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Evaluation of Pyriproxyfen 8% + Clothianidin 3.5 SE against Sucking Pests of Cotton

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ABSTRACT: The field trials to evaluate the bio-efficacy of different doses of Pyriproxyfen 8% + Clothianidin 3.5 SE as foliar spray against sucking pests of cotton were conducted at Agricultural Research Station-Borwat Farm, Banswara (Rajasthan) during *Kharif* 2016 and 2017. The results of the investigation revealed that the ready mix molecule of Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1500 ml and 1250 ml ha^{-1} were very effective in providing protection against sucking pests of cotton *viz.* whiteflies, jassids and thrips with highest mean seed cotton yield (1986 & 1831 kg ha^{-1}, respectively) and were statistically at par. The next best treatments were Diafenthiuron 50 WP @ 600 g ha^{-1}, followed by Clothianidin 50 WDG @ 50 g ha^{-1}. None of the treatments showed any symptoms of phytotoxicity.

Keywords: Efficacy, ready mix molecule, Pyriproxyfen 8% + Clothianidin 3.5 SE, cotton and sucking pests.

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) being a significant commercial crop, plays a vital role in the social, economic and political affairs of the world. In the global market economy, cotton is one of the few commodities that every nation desires to possess. The demand for cotton will probably exist as long as civilization exists. Cotton brings prosperity to richest of nations and also brings food security for the poorest countries (Kranthi, 2011). There has been a significant increase in the cotton production, in India, over the years and the country has become one of the largest producers of cotton with around 22% of the world cotton production. India also has the largest area under cotton cultivation of about 12.0 to 13.5 million hectares, being 37% of the world area. However, its productivity, which is around 469 Kg/hectare, is still lower than the average world yield of 787 Kg/hectare (Anonymous, 2022). Crop diseases and insect pests are one of the main yield-limiting factors in nearly all cotton producing countries (Luttrell *et al.* 1994).

Cotton crop is reported to harbour as much as 1326 species of insect in various cotton producing countries of the world (Forrester, 1994), out of which 162 species have been reported in India alone (Sundramurthy and Chitra 1992). Among these, sucking pests have become the major factor responsible for reduced yield and may lessen the production up to 28.13 % (Dhawan *et al.*, 1988; Chavan *et al.*, 2010). To guard the crop from sucking pest attack, farmers are generally depended on environmentally hazardous chemicals. In this view, newer chemistry molecules have a good scope of being utilized as they are competitively safer and effective for controlling sucking pests in cotton.

MATERIAL AND METHODS

The field experiments were conducted at Agricultural Research Station-Borwat Farm, Banswara (Rajasthan) during *Kharif* 2016 and 2017 in order to assess the efficacy of Pyriproxyfen 8% + Clothianidin 3.5 SE as foliar spray against cotton sucking pests. The trial was laid out in RBD with 8 treatments replicated thrice. The treatments were Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1000, 1250 & 1500 ml, Clothianidin 50 WDG @ 50g, Pyriproxyfen 10% EC @ 1000 ml, Diafenthiuron 50% WP @ 600g, Pyriproxyfen 8% + Clothianidin 3.5 SE @ 2500ml ha^{-1} (for phytotoxicity test) and untreated check. The seeds of cotton hybrid, Bunny Bt BG II were dibbled at a spacing of 90 × 45 cm. The plot sizes were kept 6.0 × 5.4 meters. All recommended package of practices were followed to grow the crop, except for measures of plant protection.

