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CHILLI LEAF CURL SUPPRESSION THROUGH THE INTEGRATION OF CHEMICAL, BOTANICAL AND MICROBIAL CONTROL OF SUCKING PESTS

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ABSTRACT

Lef curl in chilli as known due to gross effect in injury cause mainly by trips, Scirtothrips dorsalis Hood (upward curling) and mite, polyphagotarsonemus latus Bank (downward curling) is one of the important limiting factors in cultiva -tion of chilli which commonly prevails all over the chilli growing areas of the world. The mite and thrips were found mainly congregated on top canopy of the plant i.e. mite preferring on lower surface and thrips on upper surface of the leaf for feeding and multiplication, while aphids (Myzus persicae Sulzer) mostly on bottom canopy preferring lower leaf surface. They were bserved thorough out the crop period being fairly active during October to December causing leaf curling in the plant. Results revealed that application of Carbofuran 3G @ 1kg. a.i./ha 15 days after transplanting(DAT) followed by Dicofol 0.04 % at 45, 60, 75 and 90 DAT was most effective against mite pest. The Neem product Neemectin 0.15 @ 0.0006 % azadirachtin alternative with endosulfan 0.075 % and neem product alternated with microbial pesticide (Bacillus thurigiensis Kurtski B.t. @ 1kg/ha)) applied at above periods were highly effective against thrips. In case of aphids, endosulfan altenated with dicofol and neem product alternated with Bt. Were quite effective. As regards to predatory mite, Amblyseius (Euseius) ovalis Evans, monocrotophos 0.04 % was highly toxic, while plant product altenative with microbial pesticide or their alternated spray with chemical were alternatively sfer. Though the highest yield of green chilli fruit 05)t/ha) was recorded with endosulfan alternated with dicofol, it was comparable to that of plant product alternated either with endosulfan or with microbial pesticides.

INTRODUCTION

Thrips (Scirtothrips dorslalis) aphids (Myzus persicae and aphis gossypi) and tarsonemid mite (Polyphagotarsonemus latus) are major pests of chilli (Butany, 1976) and known to involed for the cause of leaf curl (Khodawa, 1975). Ahmad et. al. (1987) reported 34.5 % yield losee due to infestation of these pests. Full control of these pests could only save the crop from leaf curl. A number of systemic and contact insecticides have been tried and recommended. Realizing the danger involved in frequent uses of chemicals, certain biopesticides (Botanicals and microbial origins) and their integration with conventional pesticides with a view to reduce pesticides load were evaluated to developed ecofriendly and sustainable pest management tactics for containing the pest on the chilli under agroclimatic condition of south Gujarat.

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MATERIALS AND METHODS

Incidence of sucking pest like mite (P. latus), thrips (S. dorsalis) aphids (M. persicae) and Phytoscid predators(amblyseius(Euseius) ovalis) on Kharif planted (12 August, 1997) unsprayed twelve chilli cultivars (60 cm x 60 cm spacing) in RBD with three replication (plot size : 3.6 x 3.6 m). three random leaves representing top, middle and bottom canopy from each of five random plants per plot were observed under binocular microscope for counting prey and predators both, commencing from 45 days after transplanting thereafter at weekly interval till the crop. The data on species counts for all these varieties sampled weekly were pooled separately, considering all these varieties as one variety and used

or analyzing succession of pest and predator's incidence their distribution and interaction, similarly, the percentage of leaf curl plants as well as intensity of leaf curling through visual grading (0-4 scale) was worked out (Niles, 1980) and correlated with pest incidence.

