Research Paper :

Evaluation of eco-friendly management module in comparison with farmers practices against chilli sucking pests

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International Journal of Plant Protection (October, 2010), Vol. 3 No. 2 : 319-324

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SUMMARY

The field trial was conducted at Negamum, Coimbatore district to compare the eco-friendly and farmers practice. Eco-friendly practice includes plant growth promoting Rhizobacteria (PGPR), *Pseudomonas fluorescens* Migula, plant growth regulator, naphthalene acetic acid (NAA), neem oil and their combinations against chilli thrips, *Scirtothrips dorsalis* (Hood), green peach aphid, *Myzus persicae* (Sulzer) and chilli mite, *Polyphagotarsonemus latus* (Banks). The results revealed that application of *P. fluorescens* + NAA + neem oil resulted in effective control of chilli thrips, *Scirtothrips dorsalis* (Hood), green peach aphid, *Myzus persicae* (Sulzer) and chilli mite, *Polyphagotarsonemus latus* (Banks). The eco-friendly plot recorded the yield of 14,937 kg/ha with cost benefit ratio of 3.24 while farmers field recorded the yield of 14,330 kg/ha with cost benefit ratio of 3.64.

Key words :
Myzus persicae, Naphthalene Acetic Acid, neem oil *Polyphagotarsonemus latus, Pseudomonas fluorescens, Scirtothrips dorsalis*

Accepted : August, 2010

Chilli (*Capsicum annnuum* L.) is one of the important spice – cum-vegetable crops of high commercial value grown extensively in South India. India is the largest producer of chilli in the world contributing 25 per cent of the world production. The crop is attacked by various pests in all the stages of crop growth. The yield is affected mainly by the sucking pests like chilli thrips, *Scirtothrips dorsalis* (Hood), green peach aphid, *Myzus persicae* (Sulzer) and chilli mite, *Polyphagotarsonemus latus* (Banks), which affect the crop from nursery till harvest. The damage is resulted not only by desapping leading to crinkling and curling of leaves and loss of plant vigour, but also by the transmission of serious diseases like leaf curl and mosaic viruses (Abdul Kareem *et al*., 1977; Saivaraj *et al*., 1979).

Complete crinkling of leaves, stunting of the plant occurs in nursery itself due to the sucking pests which results in poor stand of the crop after transplanting and also the vitality of the plant is lost. So, any control measure to the crop starting from the nursery with a much prolonged effect will help the plant to be free from the sucking pests from the early stages onwards and thereby increase the yield of the crop. Farmers rely solely on the chemical insecticides for the management of pests of chilli because of easy adaptability, immediate and spectacular knockdown effects (Verma, 1989). Despite these credentials, continuous use of chemical insecticides found to be ecologically unsafe and indiscriminate use of insecticides has resulted in accumulation of pesticide residues in fruits, resurgence of secondary pests, mortality of predators and parasitoids and environmental pollution (Mahapatro and Gupta, 1998). There is a little time lag between treatment, harvest and consumption of chilli. The use of persistent insecticides acquires special concern on chilli, because it is a common vegetable cum spice in Indian dietary system. So, the increasing concern for environmental safety and global demand for pesticide residue free food has evoked interest of ecofriendly methods of pest management *viz*., plant growth promoting Rhizobacteria (*Pseudomonas fluorescens* Migula), plant growth regulator, naphthalene acetic acid (NAA) and the botanicals have been receiving considerable attention of scientific community as important components in integrated pest management.

MATERIALS AND METHODS

Efficacy of eco-friendly pest management module comprising application of *P. fluorescens*, PGR and neem oil in comparison with farmers conventional practices of applying chemical pesticides and untreated check were evaluated under field conditions at Negamum, Coimbatore district, Tamil Nadu during December 2005 – March 2006 on chilli hybrid (Bharat). Each module was tested in 0.4 ha area which kept apart 50m from each other. Each plot was equally divided into ten subplots and treated as replications.