To record observations on pest incidence, 5 fixed plants/plot were randomly selected and tagged. The number of sucking pests *viz.* jassids, thrips, aphids and whitefly were recorded from three leaves (bottom, middle and top) per plant, before spraying, 3rd and 7th days after spray. First spray was given at economic threshold level (ETL) and consequent sprays were given at fortnight interval. The seed cotton yield was recorded plot wise during harvesting and calculated as kg ha^{-1} for comparison and analysis. The percent reduction in insect pest population vis-a-vis control was

calculated using the following method given by Henderson and Tilton (1955):

$$Per\ cent\ reduction\ in\ population = 100\ x\ \left[1 - \frac{T_a\ x\ C_b}{T_b\ x\ C_a}\right]$$

where, T_a = Number of insects after treatment

T_b = Number of insects before treatment

C_a = Number of insects in untreated check after treatment

C_b = Number of insects in untreated check before treatment

The reduction % figures were changed into arc sine values and subjected to analysis of variance. The visual observations on the phytotoxicity symptoms on the crop were rated by the criteria given by Clay and Davison (1978) on a scale of 0 to10 where; 0 represents no injury and 10 represents dead plants. The observations on the phytotoxicity symptoms *viz.*, wilting, leaf injury, stunting, necrosis, vein clearing, chlorosis, hyponasty and epinasty on crop due to application of Pyriproxyfen 8% + Clothianidin 3.5 SE @ 2500 ml ha^{-1} were recorded at 1, 3, 5, 7, 10 and 15 days after spray.

RESULTS AND DISCUSSION

The efficacy of different doses of Pyriproxyfen 8% + Clothianidin 3.5 SE (1000, 1250 and 1500 ml ha^{-1}) along with Clothianidin 50 WDG @ 50g ha^{-1}, Pyriproxyfen 10% EC @ 1000 ml ha^{-1} and Diafenthiuron 50 WP @ 600g ha^{-1} were evaluated against whiteflies, jassids and thrips in cotton under field conditions during the year 2016 and 2017, whose results are given in Table (1-4).

Bio-efficacy against whiteflies. During the year 2016, the population of whiteflies before treatment was consistent and no significant difference was observed among the treatments/plots (21.33 to 23.00 per three leaves) before first spray. The highest reduction in the whitefly population of 70.15 & 80.16 and 73.33 & 81.07 % was recorded in Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1500 ml ha^{-1} at 3rd and 7th day after first and second spray, respectively. However, it was recorded to be statistically at par with its lower dose *i.e.* Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1250 ml ha^{-1} with the 68.19 & 77.36 and 70.26 & 78.13 % reduction in whiteflies population. The subsequent best treatments were Diafenthiuron 50 WP @ 600 g ha^{-1}, Clothianidin 50 WDG@ 50 g ha^{-1} and Pyriproxyfen 10% EC @ 1000 ml ha^{-1}. Whereas, minimum % reduction in whitefly population of 60.54 & 65.41 and 61.84 & 67.01 was recorded in Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1000 ml ha^{-1} at 3rd and 7th day after first and second spray, respectively (Table 1).

During the year 2017, the population of whiteflies before treatment was consistent and no significant difference was observed among the treatments/plots (22.67 to 24.33 per three leaves) before first spray. The highest reduction in the whitefly population of 71.41 & 82.83 and 76.27 & 84.30 % was recorded in Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1500 ml ha^{-1} at 3rd and 7th day after first and second spray, respectively. However, it was observed to be statistically at par with its lower dose *i.e.* Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1250 ml ha^{-1} with 68.69 & 79.42 and 73.42 & 79.63 % reduction in whiteflies population. The subsequent best treatments were Diafenthiuron 50 WP @ 600 g ha^{-1}, Clothianidin 50 WDG@ 50 g ha^{-1} and Pyriproxyfen 10% EC @ 1000 ml ha^{-1}. Whereas, minimum % reduction in whitefly population of 62.10 & 67.78 and 62.68 & 68.08 was recorded in Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1000 ml ha^{-1} at 3rd and 7th day after first and second spray, respectively (Table 1).

