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EFFICACY OF SULFOXAFLOR 12%SC AGAINST APHIDS COMPLEX AND *COCCINELLA SEPTEMPUNCTATA* L. IN WHEAT

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ABSTRACT

Efficacy of dosages of sulfoxaflor 12%SC were evaluated for the control of foliar aphids under Contract Research Project on wheat during rabi seasons of 2014-15 and 2015-16 at the research farm of ICAR-Indian Institute of Wheat and Barley Research, Karnal, Haryana. The standard check insecticides thiamethoxam 25WDG and quinalphos 25EC were included along with sulfoxaflor, and all the treatments were found to be significantly superior. The incidence of aphids/ shoot/ plant was significantly less with sulfoxaflor 12 SC @ 24, 27 and 30 g a.i./ ha with 94.54, 95.27 and 96.03% reduction, respectively; these being at par with each other, followed by thiamethoxam 25WDG @ 12.5 g a.i./ ha and quinalphos 25EC @ 250 g a.i./ ha. The seven-spotted ladybird beetle *Coccinella septempunctata* L. was the main natural enemy observed in the crop, and its counts were the least (1.50/ m^2) with thiamethoxam 25WDG @ 12.5 g a.i./ha at 14 DAS. The pooled data revealed that the yield was significantly more with sulfoxaflor 12SC @ 24, 27 and 30 g a.i./ ha (52.21, 52.62 and 54.32 q/ ha) followed by thiamethoxam 25WDG @ 12.5 g a.i./ ha (49.87 q/ ha) which was at par with quinalphos 25EC @ 250 g a.i./ ha (47.73 q/ha). Considering incremental cost benefit ratio, sulfoxaflor 12% SC @30 g a.i/ ha (1:2.70) is the most economical, and no phytotoxicity symptoms were observed at its doses @30 and 60 g a.i/ ha.

Key words: Insecticides, sulfoxaflor, thiamethoxam, quinalphos, wheat, *Rhopalosiphum maidis*, *Rhopalosiphum padi*, coccinellids, *Coccinella septempunctata*, phytotoxicity, yield, cost benefits

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops and the staple food throughout the world. Among the different insect pest attacking wheat, cereal aphids are the most widely distributed and are posing a serious threat (Singh, 1983; Yadav, 2003). The major aphid species found in wheat are *Rhopalosiphum maidis* (Fitch), *Rhopalosiphum padi* L., *Sitobion miscanthi* and *Sitobion avenae* (F.) (Jasrotia et al., 2021; Singh et al., 2020) They cause direct damage by sucking cell sap of leaves, young shoots, causing distortion, stunting, leaf curling, wilting and twisting and also cause indirect damage by secreting honey dew on leaves which reduce photosynthetic activity and attract sooty mould growth and premature leaf senescence (Deol et al., 1987; Ozder, 2002;). The aphids caused 10 to 50% reduction in yield. The damage is severe in cold and cloudy weather during winters. They appear mostly from December to January (Trdan and Milevoj; 1999; Singh and Deol, 2003; Katare et al.,2018). Management of aphids has been done primarily with chemical methods. Wide spread use of the pesticides causes several socio-economic problems. More than 20 aphid species have showed resistance to carbamate, pyrethroid and organophosphate based insecticides (Yu et al., 2016). New insecticide formulations with high efficacy and novel mode of action are being used to control aphids in wheat crop (Longhurst et al., 2013; Bhanu et al., 2015; Katare et al., 2015). New chemicals such as flubendamide 480SC, thiamethoxam 25WG and chlorantranilipride 18.5SC, and entomopathogenic fungi, *Metarhizium anisopliae, Verticillium lecanii* have been tried against aphids in wheat and barley and have been found effective (Katare et al., 2017; 2018; Jasrotia et al., 2018). However, scanty information is available on the efficacy of newer insecticide, sulfoxaflor 12%SC against wheat aphids, and the present study evaluates its efficacy against wheat aphids.

