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RESEARCH PAPER

Bio-efficacy of newer insecticides against mulberry thrips

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Abstract: A field experiment on Bio-efficacy of newer insecticides against mulberry thrips was conducted in V-1 mulberry garden during 2020. The study revealed that fipronil 5 SC @ 1 ml/l was the best treatment in reducing the thrips population from 29.60 to 3.01 thrips per top three leaves with 90.01 per cent reduction over untreated control after two sprays on 30 and 45 days of pruning. While, flonicamid 50 WG @ 0.6 g/l (3.80 thrips/top three leaves) was the next best insecticide. It was followed by flufyradifurone 20 SL @ 0.1 ml/l (4.82 thrips/top three leaves) and diafenthiuron 50 WP @ 0.5 g/l (5.50 thrips/top three leaves). While, dinotefuran 20 SG @ 0.4 g/l (6.31 thrips/top three leaves) was in line with diafenthiuron 50 WP. Dichlorvos 76 EC @ 1 ml/l was found to be inferior among the chemical approaches in reducing thrips population (7.31 thrips/top three leaves). Whereas, water sprayed plants recorded thrips population of 19.26 per top three leaves. Untreated control registered significantly higher population of thrips (30.15 thrips/top three leaves).

Key words: Foliage, Insecticides, Mulberry, Thrips

Introduction

Mulberry is the sole food plant of silkworm, *B. mori.* Mulberry being perennial in nature harbour various insect pests all around the year (Sakthivel *et al*., 2019). Further, occurrence of diseases, pests and weeds affect the quality and yield of leaves by 24, 18 and 8 per cent, respectively (Govindaiah *et al*., 2005). It is known to be infested by over 300 insect and non insects in varying intensities at various stages of the crop and season (Sakthivel *et al*., 2019). Among the sap feeders, thrips, mealy bugs, leafhoppers and scale insects inflict 42.55, 20.80, 20.28 and 1.65 per cent damage to mulberry, respectively (Sakthivel, 2019).

Thrips are known to inflict damage to mulberry throughout the year. However, significant damage to young foliage and causes nutritional loss of the leaves during summer season. During severe infestation, spraying of endosulfon (3 ml/l), monocrotophos (1 ml/l) or dimethoate (2 ml/l) with a waiting period of more than 15 days were recommended by Reddy and Kotikal (1988). However, dichlorvos at 0.02 per cent is commonly used insecticide against thrips due to its lower residual toxicity of less than 10 days (Poornima and Rayar, 2015). Recent studies revealed that development of resistance by the thrips against dichlorvos (Sakthivel *et al*., 2011). Added to this the insecticide is in the list of to be banned insecticide. Hence, it is essential to identify newer insecticides against thrips by considering the safety of mulberry silkworms.

Material and methods

The experiment was laid out in Randomized Block Design (RBD) with eight treatments and replicated thrice in a V-1 mulberry garden established during 2012. The garden was maintained by following recommended cultivation practices (Dandin *et al*., 2000). The experiment was carried out during summer months (March-May). Before the initiation of experiment, mulberry plants were pruned at bottom during second fortnight of March, 2020. As per recommended dose of fertilizers for fourth crop of 70 kg/ha/yr of Nitrogen (as Urea), for the experimental plot of 3 guntas, 2 kg of N was applied. Irrigation was provided at ten days interval depending upon the climatic conditions and at thirty days of pruning inter cultivation was carried out, followed by manual weeding to keep the field clean. The treatments were imposed twice on mulberry at 30th and 45th day of pruning after recording the pre count a day before each spray. After each spray, thrips population count was taken on 1st, 3rd, 5th and 7th day after spraying on top three leaves from five randomly selected plants in each replication.

Results and discussion

Management of mulberry thrips with newer insecticides carried out during summer of 2019-20 and the results are presented in the Table 1, 2 and 3.

First spray on 30 days after pruning

One day prior to spraying of insecticides on mulberry, thrips population was uniformly distributed in the mulberry field resulting in non significant effect and the population varied from 29.60 (Fipronil 5 SC) to 37.20 thrips per top three leaves (Diafenthiuron 50 WP).