Bio-efficacy against jassids. During the year 2016, the population of jassids before treatment was constant and was not varying significantly in any plot before the initial spray (14.67 to 16.00/3 leaves). The most reduction in the population of jassids 76.74 & 83.46 and 77.70 & 84.31 % was recorded in Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1500 ml ha^{-1} 3rd and 7th day after first and second spray, respectively. However, it was recorded as statistically at par with its lower dose *i.e.* Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1250 ml ha^{-1} with 74.78 & 81.63 and 74.15 & 80.03 % reduction in jassid population. The next best treatments were Diafenthiuron 50 WP @ 600 g ha^{-1}, Clothianidin 50 WDG @ 50 g ha^{-1} and Pyriproxyfen 10% EC @ 1000 ml ha^{-1}. Whereas, minimum % reduction in jassids population of 57.22 & 61.84 and 54.78 & 65.42 was recorded in Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1000 ml ha^{-1} at 3rd and 7th day after first and second spray, respectively (Table 2).

During the year 2017, the population of jassids before treatment was constant and was not varying significantly in any plot before the initial spray (12.00 to 14.33 per three leaves). The highest reduction in the jassids population of 77.59 & 84.64 and 76.83 & 83.49 % was recorded in Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1500 ml ha^{-1} at 3rd and 7th day after first and second spray, respectively. However, it was statistically at par with its lower dose *i.e.* Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1250 ml ha^{-1} with 73.48 & 80.95 and 72.93 & 79.56 % reduction in jassids population. The then best treatments were Diafenthiuron 50 WP @ 600 g ha^{-1}, Clothianidin 50 WDG@ 50 g ha^{-1} and Pyriproxyfen 10% EC @ 1000 ml ha^{-1}. Whereas, minimum % reduction in jassids population 59.52 & 64.31 and 59.26 & 62.93 was recorded in Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1000 ml ha^{-1} at 3rd and 7th day after first and second spray, respectively (Table 2).

Bio-efficacy against thrips. During the year 2016, thrips population before the treatment was in the array of 27.67 to 30.00 /3 leaves before first spray and each one of the treatments/plot were at par statistically. The utmost reduction in the thrips population of 75.14 & 82.58 and 74.08 & 81.22 % was recorded in Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1500 ml ha^{-1} at third and seventh day after first and second spray, respectively. However, it was recorded at par statistically with its lesser dose *i.e.* Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1250 ml ha^{-1} with 71.40 & 78.47 and 70.55 & 77.29 % reduction in thrips population. The next best treatments were Diafenthiuron 50 WP @ 600 g ha^{-1}, Clothianidin 50 WDG @ 50 g ha^{-1} and Pyriproxyfen 10% EC @ 1000 ml ha^{-1}. Whereas,

minimum % reduction in thrips population of 58.36 & 63.14 and 59.04 & 62.20 was recorded in Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1000 ml ha^{-1} at 3rd and 7th day after first and second spray, respectively (Table 3).

During the year 2017, the pre-treatment population of thrips was uniform and no significant difference was observed among the treatments/plots with respect to number of 24.67 to 27.33 per three leaves before first spray. The maximum reduction in the population of thrips of 74.15 & 81.25 and 74.50 & 82.06 % was recorded in Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1500 ml ha^{-1} at 3 and 7 days after first and second spray, respectively. However, it was at par statistically with its lesser dose *i.e.* Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1250 ml ha^{-1} with 68.92 & 76.04 and 69.59 & 76.82 % reduction in thrips population. The subsequent best treatments were Diafenthiuron 50 WP @ 600 g ha^{-1}, Clothianidin 50 WDG @ 50 g ha^{-1} and Pyriproxyfen 10% EC @ 1000 ml ha^{-1}. Whereas, minimum % reduction in thrips population of 56.92 & 61.29 and 58.81 & 62.42 was recorded in Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1000 ml ha^{-1} at 3rd and 7th day after first and second spray, respectively (Table 3).

Phytotoxicity. There were no visual symptoms of phytotoxicity in any form on the cotton like leaf injury, necrosis, stunting, wilting, vein clearing, chlorosis, hyponasty and epinasty with the spray dose of Pyriproxyfen 8% + Clothianidin 3.5 SE @ 2500 ml ha^{-1}.

