Research Paper :

Effect of Plant growth promoting rhizobacteria (*Pseudomonas fluorescens*), Naphthalene acetic acid and neem oil application on the incidence of sucking pests of chilli (*Capsicum annuum* L.)

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SUMMARY

Efficacy of Plant growth promoting rhizobacteria (*P. fluorescens*), Naphthalene acetic acid, neem oil and their combinations against chilli sucking pests like chilli thrip, *Scirtothrips dorsalis* (Hood), green peach aphid, *Myzus persicae* (Sulzer) and chilli mite, *Polyphagotarsonemus latus* (Banks) was studied under field conditions at Theenampalayam village, Coimbatore district, Tamil Nadu during 2005 - 2006. The treatments were evaluated in randomized block design with three replications. The results showed that the application of *P. fluorescens* + NAA + neem oil treated plots recorded significantly lowest population of *M. persicae, S. dorsalis* and *P. latus.* This was at par with phosalone and neem oil treated plots. Untreated check recorded highest population of all the three sucking pests. Plots received with *P. fluorescens* + NAA + neem oil treatment recorded the highest yield 7,529 kg/ha and CBR was 2.49. The phosalone and neem oil treated plots recorded the yield 7,262 kg/ha and 6,770 kg/ha and had CBR ratio of 2.68 and 2.38, respectively. The phosalone treated plot recorded highest CBR ratio 2.68.The untreated check recorded lowest yield (4,125 kg/ha) and lowest CBR (1.60).

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Key words :
Myzus persicae, Naphthalene acetic acid, Neem oil, *Polyphagotarsonemus latus, Pseudomonas fluorescens, Scirtothrips dorsalis*

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Chilli (*Capsicum annum* 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. Such available 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 result 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 (Varma, 1989). Despite these credentials, continuous use of chemical insecticides have been 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 has been receiving considerable attention of scientific community as important components in integrated pest management.

MATERIALS AND METHODS

Efficacy of Plant growth promoting rhizobacteria (*P. fluorescens*), Naphthalene acetic acid, neem oil and their combinations against sucking pest complex of chilli was studied under field conditions at Theenampalayam village, Coimbatore district, Tamil Nadu during 2005 - 2006. Chilli (cv. LOCAL) seedlings were transplanted at a spacing of 60 x 45 cm in 30m^2 plots. The treatments were evaluated in randomized block design (RBD) with three replications. Foliar application of PGR, PGPR, neem oil and their combinations was carried out at 15 days after transplanting (DAT), 30 DAT and 45 DAT using high volume Aspee knapsack sprayer. The population of sucking pests was recorded at regular intervals after each application. The treatments evaluated are T_{1-} PGPR - *P. fluorescens* @ 5g lit $^{-1}$, T_2 - PGR - Naphthalene Acetic Acid (NAA) @10ppm, T_{3-} Neem oil 3% @ 30 ml lit^{-1}, T_{4-} $T_{1+}T_2$ (5g lit^{-1} + 10ppm) T_{5-} $T_{1+}T_{2+}T_3$ (5g lit $^{-1}$ + 10ppm + 30ml lit^{-1}), T_{6-} Phosalone 35EC @ 2ml lit^{-1}, T_{7-} Water spray @ 500 lit ha^{-1} and T_{8-} Untreated check. 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 treatment was recorded and additional income obtained from different treatments 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):

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

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 Plant growth promoting rhizobacteria (*P. fluorescens*), Naphthalene acetic acid and neem oil for the management of sucking pests of chilli are narrated here under :

Aphids:

The results showed statistically significant difference among the treatments against aphid population. The observations revealed that in the first round of spray, the lowest population (10.7/five plants) was noticed in plots where *P. fluorescens* @ 5 g/lit + NAA @ 10 ppm + neem oil @ 30 ml/lit was sprayed on third day after spray (Table 1). This was at par with phosalone @ 2ml/lit (11.4/five plants) where as untreated check recorded highest population (27.4/five plants). In the second round of spray also the lowest population (7.3/five plants) was recorded in the same plots at seventh day after spray. This was at par with neem oil @ 30ml/lit (8.4) treated plots. The lowest aphid population (3.2/five plants) was noticed in *P. fluorescens* @ 5 g/lit + NAA @ 10 ppm + neem oil @ 30 ml/lit sprayed plots on fourteenth day after spray. This was at par with phosalone (3.6) and neem oil (5.2) treated plots. The highest populations (17.8/five plants) were found in untreated check 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 plants (*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* (Hbn.) (Murugan, 2003). Application of MH caused increased