The population of thrips was significantly reduced by spraying newer insecticides on 30 days after pruning (DAP). On the first day after spraying, thrips population was significantly lowered on fipronil 5 SC (5.27) sprayed leaves, followed by flonicamid 50 WG (6.20), flufyradifurone 20 SL (6.80) and diafenthiuron 50 WP (5.27) which were on par with each other. While, dinotefuran 20 SG recorded 8.27 thrips per top three leaves and was on par with flonicamid 50 WG. While, 10.53 thrips per top three leaves was recorded in dichlorvos sprayed leaves. Water sprayed and untreated plants harboured 19.40 and 33.27 thrips per top three leaves.

Table 1. Evaluation of newer insecticides against mulberry thrips (30 days after pruning)

Tr.No.	Treatments	First spray					
		Thrips population (No. per top three leaves)					
		DBS	1DAS	3DAS	5DAS	7DAS	Mean
1	Diafenthiuron 50 WP (0.05 %) @ 0.5 g/l	37.20	7.27	6.80	5.20	5.87	6.28
		(6.14)	(2.79)^{ab}	(2.70)^{abc}	(2.39)^{bc}	(2.52)^{b}	(2.60)^{bcd}
2	Dinotefuran 20 SG(0.01 %) @ 0.4 g/l	33.13	8.27	7.47	6.47	7.07	7.32
		(5.80)	(2.96)^{bc}	(2.82)^{bc}	(2.64)^{c}	(2.75)^{b}	(2.80)^{cd}
3	Fipronil 5 SC (0.005%) @ 1 ml/l	29.60	5.27	4.27	2.20	3.33	3.77
		(5.49)	(2.40)^{a}	(2.18)^{a}	(1.64)^{a}	(1.96)^{a}	(2.07)^{a}
4	Flonicamid 50 WG (0.015%) @ 0.6 g/l	33.53	6.20	5.60	3.80	2.60	4.55
		(5.83)	(2.59)^{ab}	(2.47)^{ab}	(2.07)^{ab}	(1.76)^{a}	(2.25)^{ab}
5	Flufyradifurone 20 SL (0.002%) @ 0.1 ml/l	30.40	6.80	6.53	4.53	3.87	5.43
		(5.56)	(2.70)^{ab}	(2.65)^{abc}	(2.24)^{bc}	(2.09)^{a}	(2.44)^{abc}
6	Dichlorvos 76 EC (0.02 %) @ 1 ml/l	32.20	10.53	8.93	6.73	7.80	8.50
		(5.72)	(3.32)^{c}	(3.07)^{c}	(2.69)^{c}	(2.88)^{b}	(3.00)^{d}
7	Water spray	34.33	19.40	21.47	16.47	18.87	19.05
		(5.90)	(4.46)^{d}	(4.69)^{d}	(4.12)^{d}	(4.40)^{c}	(4.42)^{e}
8	Untreated control	35.07	33.27	34.73	27.40	29.27	31.17
		(5.96)	(5.81)^{e}	(5.94)^{e}	(5.28)^{e}	(5.46)^{d}	(5.46)^{f}
S.Em.		NS	0.14	0.14	0.16	0.13	0.10
CV (%)			7.20	7.33	9.93	7.54	5.29

DBS - Day before spray, DAS - Day after spray, NS - Non Significant
Figures in the parentheses are values derived from $\sqrt{x+0.5}$ transformation.
In a column, means followed by same letters are not varying significantly by DMRT (P=0.05).

Table 2. Evaluation of newer insecticides against mulberry thrips (45 days after pruning)

