EVALUATION OF DIFFERENT INSECTICIDES AGAINST LEAF MINER (*Liriomyza trifolii* BURGESS) IN TOMATO

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ABSTRACT

A field experiment was conducted at Main Vegetable Research Station, Anand Agricultural University, Anand, Gujarat during *rabi* season of the year 2011-12 to asses the efficacy of nine different insecticides (Thiamethoxam 0.0125%, Spinosad 0.015%, Diafenthiuron 0.05%, Emmamectin 0.025%, Fipronil 0.08%, Clothianidin 0.05%, Imidacloprid 0.035%, Methyl-o-demeton 0.025% and Dimethoate 0.03%) against leaf miner (*Liriomyza trifolii* Burgess) along with control. Of these, diafenthiuron, emmamectin, thiamethoxam and spinosad emerged as most effective; clothianidin, dimethoate and fipronil as mediocre, whereas methyl-o-demeton and imidacloprid found the least effective. The minimum (0.00) per cent avoidable losses were recorded in diafenthiuron followed by emmamectin (3.56). However, maximum (57.40) per cent avoidable losses were recorded in control plot followed by methyl-o-demeton (28.78) and imidacloprid (26.75). Plot treated with diafenthiuron recorded significantly higher tomato fruit yield (314.90 q/ha).

KEY WORDS: Bio-efficacy, insecticides, leaf miner, *Liriomyza trifolii*, tomato

INTRODUCTION

Tomato is an important crop of immense value in olericulture. In the world, it ranks second in importance to potato in many countries and believed to be a native of Central and South America. India ranks 4th in production followed by China, U.S.A and Turkey (Anonymous, 2008). The estimated area under tomato in India is about 6.33 lakh ha with a production of 124.25 lakh tonnes of fruits. In Gujarat, it was grown in an area of 0.34 lakh ha with the production of 8.41 lakh tonnes and a productivity of 24.89 tonnes per hectare. Various factors are responsible for reducing the crop yield, of which insect pests is one of the important factors cause considerable losses in tomato production. Of these, leaf miner, *Liriomyza trifolii* Burgess (Agromyzidae: Diptera) has been found causing serious damage since last many years. In India, it was first time reported in the proceeding of the annual castor research workers' group meeting held at Hyderabad in 1991 (Anonymous, 1991). The estimated losses due to infestation of *L. trifolii* was 46-70% loss to tomato seedlings (Pohronezny *et al.*, 1986), 90% loss to tomato foliage (Johnson *et al.*, 1983) and 70% loss of tomato yield (Zoebisch *et al.*, 1984).

The adult female of *L. trifolii* makes numerous punctures on the leaf mesophyll with her ovipositor for feeding and oviposition; which results in a stippled appearance on foliage especially at the leaf tip and along the leaf margins (Parella *et al.*, 1985). However, the major form of the damage is mining of leaves by larvae, which results in destruction of the leaf mesophyll. Extensive mining also causes premature leaf drop, which can result in lack of shading and sun scalding of fruits. Punctures on the foliage also allow entry of bacterial and fungal pathogens. Limited work has been done on the different aspects in relation to *L. trifolii* in tomato particularly under Middle Gujarat condition. Hence, the present investigation was carried out to evaluate different insecticides against *L. trifolii* in tomato.

MATERIALS AND METHODS

To study the efficacy of different insecticides against *L. trifolii* in tomato, a field experiment was conducted at Main Vegetable Research Station, Anand Agricultural University, Anand during *rabi* season of 2011-12. Nine different insecticides (thiamethoxam 0.0125%, spinosad 0.015%, diafenthiuron 0.05%, emmamectin 0.025%, fipronil 0.08%, clothianidin 0.05%, imidacloprid 0.035%, methyl-o-demeton 0.025% and dimethoate 0.03%) were evaluated along with untreated check in a randomized block designed with three replications in a plot size of 4.2 x 3.6 m with a spacing 90 x 60 cm. Tomato seedlings were transplanted during last week of September and raised successfully by adopting recommended suitable agronomical practices. First spray of respective insecticides was made on appearance of leaf miner and subsequent two sprays were given at 14 days interval. For recording observations, 5 plants were selected randomly from the whole experimental plot. The observations on number of mines and larvae were recorded from the three compound leaves from the middle portion of same selected plants. For observations on damaged leaves, total and damaged leaves from three compound leaves of the same 5 plants were counted. The observations were made prior to 24 hrs of first spray as well as 3, 7 and 14 days after each spray. Picking wise fruit yield were recorded at each picking from each plot. The periodical data on number of mines as well as larvae/leaf were subjected to analysis of variance (ANOVA) after transforming them to square root. The data on per cent damaged leaves were analyzed after transforming them to arcsine. However, the data on yield were analyzed without any transformations.