Table 1 : Effect of *P. fluorescens*, NAA and neem oil application on the incidence of aphid, *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
P. fluorescens @ 5g/lit	24.6	25.8^{d}	27.1^{d}	22.5^{b}	23.4^{a}	21.7^{b}	24.3^{b}	18.4^{b}	21.4^{b}	18.4^{b}	15.3^{c}	12.3^{b}	9.3^{b}
		(5.13)	(5.25)	(4.80)	(4.89)	(4.71)	(4.98)	(4.35)	(4.68)	(4.35)	(3.97)	(3.58)	(3.13)
NAA @ 10ppm	25.2	25.5^{d}	26.6^{cd}	23.4^{b}	26.3^{bc}	28.4^{c}	25.4^{b}	21.3^{c}	24.3^{b}	22.4^{b}	19.3^{c}	15.2^{bc}	12.7^{bc}
		(5.10)	(5.21)	(4.89)	(5.18)	(5.38)	(5.09)	(4.67)	(4.98)	(4.79)	(4.45)	(3.96)	(3.63)
Neem oil @ 30ml/lit	27.5	16.5^{b}	18.3^{ab}	20.4^{a}	24.3^{ab}	13.5^{a}	10.5^{a}	8.4^{a}	16.4^{a}	9.3^{a}	7.4^{a}	6.5^{a}	5.2^{a}
		(4.12)	(4.34)	(4.57)	(4.98)	(3.74)	(3.32)	(2.98)	(4.11)	(3.13)	(2.81)	(2.65)	(2.39)
P. fluorescens @ 5g/lit + NAA @ 10ppm	26.4	26.9^{d}	24.2^{c}	23.4^{b}	25.2^{b}	27.2^{c}	24.2^{b}	21.3^{c}	18.4^{a}	16.3^{b}	12.4^{b}	10.6^{b}	8.5^{b}
		(5.23)	(4.97)	(4.89)	(5.07)	(5.26)	(4.97)	(4.67)	(4.35)	(4.10)	(3.59)	(3.33)	(3.00)
P. fluorescens @ 5g/lit + NAA @ 10ppm + neem oil @ 30ml/lit	25.8	10.7^{a}	13.7^{a}	16.5^{a}	22.7^{a}	12.3^{a}	10.4^{a}	7.3^{a}	14.5^{a}	8.4^{a}	6.3^{a}	4.2^{a}	3.2^{a}
		(3.35)	(3.77)	(4.12)	(4.82)	(3.58)	(3.30)	(2.79)	(3.87)	(2.98)	(2.61)	(2.17)	(1.92)
Phosalone @ 2ml/lit	24.8	11.4^{a}	15.3^{a}	17.4^{a}	23.6^{a}	9.4^{a}	12.3^{a}	16.3^{b}	20.4^{b}	10.4^{a}	8.4^{a}	5.4^{a}	3.6^{a}
		(3.45)	(3.97)	(4.23)	(4.91)	(3.15)	(3.58)	(4.10)	(4.57)	(3.30)	(2.98)	(2.43)	(2.02)
Water spray	25.8	23.5^{c}	20.4^{b}	26.2^{c}	28.2^{c}	32.3^{d}	34.9^{d}	36.2^{d}	34.3^{c}	29.4^{c}	25.6^{d}	20.8^{d}	15.7^{c}
		(4.90)	(4.57)	(5.17)	(5.36)	(5.73)	(5.95)	(6.06)	(5.90)	(5.47)	(5.11)	(4.62)	(4.02)
Untreated check	26.0	27.4^{e}	25.3^{c}	28.9^{d}	29.5^{c}	26.4^{c}	28.3^{c}	34.5^{d}	32.4^{c}	30.5^{c}	27.4^{d}	22.4^{d}	17.8^{c}
		(5.28)	(5.08)	(5.42)	(5.48)	(5.19)	(5.37)	(5.92)	(5.74)	(5.57)	(5.28)	(4.79)	(4.28)

* PTC - Pre-treatment count

** Mean of the three 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

mortality of nymph and adults of aphid, *A. pisum* of broad bean, *V. faba* (Robinson, 1961). Vanemden (1964) reported that cycocel reduced the population of *Brevicoryne brassicae* (L.) and *M. persicae* in brussels sprouts. Bhalla and Robinson (1968) found that synthetic liquid diets containing PGR, MH and cycocel caused high mortality to nymphs and reduced adult population of *A. 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 aphid, *A. gossypii* and reduced the incidence of *Earias vittella* (F.) (Mukundan, 1975). Attah and Vanembden (1993) studied that in wheat, *Triticum aestivum* (L.) application of PGR reduced the weight of aphid, *Metopolophium dishodum* (Walker). Bhatnagar and Kandasamy (1993) reported that Neem rich 80 EC at 8 per cent resulted in 84.0 per cent mortality of *A. gossypii* on cotton. According to Jotwani and Srivastava (1981), neem oil one per cent was quite effective against *A. gossypii*. Nimbalkar *et al*. (1994) found that combination of Neemark and monocrotophos 36 SL spray was quite effective against *A. gossypii* on okra.