Effect on seed cotton yield. The highest seed cotton yield of 1831 and 2140 kg ha-^{1} was noted in Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1500 ml ha^{-1} during the year 2016 and 2017, respectively. It was at par statistically with its lesser dose *i.e.* Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1250 ml ha^{-1} throughout both the years. Whereas, least seed cotton yield of 885 and 1183 kg ha-^{1} was observed in untreated check during 2016 and 2017, respectively (Table 4).

The results of the present investigation revealed that ready mix molecule of Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1500 ml and Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1250 ml ha^{-1} was found very efficient for the management of sucking pests of cotton *i.e.* whiteflies, jassids. The results are in agreement with those of Swami *et al.* (2018) who reported that pyriproxyfen 8.0 SE + clothianidin 3.5 SE @ 52.5+120 g a.i. ha^{-1} gave highest control for whitefly and other sucking insect pests followed by lesser doses of pyriproxyfen 8.0 SE + clothianidin 3.5 SE. In another experiment conducted by Patel (2013), Pyriproxifen + fenpropethrin 500 ml ha^{-1} was found most useful in controlling insect pests of brinjal after Emamectin benzoate @ 10 g a.i. ha^{-1}. Similarly, spraying of pyriproxifen 10% EW @ 200 g a.i ha^{-1} gave considerably high seed cotton yield with highest % reduction in whiteflies, aphids, thrips and leafhoppers (Navi *et al.* 2021). Pyriproxyfen at upper doses was also found to decrease the whitefly population by 68-73% in other researches (Bajya *et al.* 2014; Shaikh *et al.* 2014; Kharel *et al.* 2016; Maity *et al.* 2017). The results of our investigations are also in conformity with the findings of (Pachundkar *et al.* 2013; Chaudhari *et al.* 2015; Duraimurugan and Alivelu, 2017) who reported that clothianidin was found useful in dropping the incidence of leaf hopper and thrips.

Table 1: Bio efficacy of different insecticides against whiteflies during *kharif*-2016 & 2017.

Treatments & Dosage	% mean reduction in population of whiteflies									
	2016					2017				
	PTP*	1st spray		2nd spray		PTP*	1st spray		2nd spray	
		3 DAS	7 DAS	3 DAS	7 DAS		3 DAS	7 DAS	3 DAS	7 DAS
T_1= Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1000 ml ha^{-1}	22.67 (4.76)	51.08 (60.54)	53.97 (65.41)	51.85 (61.84)	54.94 (67.01)	24.00 (4.90)	52.00 (62.10)	55.41 (67.78)	52.35 (62.68)	55.60 (68.08)
T_2= Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1250 ml ha^{-1}	21.67 (4.65)	55.66 (68.19)	61.59 (77.36)	56.95 (70.26)	62.12 (78.13)	23.00 (4.79)	55.98 (68.69)	63.02 (79.42)	58.97 (73.42)	63.17 (79.63)
T_3= Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1500 ml ha^{-1}	22.67 (4.76)	56.88 (70.15)	63.55 (80.16)	58.91 (73.33)	64.21 (81.07)	24.00 (4.90)	57.67 (71.41)	65.52 (82.83)	60.85 (76.27)	66.66 (84.30)
T_4= Clothianidin 50 WDG @ 50g ha^{-1}	21.33 (4.62)	52.64 (63.18)	58.46 (72.64)	53.39 (64.43)	60.16 (75.24)	22.67 (4.76)	54.52 (66.31)	61.29 (76.92)	55.47 (67.88)	59.59 (74.38)
T_5= Pyriproxyfen 10% EC @1000 ml ha^{-1}	22.33 (4.72)	51.93 (61.98)	59.11 (73.64)	52.99 (63.77)	59.46 (74.17)	23.67 (4.86)	53.03 (63.84)	61.85 (77.74)	53.23 (64.16)	58.82 (73.19)
T_6= Diafenthiuron 50 WP @ 600g ha^{-1}	21.67 (4.65)	52.90 (63.61)	59.54 (74.30)	55.13 (67.32)	61.05 (76.57)	23.00 (4.80)	55.26 (67.53)	62.25 (78.32)	55.68 (68.21)	61.30 (76.94)
T_7= Untreated check	23.00 (4.80)	-	-	-	-	24.33 (4.93)	-	-	-	-
S. Em. ±	-	1.18	1.67	1.43	1.29	-	1.06	1.25	1.16	1.56
CD at 5%	NS	3.71	5.24	4.50	4.04	NS	3.32	3.91	3.66	4.88

