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Positioning Thiamethoxam 70 WS Seed Treatment Towards Sustainable Management of Sucking Insect Pest Complex of Sunflower

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Abstract An experiment was conducted to observe the efficacy of thiamethoxam 70WS as seed treatment chemical against important sucking pests of sunflower during *rabi* season of 2014–2015 and 2015–2016 in a farmer's field. Out of the different treatment schedules, thiamethoxam 70WS @ 2.80 g a.i. per kg of seed was found to be most effective in reducing pest population. The leafhopper and thrips population were declined to the tune of 63.98% and 63.70% respectively. No significant knock down effects on natural enemies were recorded. Moreover, no phytotoxic symptoms were found to exhibit by the crop. Yield increment of 39.54% and 39.20% were recorded.

Keywords Sunflower, Thiamethoxam 70WS, Pest, Natural enemies, Phytotoxicity.

Introduction

India has occupied a prominent position on the oilseed map of the world both in terms of acreage and production contributing to about 10% of worlds oilseed produce. Out of the important oilseeds, sunflower is cultivated over an area of 23.50 lakh hectares with a production of 14.80 lakh tones in India [1]. It is the major source of vegetable oil and is the largest selling oil in the branded oil segment due to its innumerous health benefits. However, several biotic and abiotic stresses prevent the crop from achieving greater yield potential [2]. More than 50 insect species have been found to damage the crop at different phenological stages of growth. Sucking pests like leafhoppers (*Amrasca biguttula biguttula*), thrips (*Frankliniella occidentalis*), and whiteflies (*Bemisia tabaci*) contribute to a considerable extent of loss to the crop. Leafhopper alone can cause damage upto 46%. Several species of thrips are reported to cause enormous loss indirectly as vector of viral diseases, especially sunflower necrosis by tobacco streak virus. To combat attack of these pests farmers have a tendency to apply insecticides irrationally thus causing environmental pollution and health hazards. With a view to develop ecofriendly effective chemical management strategies that can provide good management without being applied numerous times, thiamethoxam, a second generation neonicotinoid insecticide, belonging to the thianicotinyl subclass of chemistry, attracted attention. It can be used as foliar insecticide as well as in seed treatment effectively. Keeping in view the seriousness of the sucking pests, the present investigation was undertaken to evaluate the efficiency of thiamethoxam 70 WS in seed treatment against thrips and leaf hoppers or jassids in sunflower crop, its impact on natural enemies and phytotoxicity.

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Table 1. Evaluation of thiamethoxam 70 WS (Cruiser 70WS) against jassids in sunflower at Kakdwip, 24 Parganas (S), West Bengal during November to March 2014–2015 and 2015–2016. Mean of four replications, Figures in the parentheses* are $\sqrt{x+0.5}$ transformation. DAG : Days after germination.

	Treatments	Dosages (g a.i./ kg seed)	Jassids/10 net sweeps over two seasons 2014–2015 35 DAG	42 DAG	49 DAG	56 DAG	60 DAG	Mean	% reduction from untreated control
T_1	UTC	–	7.00 (2.73)*	11.00 (3.39)*	20.00 (4.52)*	26.00 (5.14)*	30.00 (5.52)*	18.80	–
T_2	Thiamethoxam 70 WS	2.10	3.00 (2.23)	8.00 (3.33)	14.00 (4.24)	22.00 (5.19)	24.00 (5.40)	14.20	24.47
T_3	Thiamethoxam 70 WS	2.80	1.00 (1.50)	4.00 (2.50)	8.00 (3.33)	15.00 (4.37)	11.00 (3.82)	7.80	58.51
T_4	Thiamethoxam 70 WS	3.50	0.00 (0.50)	4.00 (2.50)	6.00 (2.95)	12.00 (3.96)	10.00 (3.66)	6.40	65.95
T_5	Thiamethoxam 70 WS	7.00	0.00 (0.50)	2.34 (2.03)	7.00 (3.15)	10.00 (3.66)	13.56 (4.18)	6.58	65.00
T_6	Thiamethoxam 30 FS	3.00	2.00 (1.91)	4.00 (2.50)	11.00 (3.82)	18.00 (4.74)	19.00 (4.86)	10.80	42.56
	CD (p = 0.05)		0.62	0.05	0.72	1.13	3.52	–	–

Table 1. Continued.

