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Management of Thrips (*Scirtothrips dorsalis,* Hood) of Bell Pepper Under Protected Cultivation

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ABSTRACT

The investigation on management of thrips, *Scirtothrips dorsalis* (Hood) in bell pepper under protected condition was carried out during *kharif* 2014 & 2015 at Krishi Vigyan Kendra, Junagadh Agricultural University, Khapat- Porbandar. The data on pooled over periods over sprays (2014) revealed that T_3 [*i.e.* Thiamethoxam 25% WG @ 25g a.i./ ha (First Spray); Azadirachtin 1500 ppm @ 3.0ml/ lit (Second Spray), Spinosad 2.5% SC @ 15 g a.i./ ha (Third Spray)] was found significantly superior to rest of the treatments and was recorded the lowest (1.96 thrips/ 3 leaves) thrips population followed by T_6 (2.32 thrips/ 3 leaves) and T_1 (2.60 thrips/ 3 leaves). Further, T_2 (2.78 thrips/ 3 leaves), T_4 (2.85 thrips/ 3 leaves) and T_5 (3.15 thrips/ 3 leaves) were found to be less effective as compare to T_3 against thrips. In 2015, T_3 was found significantly superior to rest of the treatments as it recorded the lowest (2.03 thrips/ 3 leaves) thrips population followed by T_6 (2.26 thrips/ 3 leaves), T_1 (2.70 thrips/ 3 leaves), T_2 (2.78 thrips/ 3 leaves), T_4 (2.92 thrips/ 3 leaves) and T_5 (3.03 thrips/ 3 leaves) as all the treatments were statistically differ from each other. Among all the treatments T_4 and T_5 were found mediocre in their effectiveness. The data on pooled over periods on leaf curling revealed that minimum leaf curling (14.01 %) was recorded in T_3 but it was at par with all the other treatments *viz.,* T_6 (16.84 %), T_1 (22.49%), T_5 (23.13%), T_4 (23.92%), and T_2 (24.65%) during 2014. The same results were obtained with minimum leaf curling (13.18 %) in T_3 followed by T_6 (16.50 %), T_1 (22.65 %), T_5 (23.70 %), T_4 (24.57 %) and T_2 (24.63 %) in 2015. The schedules (treatments) wise pooled (2014 and 2015) data on fruit yield revealed that the green fruits received from treated plot showed that maximum yield of 23901 kg/ ha with 176.75 per cent increased over control was obtained from the crop treated in T_3 followed by T_6 (21235 kg/ ha and 145.89 % increased over control) and T_1 (19900 with 130.43 %). Lower fruit yield was observed in T_2 (19140 with 121.63 %), T_4 (17987 with 108.27 %) and T_5 (17875 with 106.97 %). The data on economics revealed that gross realization was found maximum from T_3 (‘ 358515) followed by T_6 (‘ 318525), T_1 (‘ 298500) and T_2 (‘ 287100). While, maximum net realization (‘ 228975/ ha) was received from the T_3 with 47.02 C:B followed by T_6 (‘ 188985 with 47.60 C:B), T_1 (‘ 168960 with 45.66 C:B) and T_2 (‘ 157560 with 69.96 C:B).

Key words *Bell pepper, thrips, leaf curl, and management*

Bell pepper, *(Capsicum annuum* L) is one of the most popular and highly remunerative vegetable crops grown in most parts of the world, In India, it is intensively cultivated in Karnataka, Maharashtra, Tamil Nadu, Himachal Pradesh and hilly areas of Uttar Pradesh. *Capsicum* cultivation under protected condition is gaining popularity especially coloured hybrids in peri-urban production system because of easy access to urban markets. Various biotic, abiotic and physiological factors are the main constraints encountered by the farmers in getting higher productivity and good quality produce. Unlike many of the field problems, insect pest problems are peculiar to green house cultivation. Mite, thrips, whitefly, fruit borer, leaf miner, aphids, gall midge, nematodes and snails are serious problems on vegetable crops under protected condition. They multiply in large numbers under controlled temperature and relative humidity there by leading to significant crop loss. Keeping in view the above facts, management of thrips (*Scirtothrips dorsalis* Hood), of protected bell pepper was undertaken during *Kharif* 2014 and *Kharif* 2015.