Thrips:

The results of first spray revealed that *P. fluorescence* + NAA + Neem oil effectively reduced the thrips population where the lowest population (6.1/five plants) was recorded on fifth day after spray followed by phosalone (8.4) and neem oil (9.4) treated plots. Where as the highest population of thrips (14.4) were recorded in untreated check (Table 2). In the second round spray *P. fluorescens*, phosalone and neem oil were at par with each other in controlling the thrips population. In the third round of spray the lowest population (3.7/five plants) was observed in phosalone on fourteenth day after spray. This was at par with *P. fluorescens* + NAA + neem oil, *P. fluorescens* + NAA and neem oil alone treated plots. The highest populations (14.4) were found in 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 in one per cent neem oil

Table 2 : Effect of *P. fluorescens*, NAA and neem oil application on the incidence of thrip, *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
P. fluorescens @	16.5	18.2^{d}	19.4^{d}	17.3^{c}	20.6^{c}	18.4^{c}	15.4^{b}	12.9^{b}	17.4^{b}	14.2^{d}	11.3^{b}	9.2^{b}	6.3^{a}
5g/lit		(4.32)	(4.46)	(4.22)	(4.59)	(4.35)	(3.99)	(3.66)	(4.23)	(3.83)	(3.44)	(3.11)	(2.61)
NAA @ 10ppm	15.4	16.2^{c}	18.3^{d}	15.8^{b}	22.3^{d}	24.8^{e}	20.2^{c}	14.2^{b}	18.3^{b}	16.2^{d}	13.3^{b}	11.4^{b}	8.4^{b}
		(4.09)	(4.34)	(4.04)	(4.77)	(5.03)	(4.55)	(3.83)	(4.34)	(4.09)	(3.71)	(3.45)	(2.98)
Neem oil @	14.3	7.4^{a}	9.4^{b}	11.4^{a}	13.6^{a}	6.9^{b}	6.1^{a}	8.2^{a}	10.4^{a}	5.2^{b}	6.5^{a}	5.6^{a}	4.8^{a}
30ml/lit		(2.81)	(3.15)	(3.45)	(3.75)	(2.72)	(2.57)	(2.95)	(3.30)	(2.39)	(2.65)	(2.47)	(2.30)
P. fluorescens @		17.3^{d}	19.4^{d}	16.4^{b}	21.3^{cd}	20.3^{d}	18.4^{c}	15.3^{b}	18.6^{b}	8.9^{c}	7.5^{a}	6.3^{a}	5.2^{a}
5g/lit + NAA @	15.6	(4.22)	(4.46)	(4.11)	(4.67)	(4.56)	(4.35)	(3.97)	(4.37)	(3.07)	(2.83)	(2.61)	(2.39)
10ppm													
P. fluorescens @	16.1	6.5^{a}	6.1^{a}	12.3^{a}	14.5^{a}	5.2^{a}	4.6^{a}	7.4^{a}	11.3^{a}	5.8^{b}	6.3^{a}	5.2^{a}	4.2^{a}
5g/lit + NAA @		(2.65)	(2.57)	(3.58)	(3.87)	(2.39)	(2.26)	(2.81)	(3.44)	(2.51)	(2.61)	(2.39)	(2.17)
10ppm + neem oil													
@ 30ml/lit													
Phosalone @ 2ml/lit	15.8	7.1^{a}	8.4^{b}	10.6^{a}	12.3^{a}	4.8^{a}	5.8^{a}	6.7^{a}	9.8^{a}	3.2^{a}	5.6^{a}	4.6^{a}	3.7^{a}
		(2.76)	(2.98)	(3.33)	(3.58)	(2.30)	(2.51)	(2.68)	(3.21)	(1.92)	(2.47)	(2.26)	(2.05)
Water spray	14.8	12.3^{bc}	14.3^{c}	16.3^{b}	19.4^{c}	16.3^{c}	19.4^{c}	23.4^{c}	21.4^{c}	18.3^{d}	15.4^{b}	12.4^{b}	10.3^{b}
		(3.58)	(3.85)	(4.10)	(4.46)	(4.10)	(4.46)	(4.89)	(4.68)	(4.34)	(3.99)	(3.59)	(3.29)
Untreated check	14.5	15.2^{c}	13.4^{c}	17.4^{c}	21.4^{cd}	23.4^{e}	26.6^{d}	24.5^{c}	27.3^{d}	23.2^{e}	20.4^{c}	16.4^{c}	13.4^{c}
		(3.96)	(3.73)	(4.23)	(4.68)	(4.89)	(5.21)	(5.00)	(5.27)	(4.87)	(4.57)	(4.11)	(3.73)