An experiment with 12 treatment (Table 4) comprising of insecticides, acaricide, acaroinsecticide, microbial pesticide, botanical and their integration was laid out in RBD with three replication during Kharif season (24th August, 1997 planted) on chilli crop (cv. G-4). Soil application of Carbofuran 3G @ 1 kg a.i./ha 15 days after transplanting (DAT) was common to all treatments except untreated control. In later stage, four foliar spray of each treatment first starting from 30 days after granule application, thereafter at 15 days interval were given the plot size, methodology, sampling etc. for population assessments remained essentially the same as described earlier. The performance of treatment against pest and predators was judged on the basis of pooled analysis and compared with DNMRT

RESULTS AND DISCUSSION

Incidence of sucking pests and their distribution

The mite (P. latus) on Khariftransplanted chilli commenced from 39th Standard week (STW) (September) and attained peak during 43rd STW (October) (40.41 mites/15 leaves). The mites preferred to canopy (24.99 ± 19.75 mites/15 leaves) compared to middle (7.07 ± 0.08 mites/15 leaves and bottom canopy leaves (2.02 ± 4.88 mites/15 leaves). The mite shoed more preference toward under leaf surface (8.58±7.09 mites/15 leaves) than upper leaf surface (Table 1 to 3). Infested leaves showed downward curling major acitivty of P. latus from August to December (Dhooria & Bindra, 1977) and highest peak during October end (Sanap et.al., 1985) and its preference towards underside of tender young leaves on chilli and other crops have also been reported (Karmarkar, 1995).

The thrips (S.dorsalis) appeared on the crop from 41st STW (October) and continued till crop maturity. Showed peak during 49th STW (December) (4.64/15 leaves). It also showed more preference towards top canopy leaves (6.36± 3.55 thirps/15 leaves) to other but unlike mite upper surface of the leaves was highly preferred (2.12± 1.19 thrips /15 leaves) as against underside of the leaf (0.48± 0.26/15 leaves) for feeding (Table 1 to 3). Infested leaves showed upward curling. Raizada(1`965) and Borah(1987) found major activity of chilli thrips during November to March and early autumn periods.

The aphid (M.persicae) was found to infest the crop during entire crop period with a peak (9.69 aphids/15 leaves) during November (45 STW) and December (49th STW). Unlike thrips and mites, it preferred leaves at bottom canopy (15.09 ± 6.76 aphids/15 leaves) than middle and top canopy leaves as well as underside of the leaf (4.77 ± 2.01aphids/15 leaves) than upper surface (Table 1 to 3). Similarly, Murthy (1984) reported its major activity during November to February in chilli growing area of Andhra Pradesh. Singh (1988) found heavy attack of M. persicae coinciding with reproductive stage of chilli crop during colder weather.

Interaction between incidence of sucking pests and leaf curl

The correlation between thrips vs leaf curl (plant r = + 0.533*, damaged intensity r = + 0.708**) and aphid vs. leaf curl (plant r = + 0.470* damaged intensity r = + 0.730**) was positive and significant. This indicated that with increase in thrips and aphids, the degree of chilli leaf curl also increased. It was evident from highest population of thrips recorded during 49th STW when intensity of leaf curling in the plant was considerably higher (41.25 %). Similar was the case with the increase in aphid density. Though the increase in phytophagous mite showed positive indication I regards to curling, it was non significant. The cumulative impact of all sucking pests was positive related with degree of leaf curling in chilli plant (damage intensity r =+0.447*) (Table 1)

Interaction between incidence of sucking pests and predatory mite

The predatory mite, A. ovalis was observed throughout the crop period with peak during December (51st STW) (5.08 mites/15 leaves) when the density of thrips (3.30/15 leaves) and aphid (8.61/15 leaves was considerably higher as was evident from significant 'r' value (Thrips r = + 8.03 ** aphids r = + 0.723 **) (Table 1). This indicated that predatory mite may develop and multiply on these insects pests. Certain phytoseids are reported as important p[redetors of thrips and other small insects (Gupta, 1985, Rangusa Di Chiara, 1991). Predatory mite were mainly found congregated on upper strata of the plant wherein the thrips and prey mite was also higher, showing its affinity and association with these pests.