MATERIALS AND METHODS

In order to study the eco-friendly pest management modules against thrips, the experiment was laid out during *kharif* -2014 and *kharif* -2015 at Krishi Vigyan Kendra, Junagadh Agricultural University, Khapat-Porbandar. Bell pepper variety Mahabharata was transplanted at a spacing of 30 cm x 45 cm. All the recommended agronomical practices were followed for raising the good crop.

Treatments details

T_1:- Module -1	(a)	Profenofos 50% EC @500g a.i./ha.	First spray
	(b)	*Beuveria bassiana* @ 80.0g/pump.	Second spray
	(c)	Diafenthiuron 50%WP@ 300 g a.i./ha.	Third spray
T_2:- Module -2	(a)	Phosphamidon 40% SL @300g a.i./ha.	First spray
	(b)	*Beuveria bassiana* @ 80.0g/pump.	Second spray
	(c)	Acetamiprid 20%SP@20 g a.i./ha.	Third spray

T_3:- Module -3	(a)	Thiamethoxam 25% WG @ 25g a.i./ha.	First spray
	(b)	Azadirachtin 1500ppm @ 3.0ml/lit.	Second spray
	(c)	Spinosad 2.5%SC@15 g a.i./ha.	Third spray
T_4:- Module -4	(a)	Triazophos 40% EC @500g a.i./ha.	First spray
	(b)	*Verticillium lecanii* @ 80.0g/pump.	Second spray
	(c)	Clothianidin 50% WDG @20g a.i./ha.	Third spray
T_5:- Module -5	(a)	Dimethoate 30% EC @ 200g a.i./ha.	First spray
	(b)	*Verticillium lecanii* @ 80.0g/pump.	Second spray
	(c)	Carbosulfan 25% EC @ 250 g a.i./ha.	Third spray
T_6:- Module -6	(a)	Imidacloprid 17.8% SL @ 50g a.i./ha.	First spray
	(b)	Azadirachtin 1500ppm @ 3.0ml/lit.	Second spray
	(c)	Fipronil 5%SC @ 50 g a.i./ha.	Third spray
T_7		control (water spray)	

Adequate distance between two plots was maintained. The insecticidal treatment was applied through manually operated hydraulic knapsak sprayer with a pressure of 3.5 kg/ cm^2 on slight run-off stage. The observations of number of thrips/ 3 leaves before and after spraying at weekly interval starting from 10 DAT and was also recorded the damage due to thrips at 21, 42 and 60 DAT. The criterion for grading the severity of leaf damage given by Niles (1980) was adopted (0-4 grade). The yield of fruits was recorded at each picking.

RESULTS AND DISCUSSION

Pooled over Periods over Spray (*Kharif*-2014)

The data on pooled over periods over sprays presented in Table -1 revealed that all schedule treatments recorded significantly lower number of thrips (1.96 to 3.15 thrips/ 3 leaves) than control (6.36 thrips/ 3 leaves). The order of scheduled treatments in comparison to control based on thrips population given in bracket was: T_3 (1.96) > T_6 (2.32) > T_1 (2.60) > T_2 (2.78) > T_4 (2.85) > T_5 (3.15) > control (6.36). T_3 [*i.e.* Thiamethoxam 25% WG @ 25g a.i./ ha (First Spray); Azadirachtin 1500 ppm @ 3.0ml/ lit (Second Spray), Spinosad 2.5% SC @ 15 g a.i./ ha (Third Spray), Thiamethoxam 25% WG @ 25g a.i./ ha (Fourth Spray)] was found significantly superior to rest of the treatments and was recorded the lowest (1.96 thrips/ 3 leaves) thrips population as compare to control. The next best treatment was T_6 (2.32 thrips/ 3 leaves) as it was significantly superior to all other treatments except T_3 followed by T_1 which was also recorded minimum thrips population (2.60 thrips/ 3 leaves). Further, T_2 (2.78 thrips/ 3 leaves), T_4 (2.85 thrips/ 3

Table 1. Bioefficacy of insecticides against thrips, *S. dorsalis* infesting bell pepper

Treatment	No. of Thrips/ 3leaves (Pooled over Periods over Spray *Kharif* -2014)	No. of Thrips/ 3leaves (Pooled over Periods over Spray*Kharif* -2015)
T_1	1.76(2.60)	1.79(2.70)
T_2	1.81(2.78)	1.81(2.78)
T_3	1.57(1.96)	1.59(2.03)
T_4	1.83(2.85)	1.85(2.92)
T_5	1.91(3.15)	1.88(3.03)
T_6	1.68(2.32)	1.66(2.26)
T_7	2.62(6.36)	2.45(5.50)
S.Em.±	0.01	0.01
C.D. at 5 %	0.03	0.03
C.V. %	4.00	4.50