	Treatments	Dosages (g a.i./ kg seed)	Jassids/10 net sweeps over two seasons 2015–2016 35 DAG	42 DAG	49 DAG	56 DAG	60 DAG	Mean	% reduction from untreated control	Overall mean	% reduction from control
T_1	UTC	–	8.00 (2.91)*	12.00 (3.53)*	19.00 (4.41)*	24.00 (4.94)*	29.00 (5.43)*	18.40	–	18.60	–
T_2	Thiamethoxam 70 WS	2.10	4.00 (2.50)	9.00 (3.50)	11.00 (3.82)	17.00 (4.62)	18.00 (4.74)	11.80	35.86	13.00	30.11
T_3	Thiamethoxam 70 WS	2.80	2.00 (1.91)	5.00 (2.74)	7.00 (3.15)	10.00 (3.66)	14.00 (4.24)	7.60	56.52	7.70	63.98
T_4	Thiamethoxam 70 WS	3.50	1.00 (1.50)	4.00 (2.50)	6.00 (2.95)	10.00 (3.66)	13.00 (4.11)	6.80	60.86	6.60	64.52
T_5	Thiamethoxam 70 WS	7.00	0.00 (0.50)	1.20 (1.60)	6.54 (3.06)	9.00 (3.50)	12.29 (4.01)	5.81	68.42	6.19	66.72
T_6	Thiamethoxam 30 FS	3.00	6.00 (2.95)	8.00 (3.33)	16.00 (4.50)	19.00 (4.86)	24.00 (5.40)	14.60	18.47	12.70	31.72
	CD (p = 0.05)		0.35	0.15	0.23	1.52	2.23	–	–	–	–

Materials and Methods

The experiment was laid out in randomized block design with six treatments and four replications in a farmer's field at Kakdwip, 24 Parganas, West Bengal during November—March of 2014–2015 and 2015–2016. Indo-American Hybrid seeds CVT. Ltd. 1965 was sown with a spacing of 60 × 60 cm in 50 sqm plot area

Table 2. Evaluation of thiamethoxam 70 WS (Cruiser 70WS) against thrips in sunflower at Kakdwip, 24 Parganas (S), West Bengal during November to March 2014–2015 and 2015–2016. Mean of four replications, Figures in the parentheses* are $\sqrt{x + 0.5}$ transformation. DAG : Days after germination.

			No. of thrips/leaf 2014–2015					
	Treatments	Dosages (g a.i./ kg seed)	42 DAG	49 DAG	56 DAG	60 DAG	Mean	% reduction from control
T_1	UTC	–	10.00 (3.24)*	10.00 (3.24)*	19.00 (4.41)*	26.00 (5.14)*	16.25	–
T_2	Thiamethoxam 70 WS	2.10	5.00 (2.74)	7.00 (3.15)	16.00 (4.50)	18.00 (4.74)	9.20	43.39
T_3	Thiamethoxam 70 WS	2.80	3.00 (2.23)	4.00 (2.50)	7.00 (3.15)	10.00 (3.66)	6.00	63.07
T_4	Thiamethoxam 70 WS	3.50	2.00 (1.91)	3.00 (2.23)	6.00 (2.95)	10.00 (3.66)	5.25	67.69
T_5	Thiamethoxam 70 WS	7.00	1.80 (1.84)	2.50 (2.08)	5.00 (2.74)	9.00 (3.50)	7.58	71.82
T_6	Thiamethoxam 30 FS	3.00	4.00 (2.50)	6.00 (2.95)	11.00 (3.82)	21.00 (5.08)	10.50	35.38
	CD (p = 0.05)		0.34	0.17	0.54	3.45	–	–

Table 2. Continued.