Eco-friendly plot		
Treatments	Dose	Time of application
PGR - NAA (triacontanol)	1.25ppm	15 DAT*
PGPR - *P. fluorescens*	5g lit^{-1}	15 DAT
PGR - NAA (planofix)	10ppm	30 and 45 DAT
Neem oil 3%	30ml lit^{-1}	30 and 45 DAT
Yellow sticky traps	12 traps ha^{-1}	30 DAT

* DAT – Days after transplanting

Farmers plot		
Treatments	Dose	Time of application
dimethoate	2ml lit^{-1}	15 DAT
phosalone	2ml lit^{-1}	30 DAT
quinolphos	2ml lit^{-1}	45 DAT

Observations:

Sucking pests: The aphid, thrips and mite population was assessed from leaves representing the top, middle and bottom portion of the plant at 3DAS, 5DAS, 7DAS and 14DAS intervals. The number of nymphs and adults were counted from each leaf by using 10X lense. For each treatment, five randomly selected plants were sampled per replication.

Benefit cost ratio (BCR):

The yield of green chilli from each module was recorded and additional income obtained from eco-friendly module, farmer's practice over untreated check was worked out. The benefit cost ratio was arrived for all the treatments following procedure adopted by Akila and Sundara Babu (1994):

$$\mathbf{BCR} = \frac{\textbf{Gross income}}{\textbf{Total cost of cultivation + cost of treatment}}$$

Cost of treatment = Cost of material + labour charges for spraying or application

The data obtained from field experiments were analyzed with appropriate transformations. Critical different values were calculated at five per cent probability level and treatment mean values were compared using Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

The results of field trials on the evaluation of PGPR (*P. fluorescens*), PGR (NAA) and neem oil in comparison with farmers' practice of using chemical pesticides for the management of sucking pests of chilli are presented and discussed here under.

Aphids

In the first round of spray, the lowest population was recorded in eco-friendly plot (12.3/five plants). This was at par with farmers plot (14.5/five plants) on fifth day after treatment (Table 1), where as untreated check recorded highest population (27.3). In the second round of spray, the lowest population was recorded in eco-friendly plot (10.3 / five plants) on seventh day after treatment followed by farmers plot (16.4). In the third round of spray, the lowest population (4.6/five plants) was recorded in farmers plot on fourteenth day after spray. This was at par with eco-friendly plot (5.3). Compared to other two plots, untreated plot recorded highest population (10.4) on fourteenth day after spray.

Murugan *et al.* (2005) studied the bottom up and top down effect of induced resistance by PGPR, *P. fluorescens* in okra against insect pests. The application of PGPR, *P. fluorescens* (strain pf1) to seed, soil and plant has favoured the reduction in insect population *viz.,* leaf hoppers, *Amrasca biguttula biguttula* (Ishida) and aphid, *Aphis gossypii* (Glover) and fruit borer complex. Robinson (1959) reported that in broad bean plant (*Vicia faba* L.) root absorption of Maleic hydrazide (MH) caused both nymphal mortality and reduced fecundity of pea aphid, *Acyrthosiphon pisum* (Harris).

The application of talc formulation of *P. fluorescens* through seed, root, soil and foliar spray significantly reduced the leaf folder, *Cnaphalocrosis medinalis* (Guenee) incidence in rice under greenhouse and field conditions. Application of *P. fluorescens* in tomato and okra reduced the incidence and damage of leaf miner, *Liriomyza trifolii* (Burgass), whitefly, *B. tabaci* and also reduced the fecundity of *Helicoverpa armigera* (Murugan, 2003). Application of MH caused increased mortality of nymph and adults of aphid, *A. pisum* of broad bean (Robinson, 1959). Vanemden (1964) reported that cycocel reduced the population of *Brevicoryne brassicae* (L.) and *M. persicae* in Brussels sprouts. Synthetic liquid diets containing PGR, MH and cycocel cause high mortality to nymphs and reduced adult population of *A.*

Table 1 : Effect of eco-friendly/farmers practices in control of aphids, *M. persicae* on chilli