Tr. No.	Treatments	Second spray					
		Thrips population (No. per top three leaves)					
		DBS	1DAS	3DAS	5DAS	7DAS	Mean
1	Diafenthiuron 50 WP (0.05 %) @ 0.5 g/l	15.60	4.67	3.87	4.27	6.07	4.72
		(4.01)^{a}	(2.27)^{abc}	(2.09)^{abc}	(2.18)^{bc}	(2.56)^{b}	(2.28)^{b}
2	Dinotefuran 20 SG (0.01 %)@ 0.4 g/l	16.20	6.13	5.27	4.13	5.67	5.30
		(4.09)^{a}	(2.58)^{c}	(2.40)^{bc}	(2.15)^{bc}	(2.48)^{b}	(2.41)^{bc}
3	Fipronil 5 SC (0.005%) @ 1 ml/l	13.17	3.06	2.53	1.33	2.07	2.25
		(3.70)^{a}	(1.89)^{a}	(1.74)^{a}	(1.35)^{a}	(1.60)^{a}	(1.80)^{a}
4	Flonicamid 50 WG (0.015%) @ 0.6 g/l	11.73	4.07	3.26	2.73	2.13	3.05
		(3.50)^{a}	(2.14)^{ab}	(1.94)^{ab}	(1.80)^{b}	(1.62)^{a}	(1.88)^{a}
5	Flufyradifurone 20 SL (0.002%) @ 0.1 ml/l	12.93	5.27	4.53	3.73	3.27	4.20
		(3.67)^{a}	(2.40)^{bc}	(2.24)^{abc}	(2.06)^{bc}	(1.94)^{a}	(2.17)^{b}
6	Dichlorvos 76 EC (0.02 %) @ 1 ml/l	17.33	6.27	5.70	5.27	7.87	6.17
		(4.22)^{a}	(2.60)^{c}	(2.49)^{c}	(2.40)^{c}	(2.89)^{b}	(2.58)^{c}
7	Water spray	30.33	17.27	18.73	20.33	21.53	19.47
		(5.55)^{b}	(4.22)^{d}	(4.39)^{d}	(4.56)^{d}	(4.69)^{c}	(4.47)^{d}
8	Untreated control	32.47	27.33	28.10	29.53	31.67	29.13
		(5.74)^{b}	(5.28)^{e}	(5.35)^{e}	(5.48)^{e}	(5.67)^{d}	(5.44)^{e}
S.Em.		0.33	0.13	0.15	0.13	0.15	0.09
CV (%)		9.33	7.79	9.37	7.92	8.69	5.26

DBS - Day before spray, DAS - Day after spray
Figures in the parentheses are values derived from $\sqrt{x+0.5}$ transformation.
In a column, means followed by same letters are not varying significantly by DMRT (P=0.05).

Three days after application of insecticides, fipronil 5 SC (4.27) showed its superiority in reducing thrips population, followed by flonicamid 50 WG (5.60), flufyradifurone 20 SL (6.53) and diafenthiuron 50 WP (6.80) which were at par. Dinotefuran 20 SG (7.47) was on par with flonicamid 50 WG (5.60). While, dichlorvos 76 EC (8.93) was in line with dinotefuran 20 SG. The water sprayed plants harboured 21.47 thrips per top three leaves and 34.73 thrips per top three leaves on untreated plants. Similar result was obtained with fipronil 5SC by Poornima and Rayar (2015) and Patil *et al.* (2013) and confirms the present results.

On fifth day after spraying, significant reduction in thrips population was recorded in fipronil 5 SC (2.20) and flonicamid 50 WG (3.80) which were on par. They were followed by flufyradifurone 20 SL (4.53) and diafenthiuron 50 WP (5.20) and were at par with flonicamid 50 WG (3.80). Dinotefuran 20 SG (6.47)