* PTC - Pre-treatment count

** Mean of the three 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

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 the experiments to control rice thrip, *S. biformis* with neem products and reported that the 2% neem oil was as effective as phosphomidon (100 EC at 2500 ml/ha). Schmidt *et al.* (1997) reported that neemazal T/S in green house condition resulted in 91.8 per cent reduction of *F. occidentalis*. The application of PGPR, *P. fluorescens* to seed, soil and plant has favoured the reduction in sucking pests *viz*., leafhoppers, aphid and fruit bores complex (Murugan *et al*., 2005). Induction of resistance by PGPR had significantly reduced population of the striped cucumber beetle, *Diabrotica undecimpunctata howardii* (Barber) on cucumber. The application of talc formulation of *P. fluorescens* through seed, root, soil and foliar spray significantly reduced the leaf folder, *Cnaphalocrosis medinalis* (Guenee) in rice under greenhouse and field conditions. Application of *P, fluorescens* in tomato and okra reduced the incidence and damage of leaf miner, *L. trifolii* and whitefly, *B. tabaci.*

Mite:

The observations on mite population revealed that in the first round of spray, the lowest population (3.6/ five plants) was noticed on plots where *P. fluorescens* @ 5 g/lit + NAA @ 10 ppm + neem oil @ 30 ml/lit sprayed on fifth day after spray. This was at par with phosalone (5.4/five plants) @ 2 ml/lit treated plots. The highest population (18.3) was found in water spray treated plots (Table 3). In the second round of spray, *P. fluorescens* + NAA + neem oil (3.1) and phosalone (4.5) were at par with each other in reducing the mite population. The lowest mite population (2.7/five plants) was noticed in *P. fluorescens* + NAA + neem oil treated plots. This was at par with phosalone (3.5/five plants) and neem oil (4.2/ five plants) treated plots where as the highest population (23.4) was recorded in untreated check.

The role of *P. fluorescens* on the suppression of sucking pests was situated. Tomezyk (2002) made the observation studied the changes in total phenols and cucurbitacin content in the leaves of cucumber plants growing in the presence of PGPR in root system of