Treatments	*PTC	Mean population per five plants - Days after spraying**											
		I spray				II spray				III spray			
		3	5	7	14	3	5	7	14	3	5	7	14
Eco-friendly plot	27.8	16.8[b]	12.3[a]	18.8[a]	22.6[a]	14.6[b]	16.3[b]	10.3[a]	17.4[a]	9.2[a]	8.4[a]	6.2[a]	5.3[a]
		(4.16)	(3.58)	(4.39)	(4.81)	(3.89)	(4.10)	(3.29)	(4.23)	(3.11)	(2.98)	(2.59)	(2.41)
Farmers plot	27.4	13.4[a]	14.5[a]	16.7[a]	24.3[b]	11.4[a]	13.4[a]	16.4[b]	19.3[b]	9.4[a]	7.8[a]	5.7[a]	4.6[a]
		(3.73)	(3.87)	(4.15)	(4.98)	(3.45)	(3.73)	(4.11)	(4.45)	(3.15)	(2.88)	(2.49)	(2.26)
Untreated check	26.7	26.2[c]	27.3[b]	26.5[b]	24.5[b]	22.9[c]	20.3[c]	19.8[c]	21.4[c]	18.8[b]	15.1[b]	13.2[b]	10.4[b]
		(5.17)	(5.27)	(5.20)	(5.00)	(4.84)	(4.56)	(4.51)	(4.68)	(4.39)	(3.95)	(3.70)	(3.30)

* PTC - Pre-treatment count
** Mean of the seven replications
Figures in the parentheses are $\sqrt{x+0.5}$ transformed values
Means followed by common alphabets in a column are significantly not different (P=0.05) by DMRT.

pisum. Honeyborne (1969) stated that PGR treated broad bean plants affected the fecundity of aphids, *Aphis fabae* (Scop.) in chrysanthemum. Routine use of growth retardants indirectly reduced the survival rate of *M. persicae* (Worthing, 1969). Seed treatment and foliar application of PGR on okra recorded the lowest population of aphids, *A. gossypii* and reduced the incidence of *Earias vittella* (F.) (Mukundan, 1975).

Thrips:

The eco-friendly plot was noted to be superior in controlling thrips (5.8/five plants) on fifth day after spray in first round of spray, whereas in second and third rounds, farmers plot was effective followed by eco-friendly plot and recorded the lowest population of 5.8/five plants on seventh day after second round (Table 2). A similar trend was observed in third round of spray on seventh day after spray, where the eco-friendly plot was at par with farmers plot. At the end of three sprays, the observations indicated that eco-friendly methods were superior in controlling the thrips compared to untreated check.

The effectiveness of neem oil against chilli thrips was reported by Mallikarjuna Rao *et al*. (1999). They found that as seedling root dip one per cent neem oil emulsion was effective against chilli thrips, *S. dorsalis*. Thoeming *et al*. (2003) reported the systemic effect of neem against western flower thrips larvae, *Frankliniella occidentalis* (Perg.) on primary bean leaves longer persistence of neem was observed. Pillai and Ponniah (1988) conducted experiments to control rice thrips, *S. biformis* with neem products and reported that 2% neem oil was as effective as phosphomidon (100 EC at 2500 ml/ha). Schmidt *et al*. (1997) reported that neem Azal T/S in green house condition resulted in 91.8 per cent reduction of *F. occidentalis*. The results from the experiments revealed that application of phosalone @ 2ml/lit controlled the thrips effectively. The similar results were found by Ramudu and Reddy (1983). Patnaik *et al.* (1985) found that fenevelarte resulted in the lowest damage index, with lowest incidence of *S. dorsalis* and highest fruit yields, followed by dimethoate.