Table 3. Overall efficacy of newer insecticides against mulberry thrips

Tr. No.	Treatments	Pooled data Thrips population (No. per top three leaves)						
		DBS	1DAS	3DAS	5DAS	7DAS	Mean	Reduction over control (%)
1	Diafenthiuron 50 WP (0.05 %) @ 0.5 g/l	26.40 (5.19)^{b}	5.97 (2.54)^{bc}	5.33 (2.42)^{bc}	4.73 (2.29)^{bcd}	5.97 (2.54)^{c}	5.50 (2.45)^{cd}	81.76
2	Dinotefuran 20 SG(0.01 %) @ 0.4 g/l	24.67 (5.02)^{ab}	7.20 (2.77)^{cd}	6.37 (2.62)^{cd}	5.30 (2.41)^{cd}	6.37 (2.62)^{c}	6.31 (2.61)^{d}	79.08
3	Fipronil 5 SC (0.005%) @ 1 ml/l	21.38 (4.68)^{a}	4.17 (2.16)^{a}	3.40 (1.97)^{a}	1.76 (1.51)^{a}	2.70 (1.78)^{ab}	3.01 (1.87)^{a}	90.01
4	Flonicamid 50 WG (0.015%) @ 0.6 g/l	22.63 (4.81)^{a}	5.13 (2.37)^{ab}	4.43 (2.22)^{b}	3.27 (1.94)^{ab}	2.37 (1.69)^{a}	3.80 (2.07)^{b}	87.40
5	Flufyradifurone 20 SL (0.002%) @ 0.1 ml/l	21.67 (4.71)^{a}	6.03 (2.56)^{bc}	5.53 (2.46)^{bcd}	4.13 (2.15)^{bc}	3.57 (2.02)^{b}	4.82 (2.31)^{c}	84.02
6	Dichlorvos 76 EC (0.02 %) @ 1 ml/l	24.77 (5.03)^{ab}	8.40 (2.98)^{d}	7.10 (2.76)^{d}	6.00 (2.55)^{d}	7.83 (2.89)^{d}	7.33 (2.80)^{e}	75.68
7	Water spray	32.33 (5.73)^{c}	18.33 (4.34)^{e}	20.10 (4.54)^{e}	18.40 (4.35)^{e}	20.20 (4.55)^{e}	19.26 (4.45)^{f}	36.12
8	Untreated control	33.77 (5.85)^{c}	30.30 (5.55)^{f}	31.37 (5.65)^{f}	28.47 (5.38)^{f}	30.47 (5.56)^{f}	30.15 (5.54)^{g}	
S.Em.0.12		0.09	0.10	0.11	0.07	0.06		
CV (%)		4.11	5.15	5.76	6.83	4.25	3.38	

DBS - Day before spray, DAS - Day after spray

Figures in the parentheses are values derived from $\sqrt{x+0.5}$ transformation.

In a column, means followed by same letters are not varying significantly by DMRT (P=0.05)

and dichlorvos 76 EC (6.73) were the next better sprays and were on par with flufyradifurone 20 SL. Untreated plants recorded significantly higher population of thrips (27.40 thrips per top three leaves).

On seventh day of spraying, flonicamid 50 WG (2.60), fipronil 5 SC (3.33) and flufyradifurone 20 SL (3.87) were found to be significantly effective in lowering thrips population and were on par with each other. They were followed by diafenthiuron 50 WP (5.87), dinotefuran 20 SG (7.07) and dichlorvos 76 EC (7.80) which were on par and next better treatments. Water spray treatment recorded 18.87 thrips per top three leaves and maximum were noticed on untreated plants (29.27).

Mean efficacy of insecticides used in management of thrips showed superiority of fipronil 5 SC (3.77) over rest of the insecticides and accounted 87.92 per cent reduction over untreated treatment. While, flonicamid 50 WG (4.55) and flufyradifurone 20 SL (5.43) were on par with fipronil 5 SC and recorded 85.40 and 82.57 per cent reduction of thrips population over untreated treatment. Diafenthiuron 50 WP (6.28) was next best treatment and was on par with flonicamid 50 WG (4.55), followed by dinotefuran 20 SG (7.32) which was found to be on par with diafenthiuron 50 WP. Dichlorvos 76 EC (8.50) was found significantly inferior over rest of the insecticides and accounted 72.73 per cent reduction over control. Better efficacy of fipronil 5SC and lesser efficacy of dichlorvos was reported by Sakthivel (2019) and in agreement with the present results. Untreated control recorded higher thrips population (31.17) (Table 1).

Second spray on 45 days after pruning

On 45th day of pruning, the thrips population before imposing second spray showed a significant variation from 13.17 (fipronil 5 SC) to 32.47 (untreated control).

A day after spraying thrips population were significantly lower in fipronil 5 SC (3.06), followed by flonicamid 50 WG (4.07) and diafenthiuron 50 WP (4.67) and were on par to each other. While, flufyradifurone 20 SL (5.27) was next promising treatment and on par with flonicamid 50 WG. These were followed by dinotefuran 20 SG (6.13) and dichlorvos 76 EC (6.27) and both were on par with diafenthiuron 50 WP. Whereas, water (17.27) and unsprayed plants harboured higher thrips population (27.33).