Per cent loss in yield due to infestation of *L. trifolii* was calculated by comparing the highest yield obtained from the treatment with different treatments using following formula.

$$\text{Per cent avoidable loss in yield} = \frac{\text{Highest yield in treated plot} - \text{yield in treated plot}}{\text{Highest yield in treated plot}} \times 100$$

RESULTS AND DISCUSSION

Evaluation based on mines per leaf

Nine different insecticides were evaluated for their bio-efficacy against *L. trifolii* in tomato based on number of mines as well as larvae per leaf, per cent damaged leaves and fruit yield.

The data pooled over periods over sprays adjudged based on mines per leaf (Table 1) indicated that the differences among the treatments were significant. The data also indicated that all the insecticidal treatments were significantly effective when compared with control after first, second and third sprays as well as in pooled analysis. Emmamectin found significantly effective by recording minimum (3.26 mines per leaf) mines population than rest of the treatments except diafenthiuron (3.46 mines per leaf), with which it was at par after first spray (Table 1). Diafenthiuron also found significantly effective in reducing mines population as compared to spinosad (3.74 mines per leaf), imidacloprid (3.95 mines per leaf) and methyl-o-demeton (4.12 mines per leaf), but it was at par with thiamethoxam (3.54 mines per leaf), fipronil (3.62 mines per leaf), clothianidin (3.66 mines per leaf) and dimethoate (3.70 mines per leaf). Methyl-o-demeton recorded significantly higher mines population among the tested insecticides and found least effective. After second spray (Table 1), emmamectin still found most effective which recorded significantly minimum (3.22 mines per leaf) mines population in comparison to fipronil (3.50 mines per leaf), clothianidin (3.50 mines per leaf), dimethoate (3.66 mines per leaf), methyl-o-demeton (3.70 mines per leaf) and imidacloprid (3.78 mines per leaf), while it was at par with spinosad (3.34 mines per leaf),, diafenthiuron (3.38 mines per leaf) and thiamethoxam (3.38 mines per leaf). Dimethoate, imidacloprid and methyl-o-demeton did not differ significantly from each other after second spray. After third spray (Table 1), the data revealed that all the insecticides found equally effective, as they were at par with each other. The data pooled over three sprays (Table 1) indicated that emmamectin found significantly effective by recording minimum mines population (3.03 mines per leaf) than rest of the insecticides tested except thiamethoxam and diafenthiuron (3.15 mines/leaf) with which it was at par. Spinosad, clothianidin and fipronil did not significantly differ from each other. Similarly, dimethoate and fipronil as well as dimethoate, imidacloprid and methyl-o-demeton did not significantly differ from each other in pooled analysis.

Evaluation based on larvae per leaf

The data pooled over periods over sprays adjudged based on larval population (Table 2) per leaf indicated that the differences among the treatments were significant. The data also indicated that all the insecticidal treatments recorded significantly lower larval population when compared with control after first, second and third sprays as well as in pooled analysis.

