Management of Chilli Thrips, *Scirtothrips dorsalis* (Hood) Using Synthetics and Biologicals

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ABSTRACT

Bio-efficacy of synthetics, entomopathogenic fungi and natural products were evaluated against chilli thrips, *Scirtothrips dorsalis* (Hood) during *rabi* season at College of Agriculture, Hassan (Oct. 2019 to Jan. 2020). The insecticides were applied on 30-60 days old crop at the peak infestation of thrips. One week after application, most of the insecticides showed significant reduction in thrips population and were superior to untreated control. Of these, diafenthiuron accounted for maximum reduction in thrips population (87%) at 7th day after spray followed by acephate (77%), spinosad (69%) and imidacloprid (60%). Further, diafenthiuron treatment continued to record significant decline in thrips population up to 10th day. Further, diafenthiuron application was found significantly more effective upto 14 days after application and resulted in higher fruit yield of 42.20 quintals/ha. So, use of diafenthiuron and conventional insecticide, acephate alternatively is ideal as the avoidable loss was similar (52.83%). This practice would also reduce the cost of plant protection as well as the insecticide pressure on this key pest of chilli crop.

Keywords: Chilli thrips, Synthetics, Natural products, Bioefficacy, Diafenthiuron

CHILLI (*Capsicum annuum* L.) is an important condiment as well as vegetable crop grown all over the country. It is considered as one of the important cash crops because of its colour and pungency attributed by capsanthin and capsaicin, respectively. India is one of the major producers of chilli in the world with an annual production of 21,49,000 metric tonnes from about 7,52,000 ha and in Karnataka, chilli occupy an area of 1,27,000 ha with a production of 2,60,000 metric tonnes (Anonymous, 2019). Although the crop has got greater potentialities for export (apart from domestic requirement), ravages of pests and diseases are leading to drastic decrease in its yield. Among them, the insect and non-insect pests attacking at different growth stages are of most concern (Samota *et al.,* 2018). Among all, sucking pests constitute a major threat to chillies contributing severe loss from nursery till harvest of the crop. Thrips, *Scirtothrips dorsalis* (Hood) (Thripidae : Thysanoptera) is one of the most destructive pests of chilli and under severe infestation, the yield losses are severe. Thrips with its lacerating mouth parts cause necrosis of tissues by extracting contents from the epidermal cells of plant. Both nymphs and adults suck the sap from tender plant parts, resulting in shrivelling of leaves, retarded shoot development and finally the leaves fall-off.

Survey by Asian Vegetable Research and Development Centre revealed that, thrips (*S. dorsalis*), aphids (*Myzus persicae* Sulzer, *Aphis gossypi* Glover) and yellow mite (*Polyphagotarsonemus latus* (Banks) are the major pests that attack chilli. Thrips multiply at a faster rate during rabi season (Manjunath and Srinivasa, 2017) and dry weather condition and causes a yield loss of 50-90 per cent. More often use of synthetic chemicals is one of the most common and popular methods of thrips control on chilli crop, especially with the introduction of large number of newer insecticides. Indiscriminate use of pesticides has led to severe ecological consequences like destruction of natural enemy fauna, adverse effect on non- target organisms and ultimately the development of resistance to pesticides. Therefore, it is necessary that, these chemicals are used wisely in the management of key pest like chilli thrips with due consideration of economics as well as the resulting environmental damage (Vanisree *et al.,* 2017). It is apparent that, many conventional OP insecticides still remain effective against chilli thrips and find a suitable place in the plant protection schedule. It is equally necessary to formulate an alternative approach by using bio-agents in pest management. Entomopathogenic fungi have been found to be a sound tool. With this background, the harmonious use of synthetics, entomopathogenic fungi and natural products for the management of chilli thrips were studied at Hassan, Karnataka.