* Pre-treatment population/3leaves; Figures in parenthesis are retransformed % values; DAS= Day/days after spray; NS=Non-significant

Table 2: Bio efficacy of different insecticides against jassids during *kharif*-2016 & 2017.

Treatments & Dosage	% mean reduction in population of jassids									
	2016					2017				
		1st spray		2nd spray			1st spray		2nd spray	
	PTP*	3 DAS	7 DAS	3 DAS	7 DAS	PTP*	3 DAS	7 DAS	3 DAS	7 DAS
T_1= Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1000 ml ha^{-1}	16.00 (4.00)	49.15 (57.22)	51.85 (61.84)	47.74 (54.78)	53.98 (65.42)	12.00 (3.46)	50.49 (59.52)	53.31 (64.31)	50.33 (59.26)	52.49 (62.93)
T_2= Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1250 ml ha^{-1}	15.33 (3.91)	59.85 (74.78)	64.62 (81.63)	59.44 (74.15)	63.46 (80.03)	13.33 (3.65)	59.00 (73.48)	64.12 (80.95)	58.65 (72.93)	63.12 (79.56)
T_3= Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1500 ml ha^{-1}	15.67 (3.96)	61.17 (76.74)	66.00 (83.46)	61.82 (77.70)	66.67 (84.31)	12.67 (3.56)	61.74 (77.59)	66.93 (84.64)	61.22 (76.83)	66.03 (83.49)
T_4= Clothianidin 50 WDG @ 50g ha^{-1}	15.00 (3.87)	57.79 (71.59)	61.78 (77.64)	55.86 (68.50)	60.28 (75.42)	14.00 (3.74)	55.11 (67.29)	61.28 (76.90)	57.55 (71.21)	61.81 (77.69)
T_5= Pyriproxyfen 10% EC @1000 ml ha^{-1}	15.67 (3.96)	52.98 (63.75)	57.58 (71.26)	51.18 (60.70)	54.57 (66.39)	13.00 (3.60)	51.48 (61.21)	57.35 (70.89)	52.45 (62.85)	56.94 (70.24)
T_6= Diafenthiuron 50 WP @ 600g ha^{-1}	14.67 (3.83)	57.37 (70.92)	61.34 (77.00)	58.10 (72.07)	61.78 (77.64)	14.33 (3.78)	54.60 (66.44)	62.05 (78.03)	57.59 (71.28)	62.13 (78.15)
T_7= Untreated check	16.00 (4.00)	-	-	-	-	14.00 (3.74)	-	-	-	-
S. Em. ±	-	1.62	1.59	1.49	1.38	-	1.35	1.36	1.55	1.57
CD at 5%	NS	5.09	4.98	4.68	4.33	NS	4.23	4.28	4.86	4.92

* Pre-treatment population/3leaves; Figures in parenthesis are retransformed % values ; DAS= Day/days after spray; NS=Non-significant

Table 3: Bio efficacy of different insecticides against thrips during *kharif*-2016 & 2017.