After first spray, the data (Table 2) revealed that diafenthiuron recorded significantly lower (1.30 larvae per leaf) larval population than rest of the treatments, except emmamectin (1.35 larvae per leaf) with which it was at par. Thiamethoxam (1.72 larvae per leaf), dimethoate (1.81 larvae per leaf), spinosad (1.87 larvae per leaf) and clothianidin (1.96 larvae per leaf) found significantly superior to methyl-o-demeton (2.46 larvae per leaf) and imidacloprid (2.46 larvae per leaf). After second spray, diafenthiuron found most effective by recording significantly lower (0.54 larvae per leaf) larval population than rest of the treatments except emmamectin (0.69 larvae per leaf) with which it was at par (Table 2). Methyl-o-demeton (1.81 larvae per leaf) and imidacloprid (1.72 larvae per leaf) recorded significantly higher larval population and were at par with each other and also with clothianidin (1.35 larvae per leaf), fipronil (1.46 larvae per leaf) and dimethoate (1.52 larvae per leaf). Diafenthiuron and Emmamectin recorded significantly lower larval population of 0.35 and 0.50 larvae per leaf, respectively than rest of the treatments and both were at par with each other after third spray (Table 2). Thiamethoxam (0.80 larvae per leaf) and spinosad (0.85 larvae per leaf) found significantly superior in reducing larval population than clothianidin (1.38 larvae per leaf), fipronil (1.40 larvae per leaf), imidacloprid (1.60 larvae per leaf) and methyl-o-demeton (1.66 larvae per leaf), but both the insecticides were at par with each other and also with dimethoate (1.04 larvae per leaf). The data (Table 2) of pooled of three sprays revealed that diafenthiuron and emmamectin found most effective which recorded significantly lower larval population of 0.71 and 0.82 larvae per leaf, respectively than rest of the treatments and both were at par with each other. Thiamethoxam (1.19 larvae per leaf) and spinosad (1.24 larvae per leaf) found significantly superior to clothianidin (1.54 larvae per leaf), fipronil (1.63 larvae per leaf), imidacloprid (1.90 larvae per leaf) and methyl-o-demeton (1.96 larvae per leaf), but both were at par with each other and also with dimethoate (1.35 larvae per leaf). Methyl-o-demeton recorded significantly higher (1.96 larvae/leaf) larval population than rest of the treatments except imidacloprid.

Evaluation based on per cent damaged leaves

The data pooled over periods over sprays (Table 3) based on per cent damaged leaves indicated that the differences among the treatments were significant. The data also revealed that all the insecticidal treatments found significantly superior in reducing per cent damaged leaves when compared with control after first, second and third sprays as well as in pooled analysis. After first spray (Table 3), diafenthiuron recorded minimum per cent damaged leaves (9.63) and was significantly superior to rest of the treatments, except emmamectin (10.24) with which it was at par. Dimethoate found equally effective as thiamethoxam, spinosad, clothianidin, fipronil and imidacloprid. After second spray, diafenthiuron recorded significantly lower per cent damaged leaves (8.30) as compared to dimethoate, clothianidin, fipronil, methyl-o-demeton and imidacloprid, whereas it was at par with emmamectin, spinosad and thiamethoxam (Table 3). Imidacloprid recorded significantly higher per cent damaged leaves and was at par with fipronil and methyl-o-demeton. After third spray (Table 3), emmamectin and diafenthiuron found superior which recorded significantly minimum per cent damaged leaves of 3.84 and 3.87, respectively than rest of the treatments and both were at par with each other. Thiamethoxam, spinosad, fipronil, clothianidin and dimethoate were not significantly differed from each other. Similarly, fipronil, clothianidin, dimethoate, methyl-o-demeton and imidacloprid were at par with each other. The data on pooled over three sprays (Table 3) revealed that diafenthiuron and emmamectin were at par with each other but recorded significantly minimum per cent damaged leaves of 7.04 and 7.51, respectively than rest of the treatments and found most effective. Clothianidin was at par with thiamethoxam, spinosad, dimethoate and fipronil. Methyl-o-demeton and imidacloprid were at par with each other but recorded significantly higher per cent damaged leaves and found least effective.

Overall, based on infestation levels (mines, larvae and per cent damaged leaves) of *L. trifolii*, diafenthiuron, emmamectin, thiamethoxam and spinosad recorded lower number of mines as well as larvae and per cent damaged leaves emerged as most effective, while clothianidin, dimethoate and fipronil as mediocre and methyl-o-demeton and imidacloprid recorded significantly higher number of mines as well as larvae and per cent damaged leaves considered to be least effective.