On third day after spraying, population of thrips reduced significantly in fipronil 5 SC (2.53), followed by flonicamid 50 WG (3.26), diafenthiuron 50 WP (3.87) and flufyradifurone 20 SL (4.53) and all were on par with each other. While, dinotefuran 20 SG (5.27) was next best insecticide and was on par with flonicamid 50 WG. Thrips population in dichlorvos 76 EC (5.70) was on par with diafenthiuron 50 WP. Significantly higher population of thrips was registered in water spray (18.73) and untreated control (28.10). The results were in line with the findings of Patil *et al.* (2013).

On fifth day after spraying, significantly lowest population of thrips was observed in fipronil 5 SC (1.33). The next best were flonicamid 50 WG (2.73) and flufyradifurone 20 SL (3.73), dinotefuran 20 SG (4.13) and diafenthiuron 50 WP (4.27) and all were on par with each other. While, dichlorvos 76 EC recorded

5.27 thrips per top three leaves and was on par with flufyradifurone 20 SL. Higher number of thrips per top three leaves was recorded on water sprayed (20.33) and unsprayed plants (29.53).

On seventh day after spraying, considerably minimum thrips population was recorded in fipronil 5 SC (2.07), followed by flonicamid 50 WG (2.13) and flufyradifurone 20 SL (3.27) and all were on par. The next best promising insecticides were dinotefuran 20 SG (5.67), diafenthiuron 50 WP (6.07) and dichlorvos 76 EC (7.87) and were similar to each other. The thrips population of 21.53 and 31.67 on top three leaves were found on water spray and untreated mulberry.

Mean efficacy of the newer insecticides after second spray revealed the significant superiority of fipronil 5 SC (2.25) and flonicamid 50 WG (3.05) in reducing thrips population. They were followed by flufyradifurone 20 SL (4.20), diafenthiuron 50 WP (4.72) and dinotefuran 20 SG (5.30), and all were on par with each other. While, dichlorvos 76 EC harboured higher thrips population (6.17) and was on par with dinotefuran 20 SG. Water sprayed and unsprayed plants recorded 19.47 and 29.13 thrips on top three leaves (Table 2).

Mean efficacy of newer chemicals against mulberry thrips

Considering the overall efficacy of two sprays on 30th and 45th days after pruning the results revealed that fipronil 5 SC (3.01) was the best treatment in controlling the thrips population and showed 90.01 per cent reduction over untreated control. While, flonicamid 50 WG (3.80) was the next best which accounted 87.40 per cent reduction in thrips population over untreated control. Flufyradifurone 20 SL (4.82) and diafenthiuron 50 WP (5.50) were next best and recorded 84.02 and 81.76 per cent reduction over control. While, dinotefuran 20 SG (6.31) was in line with diafenthiuron 50 WP. Dichlorvos 76 EC (7.33) was found to be inferior over rest of the insecticides and recorded 75.68 per cent reduction over untreated control. Spraying of water reduced the thrips population to the tune of 19.26 per top three leaves and accounted 36.12 per cent reduction over untreated treatment. Untreated control (30.15) harboured significantly higher population of thrips (Table 3).

Systemic mode of action as well as longer residual action of fipronil, flonicamid and flufyradifurone might have aided longer protection to mulberry against thrips. Whereas, gradual build up of the population immediately in diafenthiuron, dinotefuran and dichlorvos attributed their shorter residual action due to their contact nature. Significant reduction in the thrips population infesting mulberry was recorded in fipronil (0.97), flupyradifurone (0.99) and acetamiprid (1.03) at five days after spraying by Patil *et al*. (2013). Poornima and Rayar (2015) observed the superiority of fipronil (0.005%) against mulberry thrips, followed by diafenthiuron over dichlorvos as well as untreated control. All these reports further strengthened the present observation.

Conclusion

Dichlorvos 76 EC (0.02 %) is the commonly used insecticide for the management of insect pests infesting mulberry owing to its shorter residual effect and safety to silkworms. Since it is in the list of insecticides to be banned, for the effective management of mulberry thrips Fipronil 5 SC @ 1 ml/l could be an alternate insecticide.

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