Treatments & Dosage	% mean reduction in population of thrips									
	2016					2017				
		1st spray		2nd spray			1st spray		2nd spray	
	PTP*	3 DAS	7 DAS	3 DAS	7 DAS	PTP*	3 DAS	7 DAS	3 DAS	7 DAS
T_1= Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1000 ml ha^{-1}	27.67 (5.26)	49.82 (58.36)	52.62 (63.14)	50.21 (59.04)	52.06 (62.20)	26.00 (5.10)	48.98 (56.92)	51.53 (61.29)	50.08 (58.81)	52.19 (62.42)
T_2= Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1250 ml ha^{-1}	30.00 (5.48)	57.67 (71.40)	62.36 (78.47)	57.13 (70.55)	61.54 (77.29)	27.00 (5.20)	56.12 (68.92)	60.70 (76.04)	56.53 (69.59)	61.22 (76.82)
T_3= Pyriproxyfen 8% + Clothianidin 3.5 SE @ 1500 ml ha^{-1}	28.33 (5.32)	60.09 (75.14)	65.33 (82.58)	59.40 (74.08)	64.32 (81.22)	27.33 (5.23)	59.44 (74.15)	64.34 (81.25)	59.67 (74.50)	64.94 (82.06)
T_4= Clothianidin 50 WDG @ 50g ha^{-1}	29.33 (5.42)	56.16 (68.99)	60.83 (76.24)	55.65 (68.16)	60.05 (75.07)	24.67 (4.97)	54.54 (66.34)	59.42 (74.12)	54.24 (65.85)	59.49 (74.23)
T_5= Pyriproxyfen 10% EC @1000 ml ha^{-1}	28.67 (5.35)	51.97 (62.04)	56.61 (69.71)	52.12 (62.29)	56.04 (68.79)	27.00 (5.19)	51.24 (60.80)	53.70 (64.95)	50.74 (59.96)	54.83 (66.82)
T_6= Diafenthiuron 50 WP @ 600g ha^{-1}	29.00 (5.38)	56.39 (69.36)	60.90 (76.35)	56.11 (68.91)	60.63 (75.95)	25.67 (5.07)	55.25 (67.51)	60.01 (75.01)	54.92 (66.96)	60.05 (75.07)
T_7= Untreated check	29.67 (5.45)	-	-	-	-	27.33 (5.23)				
S. Em. ±	-	1.56	1.79	1.42	1.63	-	1.74	1.82	1.69	1.78
CD at 5%	NS	4.90	5.61	4.47	5.12	NS	5.46	5.72	5.32	5.58

* Pre-treatment population/3leaves; Figures in parenthesis are retransformed % values; DAS= Day/days after spray; NS=Non-significant

Table 4: Mean seed cotton yield (kg ha^{-1}) in different treatments.

S. No.	Treatments	Dosage (ml or g ha^{-1})	Seed cotton yield (kg ha^{-1})		
			2016	2017	Mean
1.	T_1= Pyriproxyfen 8% + Clothianidin 3.5 SE	1000	1173	1481	1327
2.	T_2= Pyriproxyfen 8% + Clothianidin 3.5 SE	1250	1677	1985	1831
3.	T_3= Pyriproxyfen 8% + Clothianidin 3.5 SE	1500	1831	2140	1986
4.	T_4= Clothianidin 50 WDG	50	1409	1718	1564
5.	T_5= Pyriproxyfen 10% EC	1000	1255	1564	1410
6.	T_6= Diafenthiuron 50 WP	600	1450	1821	1636
7.	T_7= Untreated check	-	885	1183	1034
	S. Em ±	-	0.95	1.13	-
	CD at 5%	-	293.00	213.00	-
	CV%	-	13.81	13.37	-

CONCLUSION

In the present investigatons, bio-efficacy of different doses of ready mix molecule Pyriproxyfen 8% + Clothianidin 3.5 SE as foliar spray was tested against cotton sucking pests, which revealed that the above said molecule @ 1500 ml and 1250 ml ha^{-1} was found most effective. The greater dose of the chemical also did not result in any symptoms of phytotoxicity on the crop.

FUTURE SCOPE

Rigorous use of pesticides has led to the development of greater level of insecticide resistance to a number of conventional insecticides in pests. So, in future, the emphasis of researches must be on discovering new green chemistry molecules with novel mode of action and their continuous testing under field conditions.

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