Many research workers have evaluated and reported the bio-efficacy of insecticides against leaf miner, *L. trifolii* in tomato as well as other vegetable crops. Emamectin benzoate showed a rapid action against *L. trifolii* with 100% mortality even a day after application, while acephate and cyromazine exhibited slow action (Ishida *et al.*, 2002). According to Tokumaru *et al.* (2005), chloropyriphos, isoxathion, cartap, thiocyclam, cyromazine, emamectin benzoate, pyridalyl and spinosad were more toxic to the second instar larvae of all three *Liriomyza* spp. under laboratory condition, whereas cartap, thiocyclam, emmamectin benzoate and spinosad reduced the number of feeding and oviposition punctures made by female adults. Ramesh and Ukey (2007) reported abamectin 0.002% as the most effective treatment in reducing leaf miner infestation in tomato at 5 and 7 days after spraying followed by cypermethrin 0.01%, spinosad 0.0015% and endosulfan 0.05%. Imidacloprid 0.01% was least effective against this pest. Wankhede *et al.* (2007) reported that spinosad 0.01% was more effective against *L. trifolii* and also gave the highest tomato fruit yield. Thus, the above reports drawn by various research workers for the bio-efficacy of emmamectin, fipronil, spinosad, imidacloprid and clothianidin are close agreement with the present findings.

Evaluation based on fruit yield and avoidable losses

The data (Table 4) on fruit yield indicated that all the insecticidal treatments registered significantly higher yield when compared with control. Among the different insecticides, diafenthiuron recorded significantly higher (314.90 q/ha) fruit yield than rest of the treatments except emmamectin and thiamethoxam, with which it was at par. Emmamectin exhibited significantly higher (303.70 q/ha) fruit yield as compared to clothianidin, dimethoate, fipronil, imidacloprid and methyl-o-demeton. Clothianidin, dimethoate, fipronil, imidacloprid and methyl-o-demeton did not differ significantly from each other for fruit yield. The minimum (00.00) per cent avoidable losses (Table 4) were recorded in diafenthiuron followed by emmamectin (03.56), thiamethoxam (07.35) and spinosad (12.96). However, the maximum per cent avoidable losses were recorded in control plot (57.40) followed by methyl-o-demeton (28.78) and imidacloprid (26.75).

CONCLUSION

Among different nine insecticides evaluated for their bio-efficacy against *L. trifolii* infesting tomato, diafenthiuron, emmamectin, thiamethoxam and spinosad emerged as most effective; clothianidin, dimethoate and fipronil as mediocre, whereas methyl-o-demeton and imidacloprid found the least effective. The minimum (0.00) per cent avoidable losses were recorded in diafenthiuron followed by emmamectin (3.56). However, maximum (57.40) per cent avoidable losses were recorded in control plot followed by methyl-o-demeton (28.78) and imidacloprid (26.75). Plot treated with diafenthiuron recorded significantly higher tomato fruit yield (314.90 q/ha).

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Table 1: Efficacy of different insecticides against *L. trifolii* based on mines in tomato (Pooled over periods over sprays)

Treatments		Number of Mines per Leaf*			
		First Spray	Second Spray	Third Spray	Pooled over Spray
Thiamethoxam 25WG, 0.0125%		2.01^{b} (3.54)	1.97^{ab} (3.38)	1.77^{a} (2.63)	1.91^{a} (3.15)
Spinosad 45 SC, 0.015%		2.06^{c} (3.74)	1.96^{ab} (3.34)	1.84^{a} (2.89)	1.95^{b} (3.30)
Diafenthiuron 50 WP, 0.05%		1.99^{ab} (3.46)	1.97^{ab} (3.38)	1.77^{a} (2.63)	1.91^{a} (3.15)
Emmamectin 5 SG, 0.025%		1.94^{a} (3.26)	1.93^{a} (3.22)	1.78^{a} (2.67)	1.88^{a} (3.03)
Fipronil 80 WG, 0.08%		2.03^{b} (3.62)	2.00^{bc} (3.50)	1.84^{a} (2.89)	1.96^{bc} (3.34)
Clothianidin 50 WDG, 0.05%		2.04^{b} (3.66)	2.00^{bc} (3.50)	1.82^{a} (2.81)	1.95^{b} (3.30)
Imidacloprid 70 WG, 0.035%		2.11^{c} (3.95)	2.07^{d} (3.78)	1.85^{a} (2.92)	2.01^{d} (3.54)
Methyl-o-demeton 25 EC, 0.025%		2.15^{d} (4.12)	2.05^{cd} (3.70)	1.86^{a} (2.96)	2.02^{d} (3.58)
Dimethoate 30 EC, 0.03%		2.05^{bc} (3.70)	2.04^{cd} (3.66)	1.87^{a} (3.00)	1.99^{cd} (3.46)
Control		2.35^{e} (5.02)	2.33^{e} (4.93)	2.05^{b} (3.70)	2.24^{e} (4.52)
ANOVA					
S. Em. ±	**Insecticides (I)**	0.02	0.02	0.03	0.01
	Periods (P)	0.01	0.01	0.01	0.01
	Spray (S)	-	-	-	0.01
	I x P	0.03	0.04	0.04	0.01
	I x S	-	-	-	0.01
	I x P x S	-	-	-	0.04
C.D. (5%)	**Insecticides (I)**	0.06	0.05	0.10	0.03
	Periods (P)	0.03	0.03	0.04	0.02
	Spray (S)	-	-	-	0.02
	I x P	NS	NS	0.11	0.06
	I x S	-	-	-	0.03
	I x P x S	-	-	-	NS
C.V. (%)		3.00	2.39	5.23	3.27

