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Bioefficacy of newer insecticides against tomato leaf miner, *Tuta absoluta* (meyrick) on tomato, *Lycopersicon esculentum* (mill) under protected cultivation

SD Sapkal, MM Sonkamble and VG Savde

Abstract
For tomato leaf miner management seven newer insecticides were taken viz., spinosad 45% SC, chlorantraniliprole 18.5% SC, emamectin benzoate 5% SG, indoxacarb 14.5% SC, cyantraniliprole 10.26% OD, spinatoram 11.7% SC and flubendiamide 39.35% SG. The total three numbers of sprays were done. The treatment Chlorantraniliprole 18.5% SC, Emamectin benzoate 5% SG, Spinatoram 11.7% SC and Spinosad 45% SC was significantly at par with each other. Among them chlorantraniliprole 18.5% SC found most effective than all other treatment. The descending order of efficacy was recorded in all three sprays as chlorantraniliprole 18.5% SC > emamectin benzoate 5% SG > spinatoram 11.7% SC > spinosad 45% SC > flubendiamide 39.35% SG > indoxacarb 14.5% SC > cyantraniliprole 10.26% OD.

Keywords: newer insecticides, leaf miner *T. absoluta*, tomato, protected cultivation

Introduction
Tomato (*Lycopersicon esculentum* Mill.), belonging to family Solanaceae is the most important vegetable grown widely both for fresh market and processing. It is said to be a native of tropical America. Tomato is the world's largest vegetable crop after potato and sweet potato and it tops the list of canned vegetables and occupies an area of 4.5 mha in world with an annual production of 130 mt. (Anonymous, 2016) [2]. The productivity of tomato in India is very low (15.60 t/ha) compared to the global average (25.09 t/ha). Tomato is one of the important vegetable grown in India with 774 ('000 ha) area with a production of 18732 ('000 mt) (NHB, 2016) [8]. The production and quality of tomato fruits are considerably affected by array of insect pests infesting at different stages of crop growth. Though there are dozens of pests on tomato, recently a serious invasive insect pest known as South American tomato pinworm, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) also known as tomato leaf miner *Tuta absoluta* has several common names like tomato borer, South American tomato moth, tomato leaf miner and South American tomato pinworm. Since the 1960s, this moth has become one of the key pests of tomato in South America (Garcia and Espul, 1982) [4]. In Europe, *T. absoluta* presence was initially reported in the Eastern Spain in the late 2006 (Urbaneja *et al*., 2007) [11], thereafter, it was recorded in Morocco, Tunisia, France, Italy, Netherlands, Albania, Portugal, Bulgaria, Cyprus, Germany, Israel, Hungary, Greece, Bahrain, Iraq, Isreal, Japan, Jordan, Kuwait, Qatar, Saudi Arabia, Syria, Turkey, Yemen, Ukraine and other countries (CABI, 2014) [3]. Economic significance of crop produce compelled the commercial farmer to advocate insecticidal almost in alternate days, sometimes almost double the recommended doses. Such indiscriminate use of insecticides leads to development of resurgence and resistance. So these days, there is a need to search for newer chemical that are selective which can replace older spurious chemicals on tomato. Therefore, keeping the above information in view bioefficacy of newer insecticides against tomato fruit borer, *T. absoluta* (Meyrick) on tomato, *Lycopersicon esculentum* (Mill.) under protected condition.

Material and Methods
The experiment was carried out with tomato crop using variety Pusa Ruby at research farm Department of Horticulture, VNMKV, Parbhani during *Kharif* 2017-18.

The experiment was conducted in a randomized block design (RBD) with three replications and eight treatment. Two raised beds were prepared in poly house having 0.4 meter height, 1 meter width and 17 meter length. They were prepared by applying well decomposed farm yard manure. Seedling preparation tomato seeds were sown in portrays (98 cell) on June 30th using coco peat as growing media for nursery production. The seedlings of 30 days old, vigorous and uniform size were selected and transplanted on 29-07-2017 with a spacing 60x45 cm^2 at a shallow depth of 2-2.5 cm in paired row on a bed. The sprays were given during reproductive stage of the crop when *T. absolute* appears to be severe causing economic damage. The observations of leaf miner larvae was recorded from five randomly selected and tagged plants in each treatment plot before one day and 1, 3, 7 and 14 days after application of insecticides and data obtained was analyzed by standard analysis of variance method.

