except in varieties GT-4 and Kumkumadri (beedi), higher parasitization on bottom leaves was recorded in the rest. The opportunities for utilizing genetic diversity in crop plants for enhancing natural enemy activity are elucidated.

KEY WORDS: *Aphidius* sp., *Cheilomenes sexmaculata*, *Nicotiana rustica*, *Nicotiana tabacum*, tritrophic interactions

INTRODUCTION

The green peach aphid, *Myzus persicae* (Sulzer) and the pink aphid, *Myzus nicotianae* (Blackman) are major pests of tobacco which debilitate the plant by sucking the sap and retard the growth. The sooty mold that develops on the honeydew secretion of the aphids spoils the quality of cured tobacco. The loss in cured-leaf yield during epidemic years was estimated as 32.55 per cent (Chari *et al.*, 1993). *Aphelinus* sp. (parasitoid), *Syrphophagus aphidivorus* (Meyr, 1976) and *Liocyrtus aphidivorus* Shafee (endohyper parasitoids) were recorded in Andhra Pradesh. *Aphelinus* sp. caused 60-100 per cent parasitisation in laboratory (Rao *et al.*, 1984). Joshi *et al.* (1979) recorded *Cheilomenes sexmaculata* (Fabricius) as an important predator of *M. persicae*. Jayaramaiah *et al.* (1996) studied the feeding potential of *C. sexmaculata* and *Coccinella tranversalis* Fabricius on *M. nicotianae* and found that the two predators were efficient bio-control agents of the aphids. Parasitisation by *Aphidius* sp. were not recorded in this region on tobacco. Studies on the host plant interactions in understanding the ecology of insect pests and their natural enemies were considered as a research gap and the Indian Council of Agricultural Research sanctioned a network project on the implications of tri-trophic interactions in IPM of important crop pests with Central Tobacco Research Institute, Rajahmundry, as one of the centers. Under this scheme, studies were carried out during 1998-2002 to identify suitable host plants which promote natural enemy activity. Three experiments were conducted to evaluate the influence of tobacco cultivars and types having compact / open architecture, dark/ light green leaf colour, varying leaf morphology and chemistry on the population of aphidophagous *Aphidius* sp. and *C. sexmaculata*.

MATERIALS AND METHODS

Interaction between tobacco cultivars and activity of *Cheilomenes sexmaculata*

Tobacco cultivars, namely Jayasree (Erect type), Gowthami (Semi-erect type), VT-1158 (Open type) and CM-12 (Dark cast) were raised as single plants in each pot @ 5 pots per variety. The pots were completely randomized and all extraneous insects were removed and the pots were kept in a 10 mm transparent nylon mesh. When the plants were 50 days old, pink aphids @ 10 nymphs /plant were released on the top of the tobacco plants. After initial honeydew formation on leaves, freshly emerged *C. sexmaculata* adults from laboratory were released @ one pair for each plant. Supplementary nutrition in the form of honey solution (50%) was provided for the beetles. Observations were recorded daily on number of eggs, larvae, pupae and adults of the predator on the tobacco plants on top, middle and bottom leaves.

Tobacco type and *Cheilomenes sexmaculata* interactions

Seven tobacco plant types @ 5 plants for each type were raised and pink aphids were released @ 10 nymphs/ plant on the top leaf primordia when the plants were 50 days old. Freshly emerged *C. sexmaculata* from laboratory @ 2 pairs/ plant were released in the net house after noticing initial honey dew formation on the leaves. Observations were recorded daily from top, middle and bottom leaves (one each) on the number of eggs, larvae, pupae and adults of the predator.

Tobacco type and *Aphidius* sp. interactions

Aphidius species that emerged from tobacco pink aphids collected from experimental fields was reared in laboratory. At the time of honey dew formation the parasitoids were released @ 100/plant on artificially infested tobacco types raised in net house. The tobacco types raised were *Rustica* (Badami local), Burley (Banket A1 & Lonibow), FCV (Kanchan), Cheroot (*Lanka* spl.), Bidi (GT-4 & Kumkumadri), Turkish (Samsun) and Cigar Wrapper (Dixie shade). Observations were recorded on the per cent parasitization by *Aphidius* on top, middle and bottom leaves (one each) on all 5 plants per treatment. The experiments were carried out in a Completely Randomized Block Design.

