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## Evaluation of the effectiveness of some safer pest management modules against the thrips infesting chilli (*Capsicum frutescens* L.)

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**Abstract**

A field experiment was conducted during winter season of 2017-18 to evaluate the effectiveness of different module based application of insecticide against thrips (*Scirtothrips dorsalis* Hood) infesting chilli (*Capsicum frutescens*) to find out best combination against thrips and subsequent reduction in curling in plant with higher cost benefit ratio. The effectiveness of two biopesticides viz. NSKE and Rose apple LE along with five synthetic insecticides were evaluated in the field of new gangetic zone of West Bengal. It is evident from the result of present investigation that a combination of NSKE, emamectin-benzoate and chlorfenapyr sequentially in the field were most effective to minimize the thrips population 74.56% over control. Neem pesticide (57.33%) and rose leaf extract (55.81%) were found moderately effective. Although all the chemical proves effective on the thrips population over control but the NSKE and rose leaf extract considered to be more effective over the beneficial arthropod diversity and pollinators in chilli ecosystem.

**Keywords:** Thrips, bio formulation, new generation chemical pesticides

**Introduction**

India is a world leader in chilli (*Capsicum annuum* L.) production but it ranks 45th in productivity of dry chillies and peppers as compared to developed countries like USA, China, South Korea, Taiwan etc. Among the various biotic stresses, ravages caused by insect pests are significant. The pest spectrum in chilli is complex with more than 293 insects and mite species debilitating the crop in the field as well as in storage [1]. Among the sucking pests, chilli thrips *Scirtothrips dorsalis* Hood (Thripidae: Thysanoptera) is considered as the most serious and important pest as it attacks the crop from nursery till the harvest of the crop. Both nymphs and adults of thrips cause damage by scrapping the epidermis and suck the cell sap from tender leaves, growing shoots and exhibit characteristic upward curling of leaves and reduction in leaf size [7]. Besides damage, thrips also cause indirect damage by transmitting Tospo viruses [4] while it was estimated that losses due to thrips in chilli ranged from 50 to 90 per cent [2]. Chilli thrips multiply appreciably at a faster rate during dry weather periods and causes yield loss of 30 to 50 per cent in South India [11] and sometimes may cause more than 90 per cent yield reduction [5]. In the world at least 16 thrips species have been reported to cause damage to capsicum [3, 9].

Due to mono culture of chilli over a period of time, the pest buildup of *S. dorsalis* has increased enormously Surprisingly, most of the vegetable growers apply almost 10-12 sprays in a season. Thus, the fruits, which are harvested at the short intervals, are likely to retain unavoidably high level of pesticide residues which may be highly hazardous causing serious problems including pest resistance, pest outbreak, pest resurgence and environmental pollution [8]. In addition to this the increased pesticidal sprays become a threat to chilli ecosystem causing resurgence of pests and menace to natural enemies. Pesticide residues in chilli are also of great concern for domestic consumption and exports as well.

The concept of sustainable integrated pest management is becoming a practicable and acceptable approach over the world. The idea is to maintain the pest population below economic threshold rather than eradicate it. In the present study, various control measures (Neem seed kernel extract, rose apple leaf extract, use of different group new generation

insecticides) were combined in various modules together for the management of thrips population on chilli field, in order to minimize the use of pesticide. Therefore, the present study was designed to evaluate different IPM modules for the management of pest problem with least or no pesticide usage.

### Materials and methods

The field experiment was laid out at the at the Dean's Instructional Farm of Bidhan Chandra Krishi Viswavidyalaya located at Mohanpur of Nadia District of West Bengal, for a year 2016-2017 on chilli. The test Cultivar was selected for

the study was Bullet, a promising, locally accepted chilli variety with fruits of medium sized, was sown in a Randomized Block Design with six treatments modules including control and chemical check and three replications in the season of both years. Seeds were collected from the local sources and these were sown separately on raised seedbed and transplanted after 30days after sowing, at the main plot of 2m x 2m area in lines with a gap of about one foot to avoid any hazards of mix up of the main experimental field. The crop has been raised with standard agronomic practices except the pest management aspects.