Material and Methods

Field evaluation of synthetics, entomopathogenic fungi and natural products against chilli thrips was carried out during *rabi* 2019-20 (Oct. 2019 - Jan. 2020) at the College of Agriculture, Hassan with chilli hybrid, Ulka (Purchased from Private nursery) which is popularly cultivated in and around Hassan district. The treatments included five insecticides such as acephate (Asataf 75 SP), dimethoate (Rogor 30EC), imidacloprid (Confidor 17.8 SL), spinosad (Tracer 45 SC) (as standard check) and diafenthiuron (Pegasus 50 WP), four entomopathogenic fungal treatments such as *Metarhizium anisopliae* @ 2 x 10^8 CFU/g, *Lecanicillium lecanii* @ 2 x 10^8 CFU/g, *Metarhizium anisopliae* @ 1 x 10^7 CFU/g as tablets and *Lecanicillium lecanii* 1 x 10^7 CFU/g as capsule, two natural products such as NSKE @ 4 per cent and Horticulture mineral oil @ 2 per cent (MAK ALL SEASON HMO) and one untreated control. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Each treatment plot measured 5m x 4m and chilli seedlings were planted with 60cm row spacing and 30cm between plants with protective irrigation and recommended agronomic practices except the use of insecticides. In anticipation of mite incidence protective spray of dicofol @ 2.5 ml/l was given and there was no incidence of major lepidopteran pest during the experimentation. First application of insecticide was taken up when the thrips incidence was approximately at the Economic Threshold Level (ETL) of one thrips/leaf. Observations on population of thrips was recorded from five randomly selected plants at one day before (pre-treatment) and 1, 3, 7, 10 and 14 days after spray (DAS), by tapping the young shoots of the plant onto a white acrylic sheet and counting them manually. Spray was repeated after 14 days.

Thrips population recorded was expressed as the mean number per three young shoots from each plant and population data were subjected to statistical analysis (using ANOVA in SAS software) after $\sqrt{x+0.5}$ transformation and treatment means were compared by using CD value. Per cent reduction in the population of thrips in insecticide treatments was computed using the formula of Henderson and Tilton (1955).

$$\text{Per cent reduction} = \left[1 - \left(\frac{Ta}{Tb} \times \frac{Cb}{Ca}\right)\right] \times 100$$

where,

Ta = Population count after treatment

Tb = Population count before treatment

Cb = Population count in control plot before treatment and

Ca = Population count in control plot after treatment.

Red chilli fruit yield was recorded treatment-wise and extrapolated to hectare basis and subjected to statistical analysis. The avoidable loss in yield was worked out as suggested by Pradhan (1969) *i.e.,* Avoidable loss in yield = (T-C/T) × 100, where, T = yield from treated plot & C = yield from control plot.

Results and Discussion

Thrips population data is presented in Table 1 & 2 and the corresponding reduction in thrips population, Fig. 1 & 2.

Bioefficacy of Synthetics, Entomopathogenic Fungi and Natural Products against Chilli Thrips during *rabi*

I Spray

One day after first application of diafenthiuron and acephate during rabi (October 2019-January 2020), thrips population reduced to zero (from 1.13/plant or 1.27/plant, respectively), whereas in imidacloprid

TABLE 1

Bioefficacy of synthetics, entomopathogenic fungi and natural products against chilli thrips (*I Spray*)