Results and Discussion

Effect of different insecticides on larval population of fruit borer (*Helicoverpa armigera* Hubner).

Table 1: Treatment details

Tr. No.	Treatment details	Dose (g a.i) per ha	Conc. (%)	Dose (gm or ml/ 10lit. water)
T_1	Spinosad 45 SC	83	0.0144	3.2
T_2	Chlorantraniliprole 18.5 SC	30	0.0055	2.97
T_3	Emamectin benzoate 5 SG	10	0.0022	4.4
T_4	Indoxacarb 14.5 SC	75	0.0116	8
T_5	Cyantraniliprole 10.26 OD	60	0.0184	18
T_6	Spinatoram 11.7 SC	60	0.0010	0.85
T_7	Flubendiamide 39.35 SG	60	0.0078	1.98
T_8	Untreated control.	-	-	-

Table 2: Population of *Tuta absoluta* per plant in polyhouse tomato before and after first spray:

Tr. No.	Treatments	Dosages (g.a.i/ha)	Number of Larvae per plant before and after first spraying				
			Pre-count	1 DAS	3 DAS	7DAS	14 DAS
T_1	Spinosad 45 SC	83	1.07 (1.25)*	0.47 (0.93)	0.67 (1.08)	0.93 (1.20)	1.40 (1.38)
T_2	Chlorantraniliprole 18.5 SC	30	0.93 (1.19)	0.13 (0.79)	0.33 (0.91)	0.47 (0.98)	0.73 (1.11)
T_3	Emamectin benzoate 5 SG	10	0.87 (1.16)	0.20 (0.83)	0.47 (0.98)	0.60 (1.04)	1.07 (1.25)
T_4	Indoxacarb 14.5 SC	75	1.00 1.22)	0.67 (1.08)	0.87 (1.17)	1.07 (1.25)	1.47 (1.40)
T_5	Cyantraniliprole 10.26 OD	60	1.20 (1.30)	0.73 (1.11)	1.07 (1.25)	1.27 (1.33)	1.53 (1.42)
T_6	Spinatoram 11.7 SC	60	1.00 (1.22)	0.33 (0.91)	0.60 (1.04)	0.87 (1.17)	1.27 (1.33)
T_7	Flubendiamide 39.35 SG	60	0.93 (1.19)	0.53 (1.02)	0.80 (1.14)	1.00 (1.22)	1.40 (1.38)
T_8	Untreated control.	-	1.13 (1.28)	1.27 (1.33)	1.53 (1.42)	1.67 (1.47)	2.00 (1.58)
	S.E. ±		0.060	0.046	0.053	0.054	0.049
	C.D. at 5%		NS	0.140	0.162	0.166	0.152

*Fig in parenthesis are $\sqrt{X+0.5}$ transformed values,
NS: Non significant, DAS: Days after Spraying

The data on *Tuta absoluta* population on one day before first spray is presented in Table 2 and depicted in Fig 1. The results were statistically non-significant before application of insecticides indicating uniform distribution of *T. absoluta* population. There were significant differences among the treatments on one days after spray. All the treatments were recorded significantly lower population of *T. absoluta* than untreated control. The population of *T. absoluta* in Chlorantraniliprole 18.5 SC @ 30 g a.i/ha was lowest (0.13 larvae/ plant), which was significantly superior over rest of the treatments. The treatments Chlorantraniliprole 18.5 SC @ 30 g a.i/ha, Emamectin benzoate 5 SG @ 10 g a.i/ha, Spinatoram 11.7 SC @ 60 g a.i/ha and Spinosad 45 SC @ 83 g.a.i/ha were significantly at par with each other. The highest population of *T. absoluta* (1.27 larvae/ plant) was observed in untreated control. There were significant differences among the treatments on three days after spray. All the treatments were recorded significantly lower population of *T. absoluta* than untreated control. The population of *T. absoluta* in Chlorantraniliprole 18.5 SC @ 30 g a.i/ha was lowest (0.33 larvae/ plant), which was significantly superior over rest of the treatments. The treatments Chlorantraniliprole 18.5 SC @ 30 g a.i/ha, Emamectin benzoate 5 SG @ 10 g a.i/ha and Spinatoram 11.7 SC @ 60 g a.i/ha were significantly at par with each other. The highest population of *T. absoluta* (1.53 larvae/ plant) was observed in untreated control. There were significant differences among the treatments on seven days after spray. All the treatments were recorded significantly lower population of *T. absoluta* than untreated control. The treatment Chlorantraniliprole 18.5 SC @ 30 g a.i/ha was recorded lower incidence of *T. absoluta* (0.47 larvae/plant). The treatments Chlorantraniliprole 18.5 SC @ 30 g a.i/ha and Emamectin benzoate 5 SG @ 10 g a.i/ha were significantly at par with each other. The highest population of *T. absoluta* (1.67 larvae/ plant) was observed in untreated control. The data on 14 DAS indicated that all the insecticides were superior over untreated control. The population of *T. absoluta* in Chlorantraniliprole 18.5 SC @ 30 g a.i/ha was lowest (0.73 larvae/plant), which was significantly superior over rest of the other treatments. The treatments Chlorantraniliprole 18.5 SC @ 30 g a.i/ha and Emamectin benzoate 5 SG @ 10 g a.i/ha were significantly at par with each other. The highest population of *T. absoluta* (2.00 larvae/ plant) was observed in untreated control.