Note: 1. Figures in the parentheses are original values while outside are square root transformed values

2. **T_1:** Profenofos 50% EC @ 500g a.i./ ha (First Spray [FS]), *Beuveria bassiana* @ 80.0g/ pump (Second Spray [SS]), Diafenthiuron 50%WP @ 300 g a.i./ ha (Third Spray [TS]), Profenofos 50% EC @ 500g a.i./ ha (Fourth Spray [FS]) **T_2:** Phosphamidon 40% SL @ 300g a.i./ ha (FS), *Beuveria bassiana* @ 80.0g/ pump (SS), Acetamiprid 20% SP @ 20 g a.i./ ha (TS), Phosphamidon 40% SL @ 300g a.i./ ha (FS); **T_3:** Thiamethoxam 25% WG @ 25g a.i./ ha (FS); Azadirechtin 1500ppm @ 3.0ml/ lit (SS), Spinosad 2.5% SC @ 15 g a.i./ ha (TS), Thiamethoxam 25% WG @ 25g a.i./ ha (FS); **T_4:** Triazophos 40% EC @ 500g a.i./ ha (FS), *Verticillium lecanii* @ 80.0g/ pump (SS), Clothianidin 50% WDG @ 20g a.i./ ha (TS), Triazophos 40% EC @ 500g a.i./ ha (FS); **T_5:** Dimethoate 30% EC @ 200g a.i./ ha (FS), *Verticillium lecanii* @ 80.0g/ pump (SS), Carbosulfan 25% EC @ 250 g a.i./ ha (TS), Dimethoate 30% EC @ 200g a.i./ ha (FS) and **T_6:** Imidacloprid 17.8% SL @ 50g a.i./ ha (FS), Azadirechtin 1500ppm @ 3.0ml/ lit (SS) and Fipronil 5% SC @ 50 g a.i./ ha (TS), Imidacloprid 17.8% SL @ 50g a.i./ ha (FS).

Table 2. Effect of insecticidal treatments on leaf curling of bell pepper caused by thrips, *S. dorsalis* (Pooled *kharif* -2014 and pooled *kharif* -2015)

Treatment	Leaf curl (%)	
	Pooled (*Kharif* 2014)	Pooled (*Kharif* 2015)
T_1	28.31(22.49)	28.42(22.65)
T_2	29.77(24.65	29.76(24.63)
T_3	21.98(14.01)	21.28(13.18)
T_4	29.28(23.92)	29.71(24.57)
T_5	28.75(23.13)	29.14(23.70)
T_6	24.23(16.84)	23.97(16.50)
T_7	55.45(67.84)	58.55(72.77)
S.Em.±	4.35	4.18
C.D. at 5 %	13.42	12.90
C.V. %	8.56	6.86

Note: - **T_1:** Profenofos 50% EC @ 500g a.i./ ha (First Spray [FS]), *Beuveria bassiana* @ 80.0g/ pump (Second Spray [SS]), Diafenthiuron 50%WP @ 300 g a.i./ ha (Third Spray [TS]), Profenofos 50% EC @ 500g a.i./ ha (Fourth Spray [FS]) **T_2:** Phosphamidon 40% SL @ 300g a.i./ ha (FS), *Beuveria bassiana* @ 80.0g/ pump (SS), Acetamiprid 20% SP @ 20 g a.i./ ha (TS), Phosphamidon 40% SL @ 300g a.i./ ha (FS); **T_3:** Thiamethoxam 25% WG @ 25g a.i./ ha (FS); Azadirechtin 1500ppm @ 3.0ml/ lit (SS), Spinosad 2.5% SC @ 15 g a.i./ ha (TS), Thiamethoxam 25% WG @ 25g a.i./ ha (FS); **T_4:** Triazophos 40% EC @ 500g a.i./ ha (FS), *Verticillium lecanii* @ 80.0g/ pump (SS), Clothianidin 50% WDG @ 20g a.i./ ha (TS), Triazophos 40% EC @ 500g a.i./ ha (FS); **T_5:** Dimethoate 30% EC @ 200g a.i./ ha (FS), *Verticillium lecanii* @ 80.0g/ pump (SS), Carbosulfan 25% EC @ 250 g a.i./ ha (TS), Dimethoate 30% EC @ 200g a.i./ ha (FS) and **T_6:** Imidacloprid 17.8% SL @ 50g a.i./ ha (FS), Azadirechtin 1500ppm @ 3.0ml/ lit (SS) and Fipronil 5% SC @ 50 g a.i./ ha (TS), Imidacloprid 17.8% SL @ 50g a.i./ ha (FS).

leaves) and T_5 (3.15 thrips/ 3 leaves) were found to be less effective as compare to T_3 against thrips.