Treatments	Number of thrips @					
	Pre treatment	1 DAS	3 DAS	7 DAS	10 DAS	14 DAS
Acephate @ 470 g a.i./ha	1.27 (1.33)	0.00 (0.71)^{c}	0.13 (0.79)^{c}	0.13 (0.79)	0.20 (0.83)	0.47 (0.98)
Dimethoate @ 350 g a.i./ha	1.60 (1.43)	0.47 (0.98)^{bc}	0.53 (1.00)^{bc}	0.60 (1.05)	1.13 (1.27)	0.60 (1.05)
Imidacloprid @ 50 g a.i./ha	1.47 (1.40)	0.13 (0.79)^{c}	0.40 (0.95)^{bc}	0.27 (0.87)	0.33 (0.91)	0.40 (0.94)
Diafenthiuron @ 400 g a.i./ha	1.13 (1.27)	0.00 (0.71)^{c}	0.13 (0.79)^{c}	0.07 (0.75)	0.40 (0.92)	0.33 (0.89)
Metarhizium anisopliae 2 x 10^{8} CFU/g	1.60 (1.45)	0.53 (0.99)^{abc}	0.73 (1.09)^{abc}	0.67 (1.08)	0.73 (1.06)	0.67 (1.05)
Lecanicillium lecanii 2 x 10^{8} CFU/g	1.27 (1.33)	0.47 (0.97)^{bc}	0.53 (1.02)^{bc}	0.33 (0.90)	0.27 (0.87)	0.27 (0.87)
Metarhizium anisopliae 1 x 10^{7} CFU/g tablet	1.40 (1.38)	0.73 (1.10)^{ab}	1.00 (1.22)^{ab}	0.67 (1.05)	1.07 (1.23)	0.60 (1.05)
Lecanicillium lecanii 1 x 10^{11} CFU/g capsule	1.53 (1.43)	0.47 (0.97)^{bc}	0.60 (1.03)^{bc}	0.67 (1.04)	0.53 (0.99)	0.67 (1.08)
NSKE 4%	1.27 (1.33)	0.80 (1.13)^{ab}	1.13 (1.24)^{ab}	0.73 (1.10)	0.80 (1.14)	0.67 (1.08)
Horticultural Mineral oil (MAK All season HMO) 2%	1.47 (1.40)	0.33 (0.89)^{bc}	1.00 (1.22)^{ab}	0.67 (1.06)	0.73 (1.08)	0.67 (1.08)
Spinosad @ 90 g a.i./ha (Check)	1.40 (1.38)	0.27 (0.87)^{bc}	0.07 (0.75)^{c}	0.20 (0.83)	0.27 (0.87)	0.27 (0.87)
Control (Untreated)	1.60 (1.45)	1.13 (1.28)^{a}	1.60 (1.41)^{a}	0.73 (1.11)	0.67 (1.08)	0.93 (1.18)
F test	NS	*	*	NS	NS	NS
S.Em.±	(0.07)	(0.10)	(0.12)	(0.10)	(0.11)	(0.08)
CD at P=0.05	-	(0.29)	(0.35)	-	-	-

@ Number from three young shoots, DAS: Days after spray; NS: Non-significant; *: Significant at 5% probability; Figures in the parentheses are $\sqrt{x+0.5}$ transformed values; Treatments with same alphabetical superscript within the column are statistically on par

treatment the population of thrips was decreased from 1.47 to 0.37/plant. However, diafenthiuron retained its effectiveness up to seven days. Next best treatments were, spinosad, MAK ALL SEASON HMO, dimethoate, *L. lecanii* 2 x 10^{8} CFU/g, *L. lecanii* 1 x 10^{11} CFU/g capsule reduced the thrips population significantly. By 3rd day after application, acephate (0.13 thrips/plant) and spinosad (0.07 thrips/plant) were on par in their efficacy even with diafenthiuron. Diafenthiuron accounted for maximum reduction in thrips population (87%) on 7th day followed by acephate (77%) spinosad (69%) and imidacloprid (60%). Apparent decline in effectiveness of insecticides including diafenthiuron was observed on 10th day, as the number of thrips in all the insecticidal treatments increased. The reduction in thrips population in diafenthiuron treatment reduced to 15 per cent, while it was more than 50 per cent in acephate and spinosad treatments. By 14th day, thrips population in different treatments was more or less statistically on par with each other and this necessitated a repeat application after 14 days.

II Spray

After II spray, there was no significant difference among treatments up to seven days. By 10th day after application, diafenthiuron was found more effective by recording least number of thrips (0.33/plant) and all other treatments were on par with each other. Diafenthiuron retained its effectiveness upto 14 days after II spray. Apparent decline in effectiveness of all the insecticides and natural products was noticed on