Notes:* 1. *Treatment means with letter(s) in common are not significant at 5 % level of significance in respective column

2. *Figures in parentheses are retransformed values; those outside are $\sqrt{X+0.5}$ *transformed values*

Table 2 : Efficacy of different insecticides against *L. trifolii* based on larval population in tomato (Pooled over periods over sprays)

Treatments		Number of Larvae per Leaf*			
		First Spray	Second Spray	Third Spray	Pooled over Spray
Thiamethoxam 25WG, 0.0125%		1.49^{bc} (1.72)	1.27^{bc} (1.11)	1.14^{b} (0.80)	1.30^{b} (1.19)
Spinosad 45 SC, 0.015%		1.54^{c} (1.87)	1.25^{bc} (1.06)	1.16^{b} (0.85)	1.32^{b} (1.24)
Diafenthiuron 50 WP, 0.05%		1.34^{a} (1.30)	1.02^{a} (0.54)	0.92^{a} (0.35)	1.10^{a} (0.71)
Emmamectin 5 SG, 0.025%		1.36^{ab} (1.35)	1.09^{ab} (0.69)	1.00^{a} (0.50)	1.15^{a} (0.82)
Fipronil 80 WG, 0.08%		1.59^{cd} (2.03)	1.40^{cd} (1.46)	1.38^{d} (1.40)	1.46^{cd} (1.63)
Clothianidin 50 WDG, 0.05%		1.57^{c} (1.96)	1.36^{cd} (1.35)	1.37^{cd} (1.38)	1.43^{c} (1.54)
Imidacloprid 70 WG, 0.035%		1.72^{d} (2.46)	1.49^{d} (1.72)	1.45^{d} (1.60)	1.55^{de} (1.90)
Methyl-o-demeton 25 EC, 0.025%		1.72^{d} (2.46)	1.52^{d} (1.81)	1.47^{d} (1.66)	1.57^{e} (1.96)
Dimethoate 30 EC, 0.03%		1.52^{c} (1.81)	1.42^{cd} (1.52)	1.24^{bc} (1.04)	1.39^{bc} (1.43)
Control		1.99^{e} (3.46)	2.12^{e} (4.00)	1.87^{e} (3.00)	1.99^{f} (3.46)
ANOVA					
S. Em. ±	**Insecticides (I)**	0.04	0.07	0.05	0.03
	Periods (P)	0.03	0.04	0.03	0.02
	Spray (S)	-	-	-	0.02
	I x P	0.09	0.12	0.10	0.06
	I x S	-	-	-	0.03
	I x P x S	-	-	-	0.10
C.D. (5%)	**Insecticides (I)**	0.13	0.21	0.13	0.10
	Periods (P)	0.08	0.11	0.10	0.05
	Spray (S)	-	-	-	0.05
	I x P	NS	NS	NS	NS
	I x S	-	-	-	NS
	I x P x S	-	-	-	NS
C.V. (%)		8.41	15.44	10.31	11.84

Notes: 1. Treatment means with letter(s) in common are not significant at 5 % level of significance in respective column