### IPM modules

**Table 1:** Different pest management modules used for sustainable production of chilli.

IPM Module	Application of neem seed cake @ 200 kg / ha during transplanting	Spraying of insecticides
M1	Yes	(NSKE) - Prophylactic application of NSKE at 7 ml/L, applied on 7, 14, 26,39, 50, and 65 after transplanting (DAT)
M2	Yes	(Rose apple LE) – Prophylactic application of rose apple LE at 97.8 g/L, applied on 7, 14, 21, 34, 41, 47, 58 and 65 and DAT
M3	Yes	(NSKE + emamectin benzoate + chlorfenapyr) – (a) NSKE at 7, 14, 21 and 50 DAT + (b) emamectin benzoate at 12 g ai/ha on 29 DAT + (c) chlorfenapyr at 1.98 g ai/L on 65 DAT
M4	Yes	(Rose apple LE + emamectin benzoate + chlorfenapyr) – (a) rose apple LE at 97.8 g/L on 7, 14, 21 and 49 DAT + (b) emamectin benzoate at 12 g ai/ha on 27 DAT + (c) chlorfenapyr at 1.98g ai/L on 65 DAT
M5 (chemical check)	Yes	Scheduled applications of thiamethoxam @ 50 g ai/ha on 7, 43 and 76 DAT + spinosad @ 70 g ai/ha on 21 and 54 DAT + rynaxypyr at 80 g ai/ha on 32 and 65 DAT
M6 (untreated check)	Yes	No chemical Spray.

### Sampling of fruit borer for IPM modules experiment

To study bio-efficacy of different insecticides against the thrips was studied and observations on population of pests were recorded one day before each spraying as pre-treatment count as well as 10 days interval of first spraying till the end of harvest period. For recording the pest population, five plants were selected randomly from inner rows and tagged in each plot.

The observation is based on the insect count based on fine random plant from each plot. A hard paper sheet of dark colour A\$ size has been placed under the plant. The topical

portion of the plant was gently shaken with hand the insect populations fall down on the paper. The insect population on the paper was counted with the help of 10X magnified glass from upper middle and lower leaf of each plant was considered.

These bioassay data were subjected to analysis of variance after making necessary transformation for comparison of treatment means by statistically analysed with arc sine values obtained from the conversion of percentage of infestation. Reduction of borer population in different treatments over control was computed.

$$\text{Population reduction over control (\%)} = 1 - \left( \frac{\text{Post-treatment population in treatment}}{\text{Pre-treatment population in treatment}} \times \frac{\text{pre treatment population in untreated control}}{\text{post-treatment population in untreated control}} \right) \times 100$$

### Yield estimation of chilli

First plucking of fruits was made at 45 DAT and all the fruits were weighed at the time of harvest and progressively summed up.

To compare the yield performance of chilli in different treatments, analysis of variance was carried out in randomized block design. The per cent increase of yield in treatment over control was calculated from the following formula<sup>[10]</sup>.

Percentage increase of yield in treatment over control

$$= \left( \frac{\text{Yield in treatment} - \text{Yield in control}}{\text{Yield in control}} \right) \times 100$$

Analysis of incremental benefit-cost ratios (ICBR) was also carried out to find out the cost effective treatments in pest management aspect. The analysis was done by estimating

different cost of cultivation and return from fruit yield on the basis of market value, from each treatment after converting them as on hectare basis while the ratio was calculated using following formula:

$$\text{ICBR} = \text{Net gain in treatment} / \text{Total cost in treatment}$$

Where, Net gain in treatment = Realization over control – Total cost in treatment

Realization over control = Total gain in treatment – (Total gain in control- Total cost in control)

### Results and discussion

#### Evaluation of Treatment modules on Thrips population

Results (Tables 2) indicated that all the treatments were effective in suppressing the pest population buildup and their

damage on the crop. However, efficacy levels differed amongst the treatments and some of the differences were statistically significant. Management modules were designed emphasizing the role of repellent crops in suppressing or deterring pest populations so that resultant crop damage is

minimized. Sap sucking by thrips definitely causes some damages to plants but they are of greater significance as vector of leaf curl virus. All the treatment modules effectively checked their population development.

**Table 2:** Impact of the treatments on the populations of thrips and resultant leaf curling on chilli plants at Instructional Farm, BCKV, Mohanpur during 2017 – 18.