TABLE 2

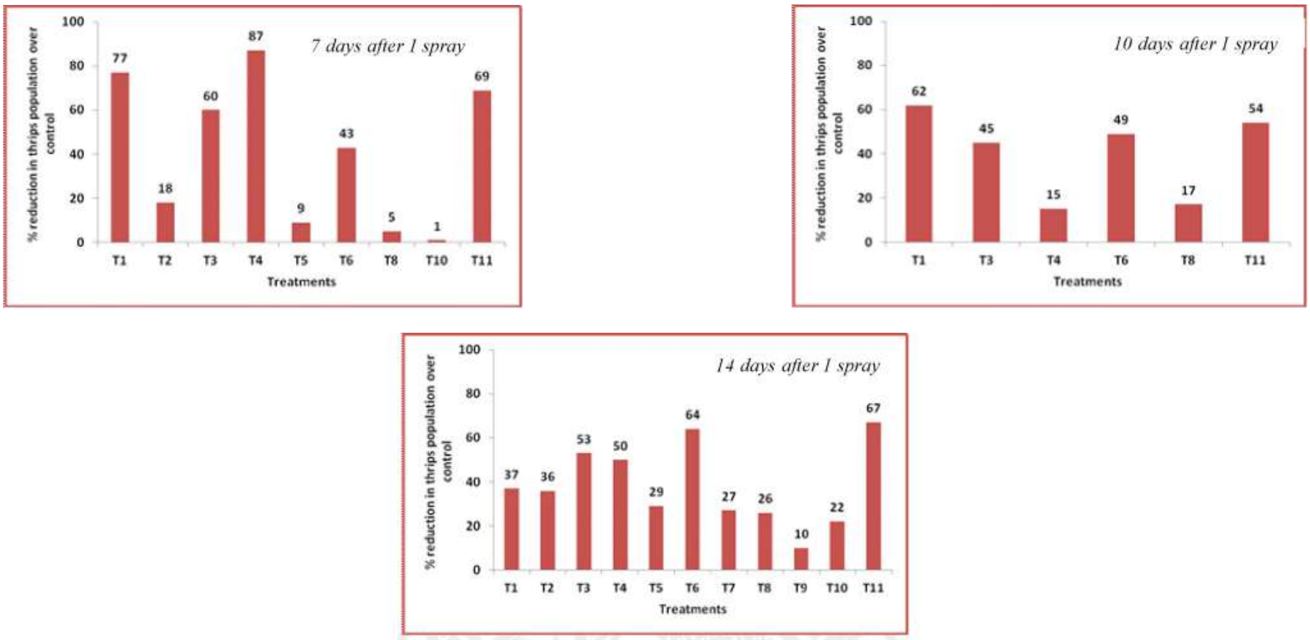
Bio efficacy of synthetics, entomopathogenic fungi and natural products against chilli thrips (*II Spray*)

Treatments details	Number of thrips @									
	1 DAS		3 DAS		7 DAS		10 DAS		14 DAS	
Acephate @ 470 g a.i./ha	0.73	(1.11)	0.27	(0.86)	0.67	(1.07)	1.00	(1.21) [a]	1.20	(1.28)[bc]
Dimethoate @ 350 g a.i./ha	1.13	(1.26)	0.80	(1.14)	0.80	(1.14)	1.00	(1.22) [a]	2.20	(1.64) [a]
Imidacloprid @ 50 g a.i./ha	0.60	(1.04)	0.80	(1.14)	0.93	(1.2)	0.93	(1.19) [a]	1.00	(1.22) [dc]
Diafenthiuron @ 400 g a.i./ha	1.00	(1.21)	0.80	(1.13)	0.47	(0.98)	0.33	(0.89) [c]	0.40	(0.93) [e]
Metarhizium anisopliae 2×10^8 CFU/g	1.00	(1.2)	0.93	(1.2)	1.07	(1.24)	0.80	(1.13) [ab]	0.73	(1.1)[dce]
Lecanicillium lecanii 2×10^8 CFU/g	1.67	(1.47)	0.60	(1.05)	0.80	(1.13)	0.93	(1.2) [a]	1.73	(1.49) [ab]
Metarhizium anisopliae 1×10^7 CFU/g tablet	1.00	(1.21)	0.67	(1.07)	0.80	(1.13)	0.93	(1.19) [a]	1.07	(1.25)[bc]
Lecanicillium lecanii 1×10^{11} CFU/g capsule	1.20	(1.28)	0.93	(1.19)	0.87	(1.16)	0.80	(1.13) [ab]	1.27	(1.31)[bc]
NSKE 4%	0.67	(1.07)	0.80	(1.14)	1.07	(1.25)	1.00	(1.22) [a]	1.20	(1.3)[bc]
Horticultural Mineral oil (MAK ALL SEASON HMO) 2%	1.13	(1.27)	1.20	(1.3)	1.20	(1.3)	0.87	(1.17) [ab]	1.33	(1.35)[bc]
Spinosad @ 90 g a.i./ha (Check)	0.27	(0.86)	0.87	(1.16)	0.73	(1.08)	0.40	(0.94)[bc]	0.47	(0.97) [de]
Control (Untreated)	1.00	(1.22)	0.93	(1.19)	0.87	(1.17)	1.07	(1.25) [a]	0.80	(1.13)[dce]
F test	NS		NS		NS		*		*	
S.Em.±	(0.13)		(0.07)		(0.10)		(0.07)		(0.09)	
CD at P=0.05	-		-		-		(0.21)		(0.25)	