Management of sucking pests

Among different treatments, the soil application of carbofuran@1 kg .i./ha 15 days after transplanting (DAT followed by folier spray of dicofol 0.04 % at 45,60,75 and 90 DAT was significantly most effective against tarsonetmid mite (13.55 mites/15 leaves) it was followed by equally effective treatments like alternative spray of Nemectin (0.0006 % azadirachtin) and dicofol as well as alternate spray of plant product and microbial pesticides at above periods . similarly, the effectiveness of dicofol gainst P. latus on chilli (Mote, 1976, David & Natarajan, 1987) as well as impact of bactospine (Bt) in reducing fecundity of spider mite (Vlyan et.al., 1980) and effectiveness of BtB-202 (Bt) @ 1 to 1.5 % against spider mite has also been reported (Vlayen ey.al., 1980)

As regards to thrips, the plant product alternated with endosulfn as well as plant product alternated with microbial pesticides was found equally effective in reducing population (2.25 & 2.50 thrips/15leaves). They were comparable to the treatments of endosulfan and nemectin alone as well as endosulfan with dicofol and nemectin alternated with dicofol. Application of endosulfan at 20 days interval initiating from 20 DAT has been found effective against thrips (Chandla and Deshpande, 1984). In case o aphids endosulfan alternated with dicofol as well as nemectin alternated with Bt were found highly effective (8.08 - 8.42/15leaves) and were comparable with nemectinspray alone, nemectin alternated with andosulfan of decofol (Table 4). Application of plant product Azadiractin (Sannino, (1997), Bt (walter & English), 1995) and endosulfan (Dhandala & Deshpande, 1984) is reported for the control of aphids.

Regarding safety to predatory mites, the treatment of plant product, or microbial pesticide alone or their alternated spray of even alternated with chemical pesticides were safer as the dendesity of mites were statistically similar to that of untreated control. The treatment of monocrotophos alone was toxic. It was followed by endosulfan alternated with dicolfol and endosulfan alone (Table 4). Safety of neem product to natural enemies iswell documented (Mansoure, et.al., 1987). Guo et.al., 1993) has also reported lower toxicity of Bt. (B-toxin) to phytosiid predator (P. persimillis).

Considering yield, the highest yield of green chilli fruits (4.05t/ha) was registered with the treatment of alternate spray of endosulfan and eicofol. It was comparable with nemectin alternated with endosulfan or with microbial pesticide (Bt) (Table 4). Overall performance of treatment (based on rank index method) in view of their effectiveness against sucking pests, safety to microbial pesticides (Bt) at 45,60,75 and 90

DAT was placed first, while plant product alternated with endosulfan and endosulfan alternated with placed first, while plant product alternated with endosulfan and endosulfan alternated with dicofol at above periods rankd second and third, respectively (Table 5).

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Table 1. Incidence of sucking pests and their interaction with phytoseiid predetor and leaf curling in chilli during 1997-98

Month	STW	Incidence of sucking pests(No./15leaves)					Predatory Mite *A.ovalis*	Leaf curl incidence		
		Mite (*P.latus*)			Thrips *S.dorsalis*	Aphids *M. persicae*		Curl plant (%)	Damage Intensity (%)	Damage index
		E	M	E+M	M	M				
Sept, 97	39	0.28	0.67	0.95	0.00	0.36	0.00	0.10	1.75	0.07
Oct.,97	40	0.33	0.56	0.89	0.00	1.39	0.03	0.033	7.50	0.30
	41	5.44	5.36	10.80	0.83	20.25	0.61	0.97	16.50	0.66
	42	11.44	10.11	21.55	0.33	3.44	0.14	2.25	8.43	39.25
	43	49.47	40.41	89.88	1.80	6.16	0.33	8.43	39.25	1.57
Nov. 97	44	64.11	31.39	95.50	2.27	6.94	0.28	12.67	48.00	1.92
	45	61.61	32.25	93.86	3.08	9.69	1.02	12.31	51.50	2.06
	46	9.13	2.66	11.79	3.89	6.30	1.86	11.10	41.25	1.65
	47	24.16	6.02	30.18	3.39	6.58	2.55	16.10	44.75	1.77
Dec. 97	48	39.19	15.19	54.38	3.44	7.83	3.69	12.07	41.50	1.66
	49	22.80	10.25	33.05	4.64	9.69	4.66	14.24	41.25	1.65
	50	23.13	7.33	30.46	2.94	7.36	4.55	16.47	42.50	1.70
	51	24.55	6.66	31.21	3.30	8.61	5.08	19.90	44.50	1.66
	52	30.11	10.55	40.66	3.55	7.86	3.41	21.41	48.00	1.92
Jan. 98	1	33.58	13.08	46.66	3.78	8.80	3.91	23.79	50.25	2.00
	2	26.41	10.53	36.94	3.39	8.02	3.08	25.19	52.50	2.10
	3	19.80	7.75	27.55	3.61	7.89	3.75	27.38	55.00	2.20
	4	15.97	6.47	22.44	2.99	6.69	2.94	30.36	57.75	2.31
Feb. 98	5	11.33	5.83	17.16	3.19	5.61	2.44	34.81	61.00	2.44
	6	7.80	4.19	11.99	1.61	4.41	1.39	38.42	62.25	2.49

