Ecofriendly pest management practices for leaf curl complex of chilli (*Capsicum annuum* L.)

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ABSTRACT

Chilli (*Capsicum annuum* L.) is an important profitable cash crop. However, the productivity of the crop is decreasing sharply day by day mainly due to leaf curl complex. Chilli thrips (*Scirtothrips dorsalis* Hood) and yellow mite (*Polyphagotarsonemus latus* Banks) are the two major pests responsible for this devastating problem. Seven IPM modules including a non-IPM module were evaluated for sustainable management of these pests. Experimental findings revealed that all the IPM-modules proved superior to non IPM-module. The module T_4 having one spray of Boom Tet followed by Abamectin and again Boom Tet at 21 days interval proved most effective in reducing pests population as well as in terms of benefit-cost ratio followed by module T_5 (Redux + Garlic extract + Diafenthiuron) and T_6 (NSKE + Redux + Boom Tet) when sprayed successively at same interval. It can be concluded that module T_4, T_5 and T_6 may be considered for sustainable production of chilli.

Key words: Biopesticide, chilli leaf curl, eco-friendly management, IPM

INTRODUCTION

Chilli (*Capsicum annuum* L.) belongs to the family Solanaceae and is one of the most important widely cultivated crops grown for the value of its fruits in India. India is rich in maximum diversity of chilli varieties with different quality factors. Besides traditional use of chilli as vegetables, spices, condiments, sauces and pickles it is also being used in pharmaceuticals, cosmetics and beverages (Tiwary *et al.*, 2005). India is a major producer, exporter and consumer of chillies in the world. However, the average productivity is very low in comparison to that in other countries. The crop is infested by more than 21 insects and non-insect pests (Dey *et al.*, 2001). Chilli leaf curl is one of the major limiting factors in cultivation of the crop, and yellow mite (*Polyphagotarsonemus latus* Banks) and chilli thrips (*Scirtothrips dorsalis* Hood) are considered the most devastating pests in West Bengal. The farmers always give priority to protecting such a high value crop from any type of damage caused by insects-pests and others. They often used huge amount of pesticides indiscriminately to protect the crop without proper diagnosis which results in resurgence of the pests, phytotoxicity on fruits, destruction of earthworm, infertility/low fruit setting due to killing of pollinators and presence of high amount of pesticidal residue on harvested fruits. In this context, some novel pesticides, majority of which derived from natural resources were used to develop eco-friendly management modules for sustainable production of the crop.

MATERIALS AND METHODS

The chilli variety, Suryamukhi is very popular and is widely cultivated in different districts of West Bengal. It is an early fruiting variety of medium height, generally having moderate number of secondary branches. The variety is very much susceptible to thrips and mites.

Field experiment

The experiments were conducted for two years from 2010 to 2011 during summer season at Agricultural farm of Palli Siksha Bhavana, Visva-Bharati, Sriniketan (23.39^{0}N latitude, 87.42^{0}E longitude). The soil of the experimental plots was loamy-sand in the texture with medium to low fertility status and acidic in nature. The experiment was laid out in completely randomized block design having seven modules (six IPM and one non IPM-modules) with three replicates (Table 1). The crop was raised in the nursery and 25 day old seedlings were transplanted in the experimental field having a plot size of 3.6 x 2.7 sqm with 45 cm x 60 cm spacing. Standard agronomic practices were followed to grow the crop.

To study mite population five plants were selected randomly from each plot and tagged. The plants were again untagged after recording the thrips population to avoid observation from the same plant. Six leaves from each plant (two each from bottom, middle and top canopy) were plucked and kept in properly labelled polypropylene bag. Later, these selected leaves were examined under stereo-binocular microscope for counting the number of mites per leaf. To study the thrips

Table 1. Details of different pest management modules (T1 to T7) followed for chilli leaf curl complex management