			No. of thrips/leaf 2015–2016							
	Treatments	Dosages (g a.i./ kg seed)	42 DAG	49 DAG	56 DAG	60 DAG	Mean	% reduction from control	Overall mean	% reduction from control
T_1	UTC	–	15.00 (3.93)*	14.00 (3.80)*	23.00 (4.84)*	32.00 (5.70)*	16.8	–	16.53	–
T_2	Thiamethoxam 70 WS	2.10	7.00 (3.15)	9.00 (3.50)	17.00 (4.62)	23.00 (5.30)	11.20	33.34	10.20	38.29
T_3	Thiamethoxam 70 WS	2.80	3.00 (2.23)	5.00 (2.74)	8.00 (3.33)	14.00 (4.24)	6.00	47.61	6.00	63.70
T_4	Thiamethoxam 70 WS	3.50	2.00 (1.91)	4.00 (2.50)	7.00 (3.15)	13.00 (4.11)	5.20	69.04	5.23	68.36
T_5	Thiamethoxam 70 WS	7.00	1.50 (1.72)	3.50 (2.37)	8.00 (3.33)	12.00 (3.96)	6.25	62.80	5.42	67.21
T_6	Thiamethoxam 30 FS	3.00	5.00 (2.74)	9.00 (3.50)	18.00 (4.74)	25.00 (5.50)	11.40	32.15	10.95	33.75
	CD (p = 0.05)		0.47	0.42	4.25	3.67	–	–	–	–

during 8.11.2014 (1st season) and 10.11.2015 (2nd season). Standard agronomic practices were followed throughout the season to raise the crop. The treatment details are as follows: T_1 = Untreated check, T_2 = thiamethoxam 70 WS @ 2.1 g a.i./kg seed (3 g / kg seed), T_3 = thiamethoxam 70 WS @ 2.8 g a.i. / kg seed (4 g / kg seed), T_4 = thiamethoxam 70 WS @ 3.5 g a.i./ kg seed (5 g/kg seed), T_5 = thiamethoxam 70 WS @ 7 g a.i./kg seed (10 g/kg seed) and T_6 = thiamethoxam 30 FS @ 3 g a.i./kg seed (10 ml/kg seed). Seeds were

Table 3. Effect of different treatment schedules of thiamethoxam 70 WS on some important natural enemies (predators and parasitoids) of sunflower ecosystem during November 14 to March 15 and November 15 to March 16 (pooled data of two seasons). Mean of four replications, Figures in the parentheses* are √x+0.5 transformation. DAG: Days after germination.

Treatments	Dosages (g a.i./ kg seed)	No. of predators (*Coccinella transversalis*) and parasitoids (*Bracon brevicornis*) per plant after treatment (DAG)					
		Predators					
		35 DAG	42 DAG	49 DAG	56 DAG	60 DAG	Over all mean
UTC	–	4.63 (2.65)	11.48 (3.89)	26.71 (5.67)	33.63 (6.30)	41.66 (6.95)	23.62
Thiamethoxam 70 WS	2.10	4.11 (2.53)	10.15 (3.69)	23.93 (5.39)	31.83 (6.14)	39.76 (6.81)	21.95
Thiamethoxam 70 WS	2.80	4.16 (2.54)	9.16 (3.53)	24.20 (5.42)	31.29 (6.09)	38.62 (6.72)	21.49
Thiamethoxam 70 WS	3.50	3.67 (2.42)	9.48 (3.58)	22.43 (5.24)	29.65 (5.94)	34.89 (6.41)	20.02
Thiamethoxam 70 WS	7.00	1.02 (1.51)	4.35 (2.59)	14.78 (4.35)	15.60 (4.38)	21.30 (5.12)	11.41
Thiamethoxam 30 FS	3.00	3.20 (2.29)	8.66 (3.44)	20.83 (5.06)	27.43 (5.74)	34.19 (6.35)	18.86
CD (p = 0.05)		0.02	0.15	0.07	0.26	0.13	–

Table 3. Continued.

Treatments	Dosages (g a.i./ kg seed)	No. of predators (*Coccinella transversalis*) and parasitoids (*Bracon brevicornis*) per plant after treatment (DAG)					
		Parasitoids					
		35 DAG	42 DAG	49 DAG	56 DAG	60 DAG	Over all mean
UTC	–	5.59 (2.88)	9.66 (3.61)	13.20 (4.13)	17.66 (4.70)	20.40 (5.02)	13.32
Thiamethoxam 70 WS	2.10	4.77 (2.68)	7.09 (3.16)	11.54 (3.90)	15.08 (4.38)	19.55 (4.92)	11.60
Thiamethoxam 70 WS	2.80	4.66 (2.66)	6.57 (3.06)	9.80 (3.63)	15.12 (4.39)	18.18 (4.76)	10.86
Thiamethoxam 70 WS	3.50	4.38 (2.59)	6.12 (2.97)	9.27 (3.54)	14.13 (4.26)	17.28 (4.66)	10.23
Thiamethoxam 70 WS	7.00	1.50 (1.73)	3.20 (2.29)	4.53 (2.63)	7.50 (3.24)	8.21 (3.37)	4.99
Thiamethoxam 30 FS	3.00	3.64 (2.41)	5.41 (2.83)	8.52 (3.42)	12.58 (4.05)	17.25 (4.65)	9.48
CD (p = 0.05)		0.07	0.26	0.32	0.06	0.04	–