Simple correlation 'r' value						Simple correlation 'r' value			
Predator VS	+0.063	- 0.229	- 0.041	+0.803**	+ 0.723**	Thrips VS	+0.533*	+0.708**	+0.708**
						Aphid VS	+0.055	+0.447*	+0.447*
						Mite VS	+0.240	+0.240	+0.240*

STW = Standard week; * = 'r' value significant at 5% leve of significance;
** 'r' value significnae 1% level of significance

Table 2. Distribution of sucking pests on chilli plant during 1997-98

Month	STW	Average No. /15 leaves at different canopy levels of the plant								
		Mite			Thrips			Aphid		
		Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Bottom
Sept, 97	39	1.31	0.70	0.00	0.00	0.00	0.00	0.00	0.38	0.70
Oct.,97	40	0.97	0.56	0.16	0.00	0.00	0.000	0.40	1.39	2.40
	41	11.17	2.88	2.04	1.73	0.45	0.32	0.86	1.21	4.69
	42	21.24	5.27	3.81	0.70	0.17	0.12	1.30	1.79	7.23
	43	70.44	30.10	20.70	3.14	1.34	0.92	3.16	4.59	10.74
Nov. 97	44	61.49	24.78	7.89	4.45	1.79	0.57	1.74	5.48	13.60
	45	64.55	27.17	5.02	6.17	2.60	0.48	1.51	8.16	19.40
	46	7.00	0.99	0.00	10.24	1.44	0.00	0.00	1.41	18.34
	47	16.78	1.29	0.00	9.45	0.73	0.00	0.00	1.41	18.34
Dec. 97	48	36.95	8.36	0.25	8.37	1.89	0.06	0.13	4.31	19.05
	49	21.55	8.87	0.35	9.75	4.02	0.16	0.33	8.38	20.37
	50	18.14	3.77	0.08	7.28	1.51	0.03	0.08	3.79	18.21
	51	18.01	1.98	0.00	8.92	0.98	0.00	0.00	2.56	23.28
	52	27.17	4.47	0.00	9.14	1.50	0.00	0.00	3.31	20.09
Jan. 98	1	32.92	6.25	0.08	9.51	1.81	0.02	0.05	4.21	22.15
	2	27.36	4.21	0.05	8.81	1.36	0.00	0.00	3.21	20.84
	3	20.11	3.10	0.03	9.37	1.44	0.02	0.05	3.16	20.47
	4	16.78	2.59	0.00	7.78	1.20	0.02	0.04	2.68	17.35
Feb. 98	5	15.15	2.33	0.00	4.18	0.66	0.00	0.000	1.78	11.45
	6	10.88	1.68	0.00	4.18	0.66	0.00	0.00	1.78	11.45
Av ± SD		24.99	7.06	2.02	6.36	1.31	0.14	0.48	3.32	15.09
		± 9.75	± 9.08	± 4.88	± 3.55	± 0.93	± 0.25	± 0.84	± 2.12	± 6.76