Module Number	Module	Spraying interval
T_1 :	Neem cake (Basal)+ 2 weeding (15 and 30 DAT) + Yellow sticky trap + Boom Tet (1ml/l) + Boom Tet (1ml/l) + Boom Tet (1ml/l)	1st spraying at 35 DAT, 2nd spraying at 56 DAT and 3rd spraying at 77 DAT i.e. at 21 days interval for T_1 to T_6
T_2 :	Neem cake (Basal) + 2 weeding (15 and 30 DAT) + Yellow sticky trap + Redux (1ml/l) + Redux (1ml/l) + Redux (1ml/l)	
T_3 :	Neem cake (Basal) + 2 weeding (15 and 30 DAT) + Yellow sticky trap + Abamectin 1.9 EC (1ml/l) - NSKE 5% - Garlic extract 10%	
T_4 :	Neem cake (Basal) + 2 weeding (15 and 30 DAT) + Yellow sticky trap + Boom Tet (1ml/l) -Abamectin (1 ml/l) - Boom Tet (1ml/l)	
T_5 :	Neem cake (Basal) + 2 weeding (15 and 30 DAT) + Yellow sticky trap + Redux (1 ml/l) -Garlic extract 10%-Diafenthiuron 50 WP (0.5g/l)	
T_6 :	Neem cake (Basal) + 2 weeding (15 and 30 DAT) + Yellow sticky trap + NSKE 5% - Redux (1 ml/l) - Boom Tet (1ml/l)	
T_7 :	Non IPM-module: 2 weeding (15 and 30 DAT) + Endosulfan 35 EC (2 ml/l) 6 sprays at 35,45,55,65,75 and 85 DAT	10 days interval for T_7

Boom Tet : Natural alkaloids and lactone (0.4%) +Terephenoids and isoflavones (1.6%)

Redux : See weed extract (10%) + Chavicol (2%)

Garlic extract (10%) : Crashed garlic 10g + Water 100 ml;

Neem cake @ 2t/ha and One yellow sticky trap was installed at the centre of each plot

population another five plants were selected randomly from each plot. A pot containing kerosinized water was placed under the selected plant and each twig was shaken gently, and thrips which fell on the water were noted down. Observations were recorded at seven days interval starting from 14 days after transplanting (DAT) upto last harvesting of fruits. First plucking of fruits was made at 65 DAT and successive plucking was done at an interval of 10 days. Fruit yield of each plot was taken from whole population separately and yield of each module was calculated by cumulating the successive plucking from respective plots. Data were subjected to analysis of variance after making necessary transformation whenever required (Gomez and Gomez, 1984). Thrips and mite infested plants were observed minutely and the symptoms were recorded in different stages of crop growth.

Cost Benefit Ratio

The fruit yield per plot was recorded and computed to tonne per hectare. The data were tabulated, pooled and ranked on the basis of their yield performance. The benefit-cost ratio (CBR) of different modules was calculated by estimating different cost of cultivation and return from fruit yield after converting them to one hectare of land. The average market price of chilli was rupees 50 per kg during the experimental period. Benefit-cost ratio was calculated using the following formula:

$$CBR = \frac{\text{Benefit}}{\text{Total cost of cultivation}}$$

where, Benefit = Total return – Total cost of cultivation

RESULTS AND DISCUSSION

Symptomatology

The adults and nymphs of mites generally suck sap from leaves, petioles and tender twigs. The margin of the young leaves curled downwards in an inverted boat shaped manner. The leaves look shiny, and silvery lining was recorded on the ventral surface. However, the older leaves and petioles were

found elongated. In severely infested plant, leaves and terminal twigs become hardened, twisted and thickened. Infested plant produced very small sized leaves. In such a plant most of the young fruits look silvery and shiny, and in later stage the fruits become cracked and deformed. Besides, bud and flower shedding were also noted down but fruit shedding was observed rarely. The findings are well corroborated with the earlier works of Karmakar (1995) and Gerson (1992). On the other hand, thrips was recorded on the upper surface of leaves. The insect lacerates the epidermis and suck sap. The white minute, streaky spots were commonly noticed on infested leaves which curled upward, thickened and crinkled. In severe infestation, margin of the leaves showed burnt appearance and dried up.