Table 3: Population of *Tuta absoluta* per plant in polyhouse tomato before and after second spray:

Tr. No.	Treatments	Dosages (g.a.i/ha)	Number of Larvae per plant before and after second spraying				
			Pre-count	1 DAS	3 DAS	7DAS	14 DAS
T_1	Spinosad 45 SC	83	2.13 (1.62)*	0.53 (1.02)	0.67 (1.07)	1.00 (1.22)	1.53 (1.43)
T_2	Chlorantraniliprole 18.5 SC	30	2.27 (1.66)	0.20 (0.83)	0.33 (0.91)	0.60 (1.05)	1.20(1.30)
T_3	Emamectin benzoate 5 SG	10	2.20 (1.64)	0.27 (0.86)	0.40 (0.94)	0.67 (1.08)	1.20(1.30)
T_4	Indoxacarb 14.5 SC	75	2.40 (1.70)	0.73 (1.11)	0.93 (1.20)	1.13 (1.28)	1.73 (1.49)
T_5	Cyantraniliprole 10.26 OD	60	2.27 (1.66)	0.87 (1.17)	1.00 (1.22)	1.27 (1.33)	1.87 (1.54)
T_6	Spinatoram 11.7 SC	60	2.07 (1.60)	0.40 (0.94)	0.67 (1.07)	0.87 (1.17)	1.47 (1.40)
T_7	Flubendiamide 39.35 SG	60	1.93 (1.53)	0.73 (1.11)	0.87 (1.17)	1.07 (1.25)	1.67 (1.47)
T_8	Untreated control.	-	2.33 (1.68)	2.53. (1.74)	2.67 (1.78)	2.80 (1.82)	2.93 (1.85)
	S.E. ±		0.052	0.057	0.058	0.042	0.041
	C.D. at 5%		NS	0.174	0.179	0.128	0.128

*Fig in parenthesis are $\sqrt{X+0.5}$ transformed values
NS: Non Significant, DAS: Days After Spraying

The data on *Tuta absoluta* population on one day before second spray is presented in Table 3 and depicted in Fig 2. The results were statistically non significant before application of insecticides indicating uniform distribution of *T. absoluta* population. The population of *T. absoluta* ranges from 0.20 larvae/plant to 0.87 larvae/plant within three days after spray. Lowest population of *T. absoluta* was recorded in treatment of Chlorantraniliprole18.5 SC @ 30 g a.i/ha (0.20 larvae/plant) which was significantly superior over other treatments. The treatments Chlorantraniliprole 18.5 SC @ 30 g a.i/ha, Emamectin benzoate 5 SG @ 10 g a.i/ha and Spinatoram 11.7 SC @ 60 g a.i/ha were significantly at par with each other. The highest population of *T. absoluta* (2.53 larvae/ plant) was observed in untreated control. There were significant differences among the treatments on three days after spray. All the treatments were recorded significantly lower population of *T. absoluta* than untreated control. The population of *T. absoluta* in Chlorantraniliprole 18.5 SC @ 30 g a.i/ha was lowest (0.33 larvae/ plant), which was significantly superior over rest of the treatments. The treatments Chlorantraniliprole 18.5 SC @ 30 g a.i/ha, Emamectin benzoate 5 SG @ 10 g a.i/ha and Spinatoram 11.7 SC @ 60 g a.i/ha were significantly at par with each other. The highest population of *T. absoluta* (2.67 larvae/ plant) was observed in untreated control. The population of *T. absoluta* on 7 DAS varies from 0.60 to 1.27 larvae/ plant. The treatment Chlorantraniliprole 18.5 SC @ 30 g a.i/ha recorded the lowest population of *H. armigera* (0.60 larvae/plant) which was significantly superior over other treatments. The treatments Chlorantraniliprole 18.5 SC @ 30 g a.i/ha, Emamectin benzoate 5 SG @ 10 g a.i/ha and Spinatoram 11.7 SC @ 60 g a.i/ha were significantly at par with each other. The highest population of *T. absoluta* (2.80 larvae/ plant) was observed in untreated control. The data on 14 DAS indicated that all the insecticides were superior over untreated control. The population of *T. absoluta* in Chlorantraniliprole 18.5 SC @ 30 g a.i/ha was lowest (1.20 larvae/plant), which was significantly superior over rest of the other treatments. The treatments Chlorantraniliprole 18.5 SC @ 30 g a.i/ha, Emamectin benzoate 5 SG @ 10 g a.i/ha and Spinatoram 11.7 SC @ 60 g a.i/ha were significantly at par with each other. The highest population of *T. absoluta* (2.93 larvae/ plant) was observed in untreated control.