MATERIALS AND METHODS

A field experiment was conducted at ICAR- ICAR-Indian Institute of Wheat and Barley Research, Karnal (22.93°N, 88.53°E, 9.75 masl) during 2014-15 and 2015-16. Sulfoxaflor 12% SC w/v (11.4% SC w/w) was evaluated as foliar spray. The experiment was carried out in the 3rd week of November in randomized block design with eight treatments viz., T_1-Sulfoxaflor 12%SC (21 g a.i/ ha), T_2-Sulfoxaflor 12%SC (24 g a.i/ ha), T_3-Sulfoxaflor 12%SC (27 g a.i/ ha), T_4-Sulfoxaflor

12%SC (30 g a.i/ ha), T_5-Thiamethoxam 25%WDG (12.5 g a.i/ ha), T_6-Quinalphos 25%EC (250 g a.i/ ha), T_7-Sulfoxaflor 12%SC (60 g a.i/ ha) and T_8-Untreated control; and with three replications using variety HD 2967. A plot size of 7.5 m^2 was maintained, and standard package of practices followed (Kumar et al., 2001; Anonymous, 2014). The insecticidal sprays were applied just after mean infestation reached 20 aphids/ shoot/ plant or above. Five shoots from each treatment were selected randomly for recording the aphid incidence, with pre-count done 24 hr before spray and post-counts at 1, 3, 7 and 14 days after treatment (DAT). Only live aphids were counted, and of *R. maidis* and *R. padi*. The natural enemy that was observed was the seven-spotted ladybird beetle *Coccinella septempunctata* L. The occurrence of this beetle (adults and grubs) was observed in 1 m^2 quadrat in three spots in treated plots. At maturity, grain yield was recorded on whole plot basis and converted in q/ ha. Sulfoxaflor 12%SC (30g a.i/ha) (T_4) was evaluated for both efficacy and phytotoxicity while sulfoxaflor 12%SC (60g a.i/ ha) (T_7) for only phytotoxicity. For benefit cost analysis, the cost of insecticidal application was calculated as cost of insecticide+ labour charges+ machine cost etc. Similarly, the price of harvested wheat was calculated as per the prevailing market rate. The data were subjected to ANOVA and treatment means were separated by least significant difference test (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The pooled data for 2014-15 and 2015-16 revealed that before spraying, incidence ranged from 33.20 to 30.20 aphids/ tiller/ plant and did not vary significantly. All the treatments were significantly superior over the control in respect of reducing foliar aphids. One day after the spray, leasr counts (4.00 aphids/ tiller/ plant) were observed in T_4 (sulfoxaflor 12%SC @ 30 g a.i/ ha). However, it was statistically at par with its dose @ 27g a.i/ ha- 4.43 aphids/ tiller/ plant and also @ 24 g a.i/ ha- 4.87 aphids/ tiller/ plant. Three days after the spray, again T_4 i.e was superior (0.87 aphids/ tiller/ plant) but statistically at par with its dose at 27 g a.i/ ha (1.30 aphids/ tiller/ plant 0 (Table 1). At 7 and 14 days after the spray, similar results were obtained followed by standard T_5 (thiamethoxam 25WDG @ 12.5 g a.i./ ha) and T_6 (quinalphos 25EC @ 250 g a.i./ ha). In untreated control plot, maximum number of aphids/ tillar/ plant were observed as 33.43, 33.43, 33.47 and 27.27 at 1, 3, 7 and 14 days after spray, respectively. The occurrence of *C. septempunctata* was non-significant at precount, and the least (1.50/ m^2) in the standard check T_5 at 14 days after spraying (Table 2).

These observations agree with those of Chandi (2019). Comprehensive evaluation of field efficacy indicated that sulfoxaflor had quick acting properties and long persistent effects and it should be used

Table 1. Efficacy of doses of ssulfoxaflor 12% SC against foliar aphids in wheat

S. No.	Treatments	Dose (g a.i./ ha)	Before spray (BS) (Mean no. of aphids/