Table 3 : Effect of *P. fluorescens*, NAA and neem oil application on the incidence 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
P. fluorescens @ 5g/lit	13.2	14.2^{d}	16.2^{d}	15.3^{c}	17.5^{d}	19.2^{b}	16.3^{c}	14.4^{c}	20.3^{c}	22.3^{b}	19.4^{d}	16.5^{c}	12.4^{b}
		(3.83)	(4.09)	(3.97)	(4.24)	(4.44)	(4.10)	(3.86)	(4.56)	(4.77)	(4.46)	(4.12)	(3.59)
NAA @ 10ppm	10.8	12.3^{c}	15.3^{d}	13.3^{c}	18.3^{d}	20.2^{b}	17.4^{c}	12.8^{c}	18.6^{c}	21.4^{b}	23.5^{e}	19.4^{d}	16.3^{c}
		(3.58)	(3.97)	(3.71)	(4.34)	(4.55)	(4.23)	(3.65)	(4.37)	(4.68)	(4.90)	(4.46)	(4.10)
Neem oil @ 30ml/lit	12.7	6.4^{b}	8.2^{b}	9.8^{b}	11.3^{b}	5.7^{a}	5.1^{b}	7.4^{b}	9.4^{b}	4.7^{a}	3.8^{a}	5.4^{a}	4.2^{a}
		(2.63)	(2.95)	(3.21)	(3.44)	(2.49)	(2.37)	(2.81)	(3.15)	(2.28)	(2.07)	(2.43)	(2.17)
P. fluorescens @ 5g/lit + NAA @ 10ppm	11.7	13.2^{c}	12.3^{c}	10.4^{b}	15.3^{c}	19.1^{b}	22.3^{d}	20.4^{d}	24.3^{d}	21.4^{b}	16.4^{c}	13.2^{b}	10.4^{b}
		(3.70)	(3.58)	(3.30)	(3.97)	(4.43)	(4.77)	(4.57)	(4.98)	(4.68)	(4.11)	(3.70)	(3.30)
P. fluorescens @ 5g/lit + NAA @ 10ppm + neem oil @ 30ml/lit	11.2	4.5^{a}	3.6^{a}	7.8^{a}	9.4^{a}	3.8^{a}	3.1^{a}	5.4^{a}	7.4^{a}	3.0^{a}	2.5^{a}	3.2^{a}	2.7^{a}
		(2.24)	(2.02)	(2.88)	(3.15)	(2.07)	(1.90)	(2.43)	(2.81)	(1.87)	(1.73)	(1.92)	(1.79)
Phosalone @ 2ml/lit	13.1	3.8^{a}	5.4^{a}	9.8^{b}	11.3^{b}	4.1^{a}	4.5^{a}	5.9^{a}	7.8^{a}	3.8^{a}	5.3^{b}	4.6^{a}	3.5^{a}
		(2.07)	(2.43)	(3.21)	(3.44)	(2.14)	(2.24)	(2.53)	(2.88)	(2.07)	(2.41)	(2.26)	(2.00)
Water spray	12.4	14.5^{d}	18.3^{e}	22.3^{e}	21.4^{e}	24.5^{c}	27.3^{e}	29.3^{e}	28.3^{e}	30.2^{c}	27.2^{f}	23.2^{e}	19.4^{d}
		(3.87)	(4.34)	(4.77)	(4.68)	(5.00)	(5.27)	(5.46)	(5.37)	(5.54)	(5.26)	(4.87)	(4.46)
Untreated check	10.0	13.2^{c}	16.2^{d}	19.2^{d}	22.4^{e}	26.5^{d}	28.4^{e}	30.3^{e}	33.4^{f}	35.4^{d}	31.3^{g}	26.4^{f}	23.4^{e}
		(3.70)	(4.09)	(4.44)	(4.79)	(5.20)	(5.38)	(5.55)	(5.82)	(5.99)	(5.64)	(5.19)	(4.89)

* PTC - Pre-treatment count
** Mean of the three 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 : Effect of *P. fluorescens*, NAA and neem oil application on the incidence 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
P. fluorescens @ 5g/lit	5587^{e}	39112	1462	10237	18714	2.09
NAA @ 10ppm	5871^{d}	41101	1746	12226	18768	2.19
Neem oil @ 30ml/lit	6770^{b}	47395	2645	18520	19914	2.38
P. fluorescens @ 5g/lit + NAA @ 10ppm	6336^{c}	44352	2211	15477	19368	2.29
P. fluorescens @ 5g/lit + NAA @ 10ppm + neem oil @ 30ml/lit	7529^{a}	52708	3404	23833	21168	2.49
Phosalone @ 2ml/lit	7262^{a}	50834	3137	21959	18969	2.68
Water spray	4632^{f}	32424	507	3549	18114	1.79
Untreated check	4125^{g}	28875	-	-	17664	1.60

*Cost of cultivation – Rs. 17,664/ha
Means followed by common alphabets in a column are significantly not different (P=0.05) by DMRT

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 was known to affect the nutrition of phytophagous mites (Rodriguez and Campbell, 1961). Erchmeir 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). A number of insects, plant pathogens and nematodes were controlled by neem products including mite. The role of neem against mite was studied by several authors. Karupuchamy and Mohansundaram (1987) reported the effectiveness of neem oil 3% in reducing the mite population. The neem oil gave significant control of the mites, but was less effective than the synthetic insecticides (Rajashri *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 caused mortality of *T. cinnabarinus* (Mansour *et al*., 1997).

Yield and cost benefit ratio:

Plots received with *P. fluorescens* + NAA + neem oil treatment recorded the highest yield 7,529 kg/ha and CBR was 2.49. The phosalone and neem oil treated plots recorded the yield 7,262 kg/ha and 6,770 kg/ha and had CBR ratio of 2.68 and 2.38, respectively (Table 4). The phosalone treated plot recorded highest CBR ratio 2.68.The untreated check recorded lowest yield (4,125 kg/ha) and lowest CBR (1.60).

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 regulators as important components in integrated pest management and in organic farming.

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