Pooled over Periods over Spray (*Kharif*-2015)

The data on pooled over periods over sprays presented in Table -1 revealed that all schedule treatments recorded significantly lower number of thrips (2.03 to 3.03 thrips/ 3 leaves) than control (5.50 thrips/ 3 leaves). The order of scheduled treatments in comparison to control based on thrips population given in bracket was: T_3 (2.03) > T_6 (2.26) > T_1 (2.70) > T_2 (2.78) > T_4 (2.92) > T_5 (3.03) > control (5.50). T_3 [*i.e.* Thiamethoxam 25% WG @ 25g a.i./ ha (First Spray); Azadirachtin 1500 ppm @ 3.0ml/ lit (Second Spray), Spinosad 2.5% SC @ 15 g a.i./ ha (Third Spray), Thiamethoxam 25% WG @ 25g a.i./ ha (Fourth Spray)] found significantly superior to rest of the treatments recorded the lowest (2.03 thrips/ 3 leaves) thrips population as compare to control. The next best treatments were T_6 (2.26 thrips/ 3 leaves) followed by T_1 (2.70 thrips/ 3 leaves), T_2 (2.78 thrips/ 3 leaves), T_4 (2.92 thrips/ 3 leaves) and T_5 (3.03 thrips/ 3 leaves) as all the treatments were statistically differ from each other. Among all the treatments T_4 and T_5 were found mediocre in their effectiveness.

Thus, thrips population in bell peeper can be effectively managed by schedule spray application of T_3. While in case of T_6, T_1 and T_2 found mediocre in their effectiveness. Treatment T_4 and T_5 did not perform better in giving satisfactory protection to thrips population in bell pepper.

The present findings were close confirmation with results recorded by earlier workers depicted below. According to Nandini *et al*. (2012) reported that the thiamethoxam (0.65& 27.7%) and difenthiuron (0.7 & 32.7%) were found to be significantly superior compared to others for management of thrips in capsicum. Shitole (2013) revealed that significantly the highest reduction in thrips population (7.33 thrips/3 twig) and leaf curling (13.29 per cent) was recorded on chilli crop treated with spinosad 0.009 per cent.

Leaf curl (Per cent)

Pooled over periods (*kharif*- 2014)

The pooled effect of 21, 42, and 60 days after transplanting of the various insecticidal schedules on leaf curling caused by thrips, *S. dorsalis* infesting bell pepper during *kharif* 2014 is presented in Table 4.23 and depicted in Fig. 4.11. The data revealed that the percentage of leaf curling was significantly lower than the control (67.84 %) in all the treatments. However, the minimum leaf curling 14.01 per cent was recorded in T_3 but it was at par with all the other treatments *viz.,* T_6 (16.84 %), T_1 (22.49%), T_5 (23.13%), T_4 (23.92%) and T_2 (24.65%). There were no significant differences among all the treatments.

Pooled over periods (*kharif*- 2015)

The pooled effect of 21, 42, and 60 days after transplanting of the various treatments on leaf curling caused by thrips, *S. dorsalis* infesting bell pepper during *kharif* 2015 is presented in Table 4.24 and depicted in Fig.

Table 3. Marketable green fruit yield in different treatment (Pooled of *kharif*-2014 and *kharif* -2015

Treatments	Yield (kg/ha)		
	Pooled	Increase in yield over control (%)	Avoidable yield loss (%)
T_1	19900	130.43	56.60
T_2	19140	121.63	54.88
T_3	23901	176.75	63.87
T_4	17987	108.27	51.99
T_5	17875	106.97	51.68
T_6	21235	145.89	59.33
T_7	8636	-	-
S.Em.±	452	-	-
C.D. at 5 %	1290	-	-
C.V. %	6.96	-	-
Y			
S.Em.±	241.62	-	-
C.D. at 5 %	NS	-	-
Y × T			
S.Em.±	639.26	-	-
C.D. at 5 %	NS	-	-