@ Number from three young shoots, DAS: Days after spray; NS: Non-significant; *: Significant at 5% probability; Figures in the parentheses are $\sqrt{x+0.5}$ transformed values; Treatments with same alphabetical superscript within the column are statistically on par.

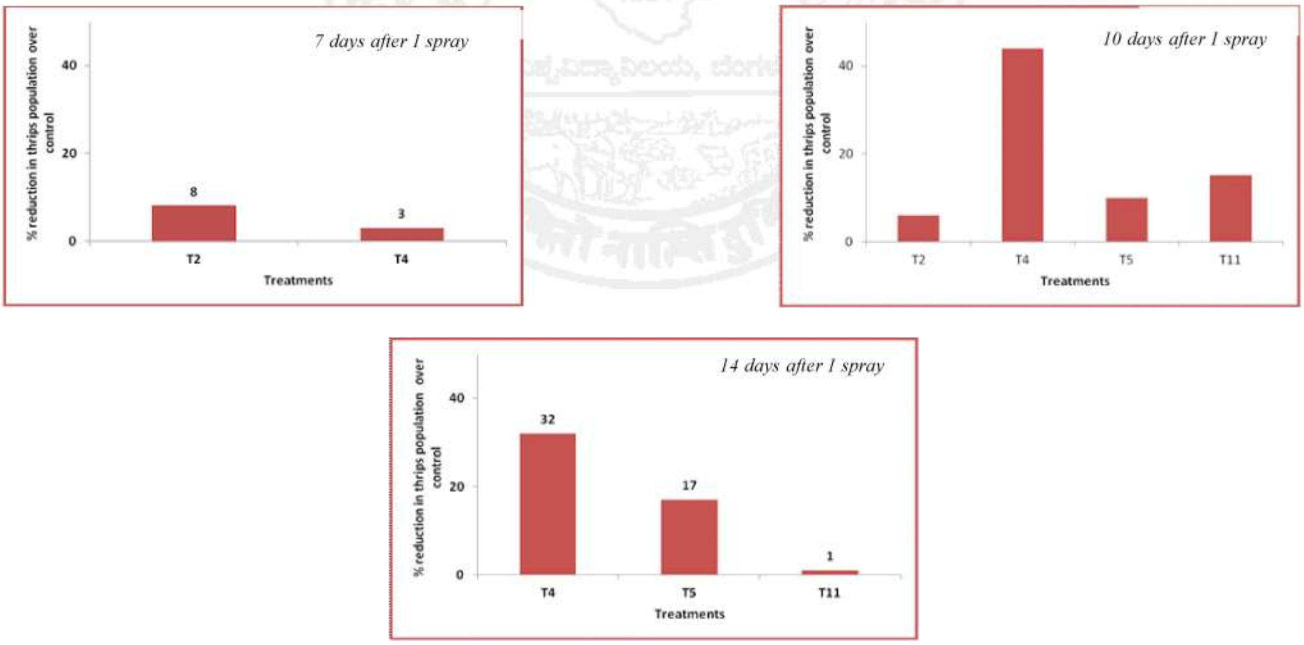
10[th] day, as the number of thrips in all the treatments increased. But, the reduction in diafenthiuron treatment was highest (44%) while it was less than 15 per cent in spinosad, acephate and *Metarhizium anisopliae* 2×10^8 CFU/g treatments. By 14[th] day, thrips population reached more or less the same in all insecticide treated plots except diafenthiuron treatment (Table 2 & Fig. 2).