Table 2 : Effect of eco-friendly/farmers practices in control of thrips, *S. dorsalis* on chilli

Treatments	*PTC	Mean population per five plants - Days after spraying**											
		I spray				II spray				III spray			
		3	5	7	14	3	5	7	14	3	5	7	14
Eco-friendly plot	16.4	9.4[b]	5.8[a]	9.8[a]	13.5[a]	7.1[a]	6.1[a]	6.9[a]	8.4[a]	5.7[a]	6.5[a]	4.3[a]	3.9[a]
		(3.15)	(2.51)	(3.21)	(3.74)	(2.76)	(2.57)	(2.41)	(2.98)	(2.49)	(2.65)	(2.19)	(2.07)
Farmers plot	16.9	6.9[a]	7.5[b]	10.6[ab]	14.6[ab]	6.3[ab]	7.4[ab]	5.8[a]	11.9[b]	6.3[a]	5.4[a]	3.8[a]	4.5[a]
		(2.72)	(2.83)	(3.33)	(3.89)	(2.61)	(2.81)	(3.11)	(3.52)	(2.61)	(2.43)	(2.26)	(1.92)
Untreated check	15.8	15.2[c]	17.8[c]	18.4[b]	20.4[b]	14.8[b]	17.9[b]	15.3[b]	14.2[c]	13.1[b]	10.4[b]	8.4[b]	7.2[b]
		(3.96)	(4.28)	(4.35)	(4.57)	(3.91)	(4.29)	(3.97)	(3.83)	(3.69)	(3.30)	(2.98)	(2.77)

* PTC - Pre-treatment count
** Mean of the seven replications
Figures in the parentheses are $\sqrt{x+0.5}$ transformed values
Means followed by common alphabets in a column are significantly not different (P=0.05) by DMRT.

Mite:

The observations from first round spray revealed that the lowest population (8.3/five plants) was recorded in eco-friendly plot on seventh day after spray. The similar trend was observed in second round of spray on fifth day after spray where the farmer's plot was at par with eco-friendly plot. In third round spray, farmers plot recorded lowest population (4.7/five plants) when compared to eco-friendly plot (5.3/five plants) (Table 3). The results after three sprays revealed that farmer's practices were effective in controlling the mite population compared to eco-friendly practices. But eco-friendly practices were superior than untreated check.

The role of *P. fluorescens* on the suppression of sucking pests was studied and Tomezyk (2002) reported the changes in total phenols and cucurbitacin content in the leaves of cucumber plants growing in the presence of PGPR in root system of healthy plants and plants infested with two spotted mite, *Tetranychus urticae* (Koch). Increase in the total cucurbitacin content was found on non-bacterised plants only after spider mite feeding but on bacterized plants that were mite free.

The effectiveness of PGR against mite has been reported by several authors. Chandramohan *et al.* (1978) reported that the foliar application of growth retardants reduced the population of red spider mite, *Tetranychus cinnabarinus* (Boisdual) on okra. The PGR application is known to affect the nutrition of phytophagous mites. Eichmeir and Gordongyuer (1960) found that the reproduction rate of two-spotted spider mite, *Tetranychus telarius* (L.) was reduced when reared on PGR treated *V. faba.* The seed treatment and foliar application of cycocel 1000 ppm, GA 150 ppm and ethrel 1000 ppm on okra recorded the lowest population of mites, *T. telarius* (Mukundan, 1975).

The neem oil gave significant control of the mites, but was less effective than the synthetic insecticides (Rajasri *et al.*, 1991). Aqueous leaf extract of neem reduced the mite population to some extent (Ramaraju, 2002). Mansour *et al.* (1987) reported that NSKE spray caused high mortality and reduction in the fecundity of *T. cinnabarinus*. Neem mix 4.5% was highly repellent but did not cause mortality of *T. cinnabarinus* (Mansour *et al.*, 1997). The role of chemicals on the suppression of mite population was studied by Dhandapani and Kumaraswami (1983) who reported that phosalone 0.07 per cent and monocrotophos 0.1 per cent recorded higher percentage mortality and persistence was noticed upto 21 days after treatment in mites control. Sitarama Raju and Srinivasa Rao (1981) reported that insecticides tested like dicofol, phosalone quinalphos, dimethoate, carbaryl, methyl demeton and monocrotophos were found significantly effective in controlling the chilli mite.