Note: - **T_1:** Profenofos 50% EC @ 500g a.i./ ha (First Spray [FS]), *Beuveria bassiana* @ 80.0g/ pump (Second Spray [SS]), Diafenthiuron 50%WP @ 300 g a.i./ ha (Third Spray [TS]), Profenofos 50% EC @ 500g a.i./ ha (Fourth Spray [FS]) **T_2:** Phosphamidon 40% SL @ 300g a.i./ ha (FS), *Beuveria bassiana* @ 80.0g/ pump (SS), Acetamiprid 20% SP @ 20 g a.i./ ha (TS), Phosphamidon 40% SL @ 300g a.i./ ha (FS); **T_3:** Thiamethoxam 25% WG @ 25g a.i./ ha (FS); Azadirechtin 1500ppm @ 3.0ml/ lit (SS), Spinosad 2.5% SC @ 15 g a.i./ ha (TS), Thiamethoxam 25% WG @ 25g a.i./ ha (FS); **T_4:** Triazophos 40% EC @ 500g a.i./ ha (FS), *Verticillium lecanii* @ 80.0g/ pump (SS), Clothianidin 50% WDG @ 20g a.i./ ha (TS), Triazophos 40% EC @ 500g a.i./ ha (FS); **T_5:** Dimethoate 30% EC @ 200g a.i./ ha (FS), *Verticillium lecanii* @ 80.0g/ pump (SS), Carbosulfan 25% EC @ 250 g a.i./ ha (TS), Dimethoate 30% EC @ 200g a.i./ ha (FS) and **T_6:** Imidacloprid 17.8% SL @ 50g a.i./ ha (FS), Azadirechtin 1500ppm @ 3.0ml/ lit (SS) and Fipronil 5% SC @ 50 g a.i./ ha (TS)**,** Imidacloprid 17.8% SL @ 50g a.i./ ha (FS).

4.12. The data revealed that the percentage of leaf curling was significantly lower than the control (72.77 %) in all the treatments. However, the minimum leaf curling (13.18 %) recorded in T_3 and it was at par with all the other treatments *viz.,* T_6 (16.50 %), T_1 (22.65 %), T_5 (23.70 %), T_4 (24.57 %) and T_2 (24.63 %).

In all, during both the years, T_3 was found effective against thrips as well to leaf curling and so leaf curling can be effectively managed by schedule spray application of T_3. While in case of T_6, T_1, T_5, T_4 and T_2 were found equally effective in their effectiveness. None of the treatment performs poor in giving satisfactory protection to leaf curling in bell pepper.

Effectiveness of chemicals in reducing the leaf curl has been on report. Nagaraj *et al*. (2007) reported that the mean thrips population and leaf curl index recorded were minimum in thiamethaxam 25 WG (2.95 thrips/ leaf and 1.66 LCI). Venkat Reddy *et al*. (2007) reported that Fipronil 5% SC @ 2ml was found to be the best treatment against thrips followed by Spinosad 45% SC @ 0.3 and 0.2 ml as they resulted in lowest percent incidence, lowest score values and lowest no. of thrips/leaf. Shitole (2013) revealed that significantly the highest reduction in leaf curling (13.29 per cent) was recorded on chilli crop treated with spinosad 0.009 per cent.

Yield

The schedules (treatments) wise pooled (k*harif*- 2014 and k*harif*- 2015) data recorded on yield of green fruits are presented in Table 4.27 and depicted in Fig. 4.13. The data on fruit yield revealed that the green fruits received from

treated plot were significantly higher (17875 to 23901 kg/ ha) over untreated control (8636 kg/ ha). However significantly maximum yield of 23901 kg/ ha with 176.75 per cent increased over control was obtained from the crop treated in T_3 followed by T_6 in which also higher yield of green fruit (21235 with 145.89 per cent increased) were obtained. Further, the yield of green fruits were obtained from the T_1 (19900 with 130.43 per cent increased) was found at par with T_2 (19140 with 121.63 per cent increased) while T_2 was at par with T_4 (17987 with 108.27 per cent increased) and no significant difference was observed between T_4 and T_5 (17875 with 106.97 per cent increased).

Effectiveness of chemicals in increasing the yield has been on report. Shitole (2013) revealed that the significantly maximum yield (15278 kg/ha) of green chilli with 229.34 per cent increased over control was recorded from the crop treated with spinosad 0.009 per cent. Vanisree *et al.* (2013) reported that spinosad 0.015 per cent was found most effective in reducing the population of *S. dorsalis* as well as in increasing yields. These studies support the present findings.

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