treated once before sowing. They were soaked overnight in water and in the morning were taken out from water in a shade. Slurry was prepared by using required quantity of the test chemical and seeds were treated in it which were further dried in shade and sown in the plots. The target pests were thrips, and jassids. The natural enemies under observation were coccinellids (predators) and *Bracon brevicornis* (parasitoid). Both nymphs and adults of thrips were counted *in situ* from three leaves from each plant. The number of nymphs and adults of jassids in the field were counted by sweeping of butterfly net @ 10 net sweeps randomly in the field. Coccinellids were recorded from five plants selected at random from each plot at 35, 42, 49, 56 and 60 DAG. Population of parasitoid *Bracon brevicornis* were recorded on the same DAG through hand sweeps from five plants selected at random from each plot. The phytotoxicity studies were undertaken as per standard protocol of CIB and RC, Govt. of India, following the 0—10 scales

Table 4. Effect of thiamethoxam 70 WS (Cruiser 70 WS) on the yield of sunflower. Mean of four replications, Figures in the parentheses* are √x+0.5 transformation, Figures in the parentheses** are angular transformed values. DAG: Days after germination.

	Treatments	Dosages (g a.i./ kg seed)	Season–I Yield (t/ha)	Season–I % increase over control	Season–II Yield (t/ha)	Season–II % increase over control
T_1	UTC	–	1.33 (1.65)	–	1.38 (1.67)	–
T_2	Thiamethoxam 70 WS	2.10	1.97 (1.90)	32.48	2.01 (1.92)	31.34
T_3	Thiamethoxam 70 WS	2.80	2.20 (1.98)	39.54	2.27 (2.01)	39.20
T_4	Thiamethoxam 70 WS	3.50	2.28 (2.1)	41.67	2.32 (2.02)	40.52
T_5	Thiamethoxam 70 WS	7.00	2.40 (2.05)	44.58	2.34 (2.03)	41.03
T_6	Thiamethoxam 30 FS	3.00	2.12 (1.96)	37.26	2.22 (1.99)	37.83

at 1, 3, 5, 7 and 10 days after germination. Thiamethoxam 70 WS was tested on parameters like yellowing, necrosis, leaf tip injury, epinasty, hyponasty, wilting, vein clearing. Yield was recorded in kg/ha. Statistical interpretations were done as and when necessary.

Results and Discussion

Effect on jassids, *A. biguttula biguttula*

Table 1 depicts the efficacy of thiamethoxam 70 WS on the population of jassids over two seasons. All the treated plots were found to give significant reduction of pests over untreated control. The population in untreated plots varied between 7.00—30.00 and 8.00—29.00 per 10 net sweeps respectively in both the crop seasons. However, during 1st season, low population was recorded in plots treated with thiamethoxam 70 WS @ 2.80 g a.i./ha which resulted in to 58.51% reduction in population over untreated control. In the 2nd season, same trend i.e. ; 56.52% reduction was recorded in the plots treated with thiamethoxam 70 WS @ 2.80, which were at par with thiamethoxam 70 WS @ 3.50 a.i./ha respectively. The number of jassids / 10 sweeps in aforesaid treatments were also statistically computed on par (14.00 and 13.00 respectively). The findings are in conformity with Kadam et al. [3].