RESULTS AND DISCUSSION

Interaction between tobacco cultivars and activity of *C. sexmaculata*

Among the tobacco cultivars, CM-12 and VT-1158 were preferred by *C. sexmaculata* as indicated by the presence of highest number of egg clusters, larvae and adults at top, middle or bottom leaves of the plants. The distribution of the predator in the crop canopy showed a marked preference for top leaves for oviposition, larval and adult foraging compared to lower leaves. Pupae were mostly observed underneath middle or bottom leaves.

The beetles preferred CM-12 and VT-1158 which are dark and medium cast with prostrate type leaves. *Harmonia axyridis* (Pallas), the Asian lady beetle, similarly exhibited greater orientation towards greener leaves and odours of aphids over short distances (Obata 1986, Hun and Chen, 2002). Idris *et al.* (2001) also reported that in chillies, varieties with prostrate plant architecture (MC-12) had higher population of aphids and coccinellids than chilli varieties with erect plant architecture. The retention of significantly higher number of egg clusters, larvae and adults on top leaves was a numerical response of the beetles for the prey (aphid) densities, which were inoculated there. In tobacco too, Athanassiou *et al.* (2003) observed that aphid colonization was higher on upper half of the tobacco plant than the lower. Jackson and Severson (1987) found that alkaloid (nicotine) levels were highest in bottom leaves decreasing upwards on the plant, which might be the reason for greater aphid densities on upper portion of the leaf. *C. sexmaculata* was found to respond maximally to increasing densities of *Aphis craccivora* and *M. persicae* on *Dolichos lab-lab* (Pervez and Omkar, 2005). Brenkey and Carlson (1944) also reported the presence of higher number of aphids *Brevicoryne brassicae* (L.) on brussel sprout with more open type leaf character than closed foliage varieties. Our experiment provided the choice of colour and compactness to the predator which showed greater preference to greener phenotypes with moderate compactness or preferably open type characters than erect or less green tobacco plants (Tables 1-4).

Table 1. Influence of tobacco cultivars on the population of *C. sexmaculata* on *M. nicotianae* infested tobacco plants

Cultivars	Egg clusters		
	Top leaves	Middle leaves	Bottom leaves
CM-12 (Dark cast)	5.88	4.90	4.20
VT-1158 (Open)	5.50	3.96	3.28
Jayasree	3.40	2.46	2.04
Gowthami (semi erect)	1.28	2.00	1.62
CD (P=0.05)	2.24	2.05	1.45
SEM ±	0.74	0.68	0.48

Table 2. Influence of tobacco cultivars on the population of *C. sexmaculata* on *M. nicotianae* infested tobacco plants

Cultivars	Egg clusters		
	Top leaves	Middle leaves	Bottom leaves
CM-12 (Dark cast)	13.66	18.01	21.66
VT-1158 (Open)	9.40	15.68	13.54
Jayasree	7.36	11.86	11.32
Gowthami (semi erect)	4.78	9.74	11.20
CD (P=0.05)	4.14	5.97	NS
SEM ±	1.38	1.99	3.41

Table 3. Influence of tobacco cultivars on the population of *C. sexmaculata* on *M. nicotianae* infested tobacco plants

Cultivars	Egg clusters		
	Top leaves	Middle leaves	Bottom leaves
CM-12 (Dark cast)	12.18	16.26	19.18
VT-1158 (Open)	8.30	15.20	14.65
Jayasree	6.02	10.89	11.24
Gowthami (semi erect)	3.82	7.80	9.72
CD (P=0.05)	3.69	5.20	NS
SEM ±	1.23	1.73	2.69

Table 4. Influence of tobacco cultivars on the population of *C. sexmaculata* on *M. nicotianae* infested tobacco plants

Cultivars	Egg clusters		
	Top leaves	Middle leaves	Bottom leaves
CM-12 (Dark cast)	10.52	7.04	3.36
VT-1158 (Open)	9.10	5.40	3.10
Jayasree	4.94	2.12	1.32
Gowthami (semi erect)	3.40	1.80	1.54
CD (P = 0.05)	3.59	1.79	1.51
SEM ±	1.19	0.59	0.50

Table 5. Influence of tobacco types on the population of *C. sexmaculata* on tobacco infested with *M. nicotianae*

Tobacco types	Egg clusters / leaf	Larvae / leaf	Pupae / leaf	Adults / leaf
Kumkumadri	42.40	143.20	86.60	17.60
Kanchan	31.80	57.00	37.20	15.80
DWFC	10.60	22.40	19.20	10.60
Banket A1	29.40	33.20	25.60	12.60
Samsun	13.00	23.80	14.60	7.40
Rustica	4.00	7.60	6.40	6.20
Lanka Special	43.20	146.00	89.40	17.80
CD (P=0.05)	5.01	15.90	19.38	3.89
SEM ±	1.71	5.44	6.64	1.34