Table 4: Population of *Tuta absoluta* per plant in polyhouse tomato before and after third spray:

Tr. No.	Treatments	Dosages (g.a.i/ha)	Number of Larvae per plant before and after second spraying				
			Pre-count	1 DAS	3 DAS	7 DAS	14 DAS
T_1	Spinosad 45 SC	83	3.07 (1.89)*	0.60 (1.05)	0.73 (1.11)	0.93 (1.19)	1.67 (1.47)
T_2	Chlorantraniliprole 18.5 SC	30	3.53 (2.01)	0.27 (0.87)	0.47 (0.98)	0.60 (1.05)	1.40 (1.37)
T_3	Emamectin benzoate 5 SG	10	3.60 (2.02)	0.33 (0.91)	0.53 (1.01)	0.67 (1.07)	1.60 (1.45)
T_4	Indoxacarb 14.5 SC	75	3.33 (1.96)	0.80 (1.14)	0.93 (1.19)	1.07 (1.25)	1.87 (1.54)
T_5	Cyantraniliprole 10.26 OD	60	3.53 (2.01)	0.93 (1.20)	1.07 (1.25)	1.20 (1.30)	1.97 (1.56)
T_6	Spinatoram 11.7 SC	60	3.27 (1.94)	0.47 (0.98)	0.67 (1.07)	0.73 (1.11)	1.67 (1.47)
T_7	Flubendiamide 39.35 SG	60	3.67 (2.04)	0.73 (1.11)	0.87 (1.17)	1.07 (1.25)	1.73 (1.49)
T_8	Untreated control.	-	3.40 (1.97)	3.53. (2.01)	3.67 (2.04)	3.80 (2.07)	4.00 (2.12)
	S.E. ±		0.059	0.052	0.054	0.052	0.051
	C.D. at 5%		NS	0.162	0.166	0.161	0.158

*Fig in parenthesis are $\sqrt{X+0.5}$ transformed values
NS: Non-Significant, DAS: Days After Spraying

The data on *Tuta absoluta* population on one day before third spray is presented in Table 4 and depicted in Fig 3. The results were statistically non significant before application of insecticides indicating uniform distribution of *T. absoluta* population. There were significant differences among the treatments on one days after spray. All the treatments were recorded significantly lower population of *T. absoluta* than untreated control. The population of *T. absoluta* in Chlorantraniliprole 18.5 SC @ 30 g a.i/ha was lowest (0.27 larvae/ plant), which was significantly superior over rest of the treatments. The treatments Chlorantraniliprole 18.5 SC @ 30 g a.i/ha, Emamectin benzoate 5 SG @ 10 g a.i/ha and Spinatoram 11.7 SC @ 60 g a.i/ha were significantly at par with each other. The highest population of *T. absoluta* (3.53 larvae/ plant) was observed in untreated control. The result obtained on *T. absoluta* population recorded on 3 DAS of third spray. All the treatments were recorded significantly lower population of *T. absoluta* than untreated control. The treatment Chlorantraniliprole 18.5 SC @ 30 g a.i/ha was recorded lower incidence of *T. absoluta* (0.47 larvae/ plant). The treatments Chlorantraniliprole 18.5 SC @ 30 g a.i/ha, Emamectin benzoate 5 SG @ 10 g a.i/ha, Spinatoram 11.7 SC