Management trial

Perusal of Table 2 revealed the overall picture of level of pest infestation in chilli at different modules. Thrips populations were significantly low in all the IPM-modules as compared to non IPM-module. No significant difference in thrips populations was observed in the modules T_1, T_2, T_5 and T_6 while significantly lowest population was recorded in T_4. In the module T_3, significantly higher thrips population was observed than other IPM-modules. Similarly, significantly higher mite population was recorded in non IPM-module than other modules. Lowest mite population was observed in module T_4 but failed to show any significant difference with T_5. The module T_1 also proved effective but was *at par* with T_2. Comparatively higher population was found in T_3 than others except T_2 and T_7.

Results on thrips population in different physiological growth stages of the crop showed that initial population of insect was relatively lower in all the IPM modules than non IPM module and these populations never crossed the latter one during the experimental period. Among IPM-modules, insect populations gradually increased with the advancement of time except module T_4 and T_6. Similar trend was also recorded in module T_7. In later period of crop growth i.e. from pre-flowering to fruiting stages slightly higher population of insect was observed in module T_3 which might be due to failure of NSKE and garlic extract to control the insect for longer period of time probably less persistency of these bio-products. More or less similar observations were recorded for mite population also. However, gradual decrease of population of mite was observed in all the modules except Module T_3 which indicates that NSKE and garlic extract are not effective for longer time while module T_4 again proved most effective to suppress the mite population from transplanting to crop maturity. Debnath and Baidya (2010) also recorded the ineffectiveness of NSKE to suppress chilli yellow mite population in totally matured crop.

Cost Benefit Ratio

The details of cost of cultivation analysis for different IPM modules have been presented in Table 3. Based on fruit yield, the module T_4 ranked first followed by T_5, T_6, T_1, T_2, T_3 and T_7. Similar trend was also followed in CBR of different modules except T_7 which gave slightly higher benefit-cost ratio as compared to T_3. Lower CBR in module T_3 might be due to increased production cost for the preparation of garlic extract. It can be concluded that module T_4, T_5 and T_6 may be considered for sustainable production of chilli. The CBR ratio was also calculated by Vishwakarma *et al.* (2010) for different treatments having organic formulations and novel pesticides against yellow mite on *'Suryamukhi'* variety of chilli.

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Table 2. Pooled mean population of thrips and mites in different modules for the year 2010 and 2011

Module No.	Thrips (No. / twig / plant)	Mites (No. / leaf / plant)
T_1	0.38	5.37
T_2	0.42	5.70
T_3	0.56	6.23
T_4	0.28	4.60
T_5	0.40	4.73
T_6	0.47	5.27
T_7	1.58	8.63
CD(p=0.05)	0.07	0.13
SEm(±)	0.03	0.04
C.V.	11.7	6.69

Table 3. Analysis of cost of cultivation for different pest management modules

Module	Production cost without Plant Protection (Rs./ha)	Cost of Plant Protection (Rs./ha)	Total cost (Rs./ha)	Fruit yield (t/ha)	Return @ Rs.50,000/t	Profit (Rs./ha)	BCR
T_1	117333.00	5250.00	122583.30	4.84(4)	242000.00	119416.70	0.97 (4)
T_2	117333.00	5000.00	122333.30	4.51(5)	225500.00	103166.70	0.84 (5)
T_3	117333.00	9000.00	126333.30	3.89(6)	194500.00	68166.67	0.53 (7)
T_4	117333.00	6000.00	123333.30	6.22(1)	311000.00	187666.70	1.52 (1)
T_5	117333.00	7666.66	125000.00	5.63(2)	281500.00	156500.00	1.25 (2)
T_6	117333.00	5083.33	122416.70	5.12(3)	256000.00	133583.30	1.09 (3)
T_7	100667.00	2333.33	103000.00	3.61(7)	180500.00	77500.01	0.75 (6)

Data in parentheses indicate ranking

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