STW = Standard Week; Mite : Polyphajotarsonemus latus; Thrips : Scirtothrips dorasalis ; Aphid : Myzup persicae

Table 3. Preference of sucking pests of chilli to leaf surfaces during 1997-98

Month	STW	Average No./15 leaves on leaf surface					
		Mite		Thrips		Aphid	
		Upper	Lower	Upper	Lower	Upper	Lower
Sept, 97	39	0.17	0.50	0.00	0.00	0.10	0.26
Oct.,97	40	0.08	0.47	0.00	0.00	0.47	0.92
	41	1.50	3.86	0.60	0.23	0.63	1.62
	42	3.14	6.97	0.23	0.10	1.00	2.44
	43	14.94	25.47	1.13	0.67	1.96	4.20
Nov. 97	44	8.97	22.42	1.62	0.65	1.98	4.96
	45	10.06	22.19	2.12	0.96	3.02	6.67
	46	0.42	2.25	3.29	0.60	1.04	5.35
	47	0.39	5.64	2.77	0.62	0.98	5.60
Dec. 97	48	2.78	12.42	2.81	0.63	1.51	6.32
	49	1.69	8.31	3.86	0.78	2.78	6.91
	50	1.19	6.14	2.46	0.46	1.72	6.89
	51	0.36	6.31	2.84	0.46	1.72	6.89
	52	1.58	8.97	3.02	0.53	1.80	6.00
Jan. 98	1	1.94	11.14	3.22	0.56	1.98	6.82
	2	1.89	8.64	2.78	0.61	2.20	5.82
	3	1.47	6.28	2.93	0.68	2.21	5.68
	4	1.03	5.44	2.53	0.47	1.53	5.16
Feb. 98	5	1.17	4.66	2.55	0.64	1.12	4.49
	6	0.72	3.47	1.31	0.30	0.81	3.60
Av ± SD		2.78 ± 3.91	8.58 ± 7.09	2.12 ± 1.19	0.48 ± 0.26	1.53 ± 0.76	4.77 ± 2.01

STW = Standard Week; Mite : Polyphajotarsonemus latus; Thrips : Scirtothrips dorasalis ; Aphid : Myzup persicae

Table 4. Effect of different treatments on the incidence of sucking pests and phytosciid predator of chilli

Soil + Foliar (one) (Four)	Average number*/15 leaves						
	Egg (*P. latus*)	Mite (*P. latus*)	Thrips (S. dorsais)	Aphids (M. persicae)	Predatory Mite (A. ovalis)	Yield (t/ha)	
C + EEEE	5.69 F (36.90)	4.42 F (22.70)	1.65 AB (2.49)	2.96 DE (9.80)	1.64 B (2.45)	2.92 cd	
C + NNNN	5.62 DEF (36.18)	4.02 CD (18.20)	1.66 AB (2.82)	2.73 AB (8.51)	1.73 BC (2.82)	2.59 cde	
C + Bt.Bt.Bt.Bt.	5.55 DE (36.14)	4.10 CD (18.80)	1.74 BC (2.82)	2.91 CDE (9.57)	1.71 BC (2.76)	2.84 cde	
C + DDDD	4.99 A (29.06)	3.51 A (13.55)	1.76 BC (2.25)	2.87 BDC (9.35)	1.63 B (2.38)	2.93 cd	
C + NENE	5.52 CD (35.24)	4.02 CD (18.20)	1.58 A (2.25)	2.74 ABC (8.57)	1.72 BC (2.78)	3.79 ab	
C + NDND	5.32 B (33.03)	3.81 B (15.78)	1.66AB (2.54)	2.75 ABC (8.63)	1.68 BC (2.65)	2.87 cd	
C + EDED	5.51 CD (35.21)	3.97 C (16.86)	1.64 AB (2.46)	2.61 A (8.08)	1.63 B (2.38)	4.05 a	
C + Bt. D.Bt.D.	5.66 EF (36.36)	4.13 E (19.66)	1.68 ABC (2.60)	3.08 EF (10.72)	1.70 BC (2.71)	2.10 de	
C + Bt. E..Bt.E	5.70 F (37.73)	4.41 E (18.66)	1.69 ABC (2.66)	2.99 DE (10.18)	1.77 BC (2.95)	2.30 de	
C + N.Bt.N.Bt.	5.41 BC (34.78)	4.11 CD (18.66)	1.60 A (2.30)	2.68 A (8.42)	1.73 BC (2.82)	3.37 abc	
C + MMMM	5.64 EF (36.20)	4.32 E (20.46)	1.68 ABC (2.60)	3.06 EF (10.60)	1.45 A (1.83)	2.74 cde	
Untreated control	6.15 G (44.68)	4.69 F (26.15)	1.68 C (3.05)	3.21 F (10.99)	1.80 C (3.15)	2.02 e	
S.Em + P	0.0471	0.0422	0.0395	0.0509	0.0392	S.Em+	0.061
T	0.0381	0.0455	0.0369	0.0549	0.0459	CD-5%	0.183
P x T	0.1632	0.1460	0.1278	0.1762	0.1339	CV-5%	3.64