Promising features of insecticides such as imidacloprid, acephate, dimethoate, diafenthiuron and spinosad used in the present study against *S. dorsalis* have been evaluated individually or separately which was also reported by many earlier workers (Seal *et al*., 2005; Nagaraj *et al.,* 2007; Reddy *et al.,* 2007; Patel *et al.,* 2009; Nandihalli, 2009; Maity *et al.,* 2015; Kumar *et al*., 2017; Sahu *et al.,* 2017; Sathua *et al*., 2017; Tirkey & Kumar, 2017 and Vanisree *et al*., 2017) particularly on chilli crop. The effectiveness of imidacloprid 17.8SL on the activity of chilli thrips in Karnataka (Nagaraj *et al.,* 2007) and Uttar Pradesh (Sahu *et al*., 2017; Sathua *et al*., 2017 and Tirkey & Kumar, 2017) corroborate the efficacy observed in the present study. The effectiveness of spinosad 45 SC on the activity of chilli thrips in the present study are supported by the observations of Manjunath *et al.* (2018). Similarly, application of diafenthiuron in Gujarat (Patel *et al.,* 2009), West Bengal (Maity *et al.,* 2015) and Andhra Pradesh (Vanisree *et al*., 2017) have shown appreciable reduction in the population of thrips at different intervals after application on chilli crop as noticed in the present study. More beneficial effect of the application of acephate 75SP and dimethoate 30EC was reported in Uttar Pradesh (Sathua *et al*., 2017



T1: Acephate @ 470 g a.i./ha, T2: Dimethoate @ 350 g a.i./ha, T3: Imidacloprid @ 50 g a.i./ha, T4: Diafenthiuron @ 400 g a.i./ha, T5: *Metarhizium anisopliae* $2x10^8$ CFU/g, T6: *Lecanicillium lecanii* $2x10^8$ CFU/g, T7: *Metarhizium anisopliae* $1x10^7$ CFU/g tablet, T8: *Lecanicillium lecanii* $1x10^{11}$ CFU/g capsule, T9: NSKE 4%, T10: Horticultural Mineral oil (MAK ALL SEASON HMO) 2%, T11: Spinosad @ 90 g a.i./ha (Check)

Fig. 1: Effect of different treatments on the population of chilli thrips (Oct.19-Jan 20) - *I spray*



T1: Acephate @ 470 g a.i./ha, T2: Dimethoate @ 350 g a.i./ha, T3: Imidacloprid @ 50 g a.i./ha, T4: Diafenthiuron @ 400 g a.i./ha, T5: *Metarhizium anisopliae* $2x10^8$ CFU/g, T6: *Lecanicillium lecanii* $2x10^8$ CFU/g, T7: *Metarhizium anisopliae* $1x10^7$ CFU/g tablet, T8: *Lecanicillium lecanii* $1x10^{11}$ CFU/g capsule, T9: NSKE 4%, T10: Horticultural Mineral oil (MAK ALL SEASON HMO) 2%, T11: Spinosad @ 90 g a.i./ha (Check)

Fig. 2: Effect of different treatments on the population of chilli thrips (Oct.19-Jan 20) - *II spray*

and Sahu *et al.,* 2017). Similarly, evaluation of spinosad 45SC in Andhra Pradesh (Vanisree *et al*., 2017) and Uttar Pradesh (Sahu *et al.,* 2017 and Tirkey & Kumar, 2017) shown appreciable reduction in thrips population of thrips on chilli as recorded in the present study.