Treatment Modules	Mean number of thrips/apical shoot (four top leaves) at days after transplanting (DAT)									Mean thrips population	% reduction over control	Curled leaf (%) (mean)
	10	20	30	40	50	60	70	80	90			
M1	8.1	4.9	5.4	6.2	6.7	5.1	5.8	6.8	7.2	6.2	57.33	12.3
M2	7.9	5.6	5.9	5.0	5.8	6.2	6.5	7.5	7.8	6.5	55.81	13.4
M3	8.5	4.9	2.2	3.4	1.2	3.3	2.2	3.2	4.6	3.7	74.56	0.94
M4	7.8	5.3	3.1	3.5	2.0	3.4	2.1	2.8	5.6	4.0	72.97	1.12
M5	8.3	2.8	4.3	4.7	3.5	3.2	4.8	8.8	10.8	5.7	61.12	3.52
M6	10.8	12.3	13.2	15.2	14.8	16.2	18.2	14.8	16.2	14.6		60.9
SEm(±)	0.78	0.81	0.62	0.61	0.58	0.82	0.59	0.51	0.61	0.27		
CD (p=0.05)	2.31	2.34	1.86	1.82	1.62	2.48	1.74	1.53	1.89	0.81		

**Table 3:** Impact of the treatments on the predatory complex and pollinators in chilli ecosystem at Instructional Farm, BCKV, Mohanpur during 2017 – 18.

Treatment Modules	Mean number of natural enemies per plant at days after transplanting (DAT)																	
	Coccinellid						Spider						Honey Bee					
	10	30	50	70	90	Ave	10	30	50	70	90	Ave	10	30	50	70	90	Ave
M1	3.5	4.7	5.4	5.8	6.2	5.12	3.2	4.6	5.2	5.3	5.6	4.78	1.2	1.3	4.6	5.2	5.1	3.48
M2	4.1	4.3	5.6	5.4	5.8	5.04	3.4	4.3	5.4	5.6	5.8	4.9	1.3	1.1	4.7	5.1	5.3	3.5
M3	3.2	3.9	3.7	3.8	4.2	3.76	3.5	3.6	3.5	3.1	2.7	3.28	1.1	1.2	3.8	4.2	4.3	2.92
M4	3.1	4.3	4.4	3.9	4.1	3.96	3.3	3.5	3.2	2.8	2.6	3.08	1.2	1.2	3.9	4.1	4.2	2.92
M5	3.2	1.2	0.84	0	0	1.048	3.5	1.2	1.6	1.4	1.4	1.82	1.3	0.6	1.2	0	0	0.62
M6	3.9	4.8	5.8	6.7	7.2	5.68	3.4	5.8	6.1	6.5	6.4	5.64	1.1	1.6	4.8	5.1	5.2	3.56
SEm(±)	0.61	0.42	0.41	0.43	0.41	0.456	0.22	0.36	0.27	0.28	0.34	0.294	0.23	0.21	0.37	0.42	0.36	0.318
CD (p=0.05)	1.82	1.22	1.12	1.13	1.24	1.306	0.96	1.13	0.82	0.84	1.02	0.954	0.67	0.65	1.11	1.23	1.06	0.944

Module M1 (NSKE) and M2 (rose apple LE) were phytochemical-based and results indicated that both of them suppressed the thrips population up to a certain level. Mean number of thrips in these treatments varied between 6.2 to 6.5/shoot. Module M3 and M4 included synthetic (chlorfenapyr) and semi-synthetic (emamectin benzoate) pesticide components in addition to plant fractions (NSKE in M3 and rose apple LE in M4) and these synthetic/semi-synthetic molecules markedly suppressed the populations of both the sucking pest species. M3 recorded mean of 3.7 thrips/apical shoot while in M4 the number was 4.0 /apical shoot as observed on different DAT. Thus module M3 and M4 were statistically at par (equivalent) but both were significantly superior to M1 and M2. Treated check (M5) suppressed thrips population but the efficacy level was inferior to the sustainable treatment module M3 and M4. Yet, due to resurgent thrips populations, the intensity of leaf curling (3.52%) was significantly higher in M5 as compared to M3 (0.94%) and M4 (1.12%). Leaf curling in M3, M4 and M5 were found only in the early vegetative phase, up to about 25 DAT and hence the mean score of curling was so low in those treatments. Phytochemicals alone (M1 and M2) could not offer adequate protection and recorded quite high apical leaf curling (12.3 - 13.4%).