@ 60 g a.i/ha and Spinosad 45 SC @ 83 g.a.i/ha were significantly at par with each other. The highest population of *T. absoluta* (3.67 larvae/ plant) was observed in untreated control. The population of *T. absoluta* on 7 DAS varies from 0.60 to 1.20 larvae/ plant indicates that all the insecticides were significantly superior over untreated control. The treatment Chlorantraniliprole 18.5 SC @ 30 g a.i/ha recorded the lowest population of *H. armigera* (0.60 larvae/ plant) which was significantly superior over other treatments. The treatments Chlorantraniliprole 18.5 SC @ 30 g a.i/ha, Emamectin benzoate 5 SG @ 10 g a.i/ha, Spinatoram 11.7 SC @ 60 g a.i/ha and Spinosad 45 SC @ 83 g.a.i/ha were significantly at par with each other. The highest population of *T. absoluta* (3.80 larvae/ plant) was observed in untreated control. There were significant differences among the treatments on fourteen days after spray. All the treatments were recorded significantly lower population of *T. absoluta* than untreated control. The population of *T. absoluta* in Chlorantraniliprole 18.5 SC @ 30 g a.i/ha was lowest (1.40 larvae/ plant), which was significantly superior over rest of the treatments. The treatments Chlorantraniliprole 18.5 SC @ 30 g a.i/ha, Emamectin benzoate 5 SG @ 10 g a.i/ha, Spinatoram 11.7 SC @ 60 g a.i/ha, Spinosad 45 SC @ 83 g.a.i/ha and Flubendiamide 39.35 SG @ 60 g a.i/ha were significantly at par with each other. The highest population of *T. absoluta* (4.00 larvae/ plant) was observed in untreated control.

The results of present investigation are in conformity with the fallowing related research publications. Abdelhamid Gacemi and Yamina Guenaoui (2012) [1], reported the results on efficacy of Emamectin-benzoate against larvae of the tomato leaf miner larvae with a mortality reaching 87%. Shalaby *et al*., (2012) revealed laboratory experiments that profenofos, cyfluthrin, lufenuron, chlorpyriphos-methyl and indoxacarb were the most toxic insecticides as compared to other chemicals. Under field conditions caused 84.1 to 73.5% reduction in *T. absoluta* infestation. Hanafy and Walaa El-Sayed (2013) evaluated that after two biweekly applications Spinetoram exhibited the highest toxic effect in reducing infestation of *T. absoluta* followed by Spinosad then Emamectin, Pyridalyl was most effective in reducing infestation of *T. absoluta* followed by Chlorantraniliprole, then Indoxacarb and least by Chlorfenapyr. Saad Mousa (2013) [9] shows that chemical pesticides such as Chlorantraniliprole 20% SC, Chlorfenapyr 36% SC, Indoxcarb 15%EC, Chlorfenapyr 36% SC mixed with Indicarb 15%EC, Spinosad 24% SC, Spinosad 24% SC mixed with Abamectin 1.8%, Emamectin benzoate 50% SG and Imidacloprid 20% SC provide excellent control against *T. absoluta*. Hashemitassuji *et al*., (2014) [6] demonstrated that Spinosad was more effective in the control of *T. absoluta* lethality, than the *B. thuringiensis* treatment. Kousika (2015) [7] concluded that Chlorantraniliprole 4.3% + abamectin 1.7% SC mixture 100% reduction of *S. litura* to an extent of 48.66-78.28% reduction of leaf miner damage and 89.73-99.36% reduction in leaf miner population.