Yield and cost benefit ratio:

The results from present experiment show that the eco-friendly plot recorded highest yield of 14,937 kg/ha where as farmers plot recorded the yield of 14,330 kg/ha which was at par with eco-friendly practices (Table 4). The highest CBR 3.64 was found in farmer's practices where as CBR 3.24 was found in eco-friendly practices. The lowest yield (8,270 kg/ha) and lowest CBR (2.19) was found in untreated check.

To summarize the present experiment, there is a little time lag between treatment, harvest and consumption of chilli. The use of persistent insecticides acquires special concern on chilli, because it is a common vegetable cum spice in Indian dietary system. So, the increasing concern for environmental safety and global demand for pesticide residue free food has evoked interest of ecofriendly methods of pest management *viz*., plant derivatives, plant growth promoting rhizobacteria and plant growth

Table 3 : Effect of eco-friendly/farmers practices in control of mite, *P. latus* on chilli

Treatments	*PTC	Mean population per five plants - Days after spraying**											
		I spray				II spray				III spray			
		3	5	7	14	3	5	7	14	3	5	7	14
Eco-friendly plot	22.4	11.2^{ab}	9.5^{a}	8.3^{a}	17.4^{a}	9.6^{a}	8.3^{a}	12.5^{a}	15.3^{a}	7.7^{ab}	6.9^{a}	6.2^{b}	5.3^{ab}
		(3.42)	(3.16)	(2.97)	(4.23)	(3.18)	(2.97)	(3.61)	(3.97)	(2.86)	(2.72)	(2.59)	(2.41)
Farmers plot	23.0	10.4^{a}	11.6^{b}	16.5^{b}	21.4^{b}	10.6^{b}	9.6^{ab}	14.2^{b}	17.2^{b}	6.1^{a}	7.4^{a}	5.2^{a}	4.7^{a}
		(3.30)	(3.48)	(4.12)	(4.68)	(3.33)	(3.18)	(3.83)	(4.21)	(2.57)	(2.81)	(2.39)	(2.28)
Untreated check	22.8	23.5^{b}	24.2^{c}	24.8^{c}	25.6^{c}	20.3^{c}	23.5^{c}	25.4^{c}	23.2^{c}	20.2^{b}	17.3^{b}	15.4^{c}	12.3^{b}
		(4.90)	(4.97)	(5.03)	(5.11)	(4.56)	(4.90)	(5.09)	(4.87)	(4.55)	(4.22)	(3.99)	(3.58)

* PTC - Pre-treatment count

** Mean of the seven replications

Figures in the parentheses are $\sqrt{x+0.5}$ transformed values

Means followed by common alphabets in a column are significantly not different (P=0.05) by DMRT.

Table 4 : Comparison of eco-friendly practices with farmers conventional practices in control of sucking pests of chilli - yield and cost benefit ratio

Treatments	Yield of fruits (kg/ha)	Gross income (kg = Rs 7.00)	Additional yield over untreated check (kg/ha)	Additional income over untreated check (Rs)	Cost of treatment + *cost of cultivation	CBR
Eco-friendly plot *P. fluorescens* @ 5g/lit + NAA @ 10ppm Neem oil @ 30ml/lit *P. fluorescens* @ 5g/lit + NAA @ 10ppm + neem oil @ 30ml/lit Yellow trap @ 12/ha	14937[a]	104569	6667	46679	32272	3.24
Farmers plot Dimethoate @ 2ml/lit Quinalphos @ 2ml/lit Phosalone @ 2ml/lit	14330[a]	100314	6060	42424	27559	3.64
Untreated check	8270[b]	57890	-	-	26314	2.19

*Cost of cultivation – Rs. 26,314/ha
Means followed by common alphabets in a column are significantly not different (P=0.05) by DMRT.

regulators as important components in integrated pest management.

Acknowledgement:

The authors are thankful to the Tamil Nadu Agricultural University for providing necessary facilities for the investigations.

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