*2. Figures in parentheses are retransformed values; those outside are $\sqrt{X+0.5}$ *transformed values*

Table 3: Efficacy of different insecticides against *L. trifolii* based on per cent damaged leaves in tomato (Pooled over periods over sprays)

Treatments (Conc.)		Per Cent Damaged Leaves**			
		First Spray	**Second Spray**	**Third Spray**	**Pooled over Spray**
Thiamethoxam 25WG, 0.0125%		20.01^{bc} (11.71)	18.05^{ab} (9.60)	14.58^{b} (6.34)	17.54^{b} (9.08)
Spinosad 45 SC, 0.015%		20.55^{c} (12.32)	17.89^{ab} (9.44)	15.17^{b} (6.85)	17.87^{bc} (9.42)
Diafenthiuron 50 WP, 0.05%		18.08^{a} (9.63)	16.74^{a} (8.30)	11.35^{a} (3.87)	15.39^{a} (7.04)
Emmamectin 5 SG, 0.025%		18.66^{ab} (10.24)	17.74^{ab} (9.28)	11.30^{a} (3.84)	15.90^{a} (7.51)
Fipronil 80 WG, 0.08%		21.07^{cd} (12.92)	$19.51b^{cd}$ (11.51)	15.96^{bc} (7.56)	18.85^{c} (10.44)
Clothianidin 50 WDG, 0.05%		21.06^{cd} (12.91)	18.44^{bc} (10.00)	16.29^{bc} (7.87)	18.60^{bc} (10.17)
Imidacloprid 70 WG, 0.035%		22.47^{de} (14.61)	20.80^{d} (12.61)	19.09^{c} (10.70)	20.79^{d} (12.60)
Methyl-o-demeton 25 EC, 0.025%		23.20^{e} (15.52)	20.16^{cd} (11.81)	18.61^{c} (10.18)	20.66^{d} (12.45)
Dimethoate 30 EC, 0.03%		21.00^{cd} (12.84)	18.41^{bc} (9.97)	17.11^{bc} (8.66)	18.84^{c} (10.43)
Control		26.46^{f} (19.85)	25.34^{e} (18.32)	23.55^{d} (15.96)	25.12^{e} (18.02)
ANOVA					
S. Em. ±	**Insecticides (I)**	0.63	0.63	1.08	0.43
	Periods (P)	0.36	0.34	0.50	0.24
	Spray (S)	-	-	-	0.24
	I x P	1.14	1.08	1.57	0.77
	I x S	-	-	-	0.42
	I x P x S	-	-	-	1.33
C.D. (5%)	**Insecticides (I)**	1.86	1.86	3.22	1.29
	Periods (P)	1.03	0.98	1.42	0.67
	Spray (S)	-	-	-	0.67
	I x P	NS	NS	NS	NS
	I x S	-	-	-	NS
	I x P x S	-	-	-	NS
C.V. (%)		8.84	9.72	19.95	11.89

***Notes:* 1. Treatment means with letter(s) in common are not significant at 5 % level of significance in respective column**

2. Figures in parentheses are retransformed values; those outside are arcsine* transformed values

Table 4: Impact of different insecticides on tomato fruit yield

Treatments (conc.)	**Fruit yield (q/ha)**	**Avoidable losses (%)**
Thiamethoxam 25WG, 0.0125%	291.77[abc]	07.35
Spinosad 45 SC, 0.015%	274.07[bcd]	12.96
Diafenthiuron 50 WP, 0.05%	314.90[a]	00.00
Emmamectin 5 SG, 0.025%	303.70[ab]	03.56
Fipronil 80 WG, 0.08%	243.21[de]	22.77
Clothianidin 50 WDG, 0.05%	258.85[cde]	17.80
Imidacloprid 70 WG, 0.035%	230.66[e]	26.75
Methyl-o-demeton 25 EC, 0.025%	224.28[e]	28.78
Dimethoate 30 EC, 0.03%	253.50[de]	19.50
Control	134.16[f]	57.40
ANOVA		
S. Em. ±	12.85	-
C. D. at 5%	38.17	-
C. V.%	08.80	-

Notes: Treatment means with letter(s) in common are not significant at 5 % level of significance in respective column

[MS received: November 01, 2012] *[MS accepted: December 11, 2012]*