Tobacco type and *C. sexmaculata* interactions

Oviposition and incidence of subsequent metamorphic stages of *C. sexmaculata* was significantly higher on *Lanka* special (Cheroot type) and Kumkumadri (bidi type) tobacco varieties (Table 5). Among the rest of the tobacco types larval incidence was higher in Kanchan (FCV type). Significantly lowest number of any life stage of the beetle was observed on Badami Local (*rustica* type) closely followed by Samsun (aromatic type). Biochemical analysis of aphids fed on Lanka tobacco type revealed the presence of higher amount of sugars (3.6 mg) and proteins (7.2 mg) per 100 mg dry weight of aphids than aphids derived from Samsun which had 2.88 mg of sugars and 6.20 mg of proteins. The nutritional value of aphids as prey was better on preferred varieties than on less attractive ones. In *Lanka* Special, the amount of leaf surface waxes was only 48μg / cm^2 compared to 225 μg / cm^2 in case of *rustica* tobacco which was least preferred by the beetle. Presence of low amount of epidermal wax is also an important determinant that affects the predator's searching ability (Shah, 1982). On cabbage varieties containing higher amounts of surface wax, coccinellid, *Hippodamia convergens* (Guerin-Meneville) was less efficient (Eigenbrode and Espelie, 1995). The experimental results prove that aphids (*M. nicotianae*) that feed on tobacco types with lower levels of leaf surface waxes and higher amounts of sugars and proteins are preferred by *C. sexmaculata*.

Interaction between tobacco type and *Aphidius* sp.

Parasitisation of aphids by *Aphidius* sp. at top leaf position in all the tobacco types was not significantly different (Table 6). Parasitisation was significantly higher

Table 6. Mean per cent parasitisation of *Myzus nicotianae* by *Aphidius* sp. on different tobacco types in nethouse

Tobacco types	Top leaves	Middle leaves	Bottom leaves
Samsun	26.11	70.0	74.99
Lonibow	36.74	35.91	70.00
Dixieshade	40.57	57.90	52.15
DR-1 (Lanka)	21.56	69.54	77.77
Kanchan	36.46	80.04	62.22
DWFC	20.37	32.71	51.94
GT-4	19.85	43.95	25.78
Kumkumadri	37.79	59.59	36.04
CD (P=0.05)	NS	23.44	30.27
SEM ±	11.79	7.82	10.09

in middle and bottom leaf positions than the upper leaf position in all the tobacco types. At middle leaf position, Kanchan supported significantly higher per cent parasitisation of the aphids followed by Samsun, DR-1 (Lanka), Kumkumadri and Dixieshade. Differences in degree of parasitization by aphids with respect to bottom leaf position were not significant among many of the tobacco types except in GT-4 and Kumkumadri. The parasitisation was high in bottom leaves of all the tobacco types with a maximum of 77.77 per cent in case of DR-1. It was a clear choice made by the parasitoid *Aphidius* sp. for aphids infesting leaves on the lower part of the plant than the upper parts. In a study on seasonal abundance of aphid parasitoids in tobacco (var. Mc Nair 944) in Greece, Kavallieratos *et al.* (2005) also similarly observed that number of mummified *M. persicae* by *Aphidius colemani* Viereck and *A. matricariae* Haliday were higher on leaves collected from the lower parts of the plants than on those from the upper parts. The reason for higher levels of parasitism on lower parts was presumably the preference for shady niches by *Aphidius* sp. and other alternative explanation is that parasitized aphids drop off from the feeding sites and mummified on lower leaves (Chow and Mackauer, 1999).

The overall conclusions made from the three experiments are that 1.tobacco plants differ significantly in their suitability for harbouring aphidophagous natural enemies, i.e., *C. sexmaculata* and *Aphidius* sp. 2.*C. sexmaculata* preferred greener and more open type plant character with lower levels of leaf surface waxes and sugar and protein rich aphids. 3.upper position of the plants were frequently foraged by the predator. *Aphidius* sp. preferred aphids on lower leaves for parasitisation. The future research priorities should concentrate on identifying plant characters suitable for enhancing natural enemy activity along with those limiting herbivory.

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