Effect on thrips, *F. occidentalis*

The pooled data on efficacy of various treatment schedules of thiamethoxam 70 WS during 2014–2015 and 2015–2016 in reducing the infestation thrips have been depicted in Table 2. All the treatment schedules were superior over untreated control plots and gave significant reduction of pests. During season 1st and 2nd, the population of thrips varied between 10.00—26.00 and 15.00—32.00 respectively in the untreated plots. Minimum population of thrips were noticed in the plots treated with thiamethoxam 70 WS @ 2.80 g a.i./ha (6.00) which is equal to 63.07% reduction from untreated control treatments. In season 2nd, the same trend was maintained, i.e. thiamethoxam 70 WS @ 2.80 g a.i./ha again registered minimum population (6.00) which is equal to 47.61% reduction over untreated control. The number of thrips with the treatment of thiamethoxam 70 WS @ 3.50 and 2.80 g a.i./ha (10.00 during season 1st and 13.00 and 14.00 during season 2nd) after 60 DAG in the treatments were at par. The results are in conformity with Naveed et al. [4]. Thiamethoxam as seed treatments were found to be very effective against thrips for at least 6 weeks from seed planting [5].

Effect on natural enemies

The natural enemy (predator) encountered in the field was *Coccinella transversalis*. Thiamethoxam 70 WS @ 2.10 and 2.80 g a.i. per kg seed and was at par and gave the best result as can be seen in Table 3. The overall mean population of coccinellid per plant in plots treated with thiamethoxam 70 WS @ 2.10 and 2.80 g a.i. per kg seed over two seasons were 21.95

Table 5. Evaluation of thiamethoxam 70 WS (Cruiser 70 WS) for phytotoxicity on sunflower at Kakdwip, 24 Parganas (S), West Bengal during November 14 to March 15 and November 15 to March 16 (pooled data of two seasons). *Values are average of four replications.

Season	Treatments	Dosages g a.i./kg seed)	Yellowing *Observation at Days After Germination (DAG)					Necrosis					Leaf tip injury				
			1	3	5	7	10	1	3	5	7	10	1	3	5	7	10
I and II pooled	T_2= Thiamethoxam 70 WS	2.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	T_3= Thiamethoxam 70 WS	2.80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	T_4= Thiamethoxam 70 WS	3.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	T_5= Thiamethoxam 70 WS	7.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 5. Continued.

Season	Treatments	Dosages g a.i./kg seed)	Epinasty *Observation at Days After Germination (DAG)					Wilting					Vein clearing				
			1	3	5	7	10	1	3	5	7	10	1	3	5	7	10
I and II pooled	T_2= Thiamethoxam 70 WS	2.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	T_3= Thiamethoxam 70 WS	2.80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	T_4= Thiamethoxam 70 WS	3.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	T_5= Thiamethoxam 70 WS	7.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

and 21.49 respectively in the two different dosages which were statistically on par.

In case of the parasitoid, *B. brevicornis*, the plots treated with thiamethoxam 70 WS @ 2.10 and 2.80 g a.i. per kg seed recorded 11.60 and 10.86 (no./plant) as overall mean over two seasons which were statistically at par with each other [6]. Thiamethoxam did not show any significant negative effect to the natural enemies. Further, the present findings are in conformity with that earlier [7, 8].

Yield

Table 4 represents the yield of sunflower over two seasons. All the treated plots gave positively higher yield than the untreated control plots. Plots treated with thiamethoxam 70 WS @ 2.80 g a.i. per kg of seed gave the highest percentage of yield increase over control (39.54 and 39.20% in the 1st and 2nd season) followed by thiamethoxam 70 WS @ 2.10 g a.i. per kg of seed (32.48 and 31.34%) which were at par with thiamethoxam 30 FS @ 3 g a.i. per kg of seed (37.26 and 37.83%).

Phytotoxicity

Table 6 clearly depicts that none of the treated plots of sunflower showed reflection of any visible symptom of phytotoxicity.

Considering the findings in the foregoing, it can be seen that, the treated plots gave significant reduction of thrips and jassid over untreated control plot up to 60 DAG. The population of predators and parasitoids were not significantly affected by the use of the chemical. The yield was found to increase significantly over control in both the seasons and also no visible phytotoxic symptoms were observed during the experiment even at higher dose of 7 g a.i./kg seed. Plots treated with thiamethoxam 70 WS @ 2.80, 2.10 g a.i. per kg of seed gave the best result in terms of their bio-effectiveness and yield. Therefore, thiamethoxam 70 WS @ 2.80 g a. i. per kg of seed is the best treatment for the control of sunflower insect pests from economic point of view.

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