* Mean of 20 observations Date of transplanting : 24th August, 1997.

Bt. = Bacillus thuringiensis var. Kurstaki - @ 1kg/ha ; E = Endosulfan - 0.075 %; D = Dicofol - 0.04 %

M = Monocrotophos - 0.04 %; Neemactin - 0.0006 % Azadirachtin

Note

1) Soil application of granular insecticide (C-Carbofuran #G @ 1kg a.i./ha) at 15 days after transplanting followed by foliar application of respective insecticide at 45,60,75 and 90 DAT.
2) Figure in paranthesis are original value of v x + 0.5
3) Mean value followed by same lette (s) are not different at 5% level of significant in respective column according to Cucan's New Multiple Range Test in case of sucking pests, while in case of yield, the data is analyzed using to RBD

Table 5. Overall performance of different treatment based on rank method

Soil + Foliar (one) (Four)	Rank given to indicated parameters					Yield	Cumulative Index	Overall Rank
	P.latus		Thrips	Aphid	Predatory Mite			
	Egg	Mobile						
C + EEEE	10	11	8	4	9	5	47	8
C + NNNN	7	5	3	5	3	9	32	5
C + Bt.Bt.Bt.Bt.	6	7	7	10	6	7	43	5
C + DDDD	1	1	6	11	10	4	33	6
C + NENE	5	4	4	1	5	2	21	2
C + NDND	2	2	5	6	8	6	29	4
C + EDED	4	3	1	3	11	1	23	3
C + Bt. D.Bt.D.	9	8	11	8	7	11	54	10
C + Bt. E..Bt.E	11	10	9	9	2	10	51	9
C + N.Bt.N.Bt.	3	6	2	2	4	3	20	1
C + MMMM	8	9	10	7	12	8	54	10
Untreated control	12	12	12	12	1	12	61	11

* Mean of 20 observations Date of transplanting : 24th August, 1997.

Bt. = Bacillus thuringiensis var. Kurstaki - @ 1kg/ha ; E = Endosulfan - 0.075 %; D = Dicofol - 0.04 %
M = Monocrotophos - 0.04 %; Neemactin - 0.0006 % Azadirachtin

Note

1) Soil application of granular insecticide (C-Carbofuran #G @ 1kg a.i./ha) at 15 days after transplanting followed by foliar application of respective insecticide at 45,60,75 and 90 DAT.
2) Figure in paranthesis are original value of v x + 0.5
3) Mean value followed by same lette (s) are not different at 5% level of significant in respective column according to Cucan's New Multiple Range Test in case of sucking pests, while in case of yield, the data is analyzed using to RBD.