Yield of Chilli

Yield data of dry chilli fruits from evaluation of synthetics, EPF's and natural products against chilli thrips, *S. dorsalis* are given in Table 3. The data revealed that, the highest yield of 42.20 q/ha was recorded in diafenthiuron treatment accounting for an avoidable loss of 65.80 per cent. Yield from other treatments such as imidacloprid, acephate, dimethoate, spinosad, HMO's, *M. anisopliae* 2 x 10^8 CFU/g, *L. lecanii* 2 x 10^8 CFU/g ranged from 26.62-30.60 q/ha with the corresponding avoidable loss ranging from 44.13-52.83 per cent and were next best to diafenthuron treatment. Diafenthiuron, imidacloprid and dimethoate applied treatments recorded higher chilli fruit yield as reported in Uttar Pradesh (Sahu *et al.,* 2017 and Tirkey & Kumar, 2017), Andhra Pradesh (Vanisree *et al*., 2017), Rajasthan (Kumar *et al.,* 2017), West Bengal (Ghosh *et al*., 2017 and Maity *et al.,* 2015) and Karnataka (Pradhan, 1969 and Nagaraj *et al*., 2007).

From the current bioefficacy study, it is shown that two applications of diafenthiuron at two weeks interval exercised 3- 87 per cent reduction in thrips population and thus increased the fruit yield. This accounted for the avoidable loss of 65.80 per cent due to thrips infestation. Supportingly, diafenthiuron has dual action against two major dreaded pests, thrips and yellow mite in chilli systems. Trans-laminar property associated with photo-conversion into toxic carbodiimide is its added features. Non-nerve poison insecticide like diafenthiuron compounds are having unique mode of action such as a metabolic poison inhibiting mitochondrial ATPase enzyme are more promising for the control of thrips. On the other hand, new generation insecticides such as imidacloprid was in use by the chilli growers with which both scientists and farmers appreciated more significant control of thrips. Later neonicotinoid, imidacloprid became more popular and it was considered as a panacea for sucking pests in particular, which damaged most of our cultivated crops at the grand vegetative growth stage or at pre-flowering period. Thus, alternate use of neonicotinoids and other molecules like fipronil and diafenthiuron was presumed to be a good practice among chilli farmers. With the introduction of other new generation neonicotinoid *viz*., thiamethoxam and clothianidin (Ghosh *et al*., 2017 and Tirkey & Kumar, 2017) the performance of diafenthiuron and fipronil were observed to be mediocre against thrips. Also at this juncture, efficacy of imidacloprid against thrips was perceived to be inconsistent due to obvious reason of its extensive use (Vanisree *et al*., 2017). Another

TABLE 3

Application of synthetics, entomopathogenic fungi and natural products against thrips *vs* yield of chilli

Treatments	Yield of chilli (q/ha)	Avoidable loss in yield (%)
Acephate @ 470 g a.i./ha	30.60 [b]	52.83
Dimethoate @ 350 g a.i./ha	27.17 [b]	46.87
Imidacloprid @ 50 g a.i./ha	29.50 [b]	51.07
Diafenthiuron @ 400 g a.i./ha	42.20 [a]	65.80
Metarhizium anisopliae 2x10^8CFU/g	33.63 [ba]	57.09
Lecanicillium lecanii 2x10^8CFU/g	28.23 [b]	48.88
Metarhizium anisopliae 1x10^7CFU/g tablet	27.37 [b]	47.26
Lecanicillium lecanii 1x10^{11}CFU/g capsule	25.83 [bc]	44.13
NSKE 4%	32.87 [ba]	56.09
Horticultural Mineral oil (MAK ALL SEASON HMO) 2%	26.55 [b]	45.64
Spinosad @ 90 g a.i./ha (Check)	26.62 [b]	45.77
Control (Untreated)	14.43 [c]	
F test	*	
SEM±	3.90	
CD (P=0.05)	11.45	

Treatments with same alphabetical superscript within the column are statistically on par.; *: Significant at 5% probability.

considerable observation in the present study is that, the conventional OP compound, acephate found next best to diafenthiuron in the order of effectiveness against thrips. This may be attributed to reduced usage leading to increased target site sensitivity in the pest.

Diafenthiuron exercised significant reduction of thrips, followed by acephate and spinosad. Harmonious alternative use of these compounds at an interval of ≈10-14 days might manage the thrips more effectively and realize better yield and reasonable avoidable losses in the yield.

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