#### Evaluation of Treatment modules over beneficial arthropods.

Records (Table 3) on the non-target impact showed that the phytochemical-based treatments were safe to predatory coccinellids and spiders and also to visiting bee populations. Populations of both of the generalist predator groups increased slowly but steadily. The sustainable treatments, on the other hand, showed a reduction in the populations of

spiders and coccinellids from 50 DAT onward (chlorfenapyr component was introduced on 63 DAT in M3 and on 55 DAT in M4) and were found inferior to M1 and M2 but significantly superior to M5 (chemical check). M5 strongly impacted the bees and though M3 and M4 (both having chlorfenapyr component) showed some negative impact on bees (slow increase), both were much safer over M5.

Bee species is a very important biotic component of agroecosystem because they play defining roles in cross pollinated crops as well as in commercial apiaries. Hence, bee toxicity of the pesticides and adverse impact of the pest management practices on bee populations are critically important. In the present study, chemical check was toxic to honey bees (*Apis* sp.) while the treatments based on the plant extracts like NSKE (M1) and rose apple LE (M2) were safe for the bee species. Bee numbers were consistent in these treatments, though increase rate was very slow; some bees emigrated while some others immigrated and overall impact showed a steady population. Sustainable/safer treatments (M3 and M4) had chlorfenapyr component and this was the reason why there was little suppression of populations of predators and pollinators, while the solely dependence over synthetic compounds reveals that they are more harmful against honey bee and results also shows that a significant decrease of pollinators found in the cop ecosystem. Results showed that the rationally designed pest management module for the chilli pests including apical leaf curling which emphasized on exploiting the *repellent crop theory* was effective, sustainable, safer, and cost-effective and in general agreement with some earlier works [12, 6].

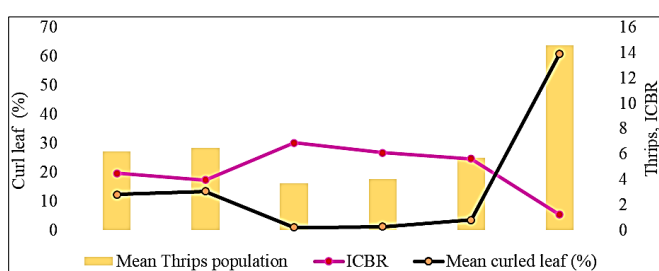
#### Economics of different pest management modules and fruit yield of Chilli

Fruit yield of corresponding to different modules were statistically analyzed and presented in Table 4 and Fig.1. All the modules produced significantly higher yield than the untreated control. The ultimate balance sheet for pest management reflects in the cost-economics and two treatments, M3 and M4 offered better benefit-cost ratio (BCR) over chemical check (1.22 and 1.4t/ha) while the phytochemical treatments showed poor ratios (T1: 4.48; T2: 3.96). The highest yield was obtained in M3 (6.8t/ha) which

was statistically significant with the modules M4 (6.2 t/ha). The results indicated that the M3 was reasonably effective against the sucking pest and highly effective against the thrips population which proved highly destructive to chilli crop. Analysis of incremental cost-benefit ratio revealed the superiority of M3 module over other Modules. The Incremental cost benefit ratio was in order of M3 (6.89) > M4 (6.12) > M5 (5.64) > M1 (4.48) > M2 (3.96) > and M6 (1.22).

**Table 4:** Economics for management under different modules during 2017-2018 in chilli for thrips infestation.

Modules	Production cost (Rs/ha)	Plant protection cost (Rs/ha)	Total cost (Rs/ha)	Yield (t/ha)	% Yield increase over control	Gross return (Rs/ha)	Net return over control (Rs/ha)	Net gain (Rs/ha)	ICBR
M1	18900	5740	24640	4.5	221.43	135000	93000	110360	1: 4.48
M2	18900	6480	25380	4.2	200.00	126000	84000	100620	1: 3.96
M3	18900	6960	25860	6.8	385.71	204000	162000	178140	1: 6.89
M4	18900	7240	26140	6.2	342.86	186000	144000	159860	1: 6.12
M5	18900	7760	26660	5.9	321.43	177000	135000	150340	1: 5.64
M6	18900		18900	1.4		42000		23100	1: 1.22



**Fig 1:** Thrips population and resultant curled leaf with ICBR

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