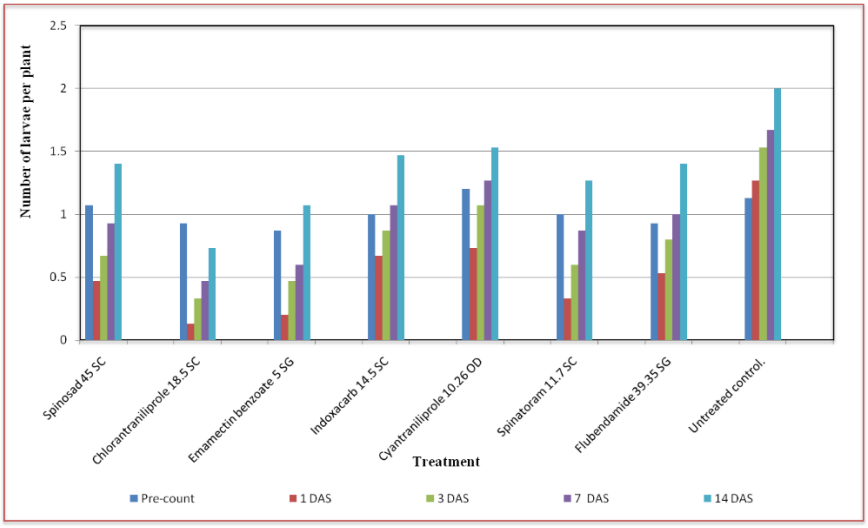

Fig 1: Population of *Tuta absoluta* per plant in polyhouse tomato before and after first spray

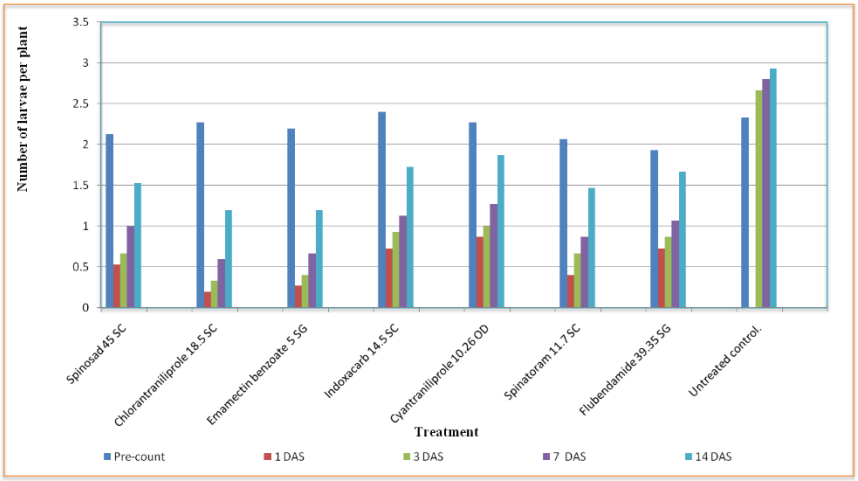

Fig 2: Population of *Tuta absoluta* per plant in polyhouse tomato before and after second spray

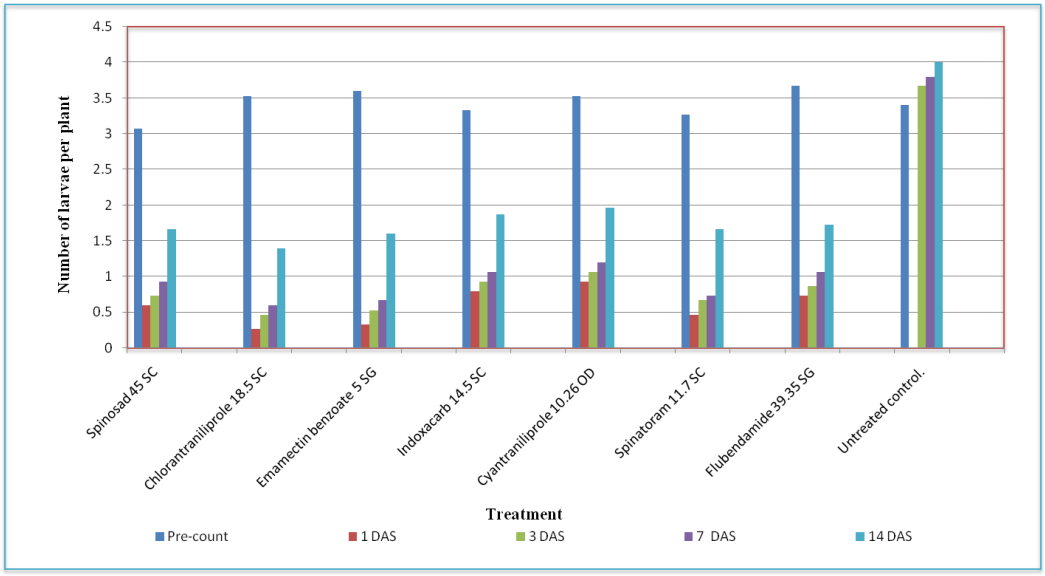

Fig 3: Population of *Tuta absoluta* per plant in polyhouse tomato before and after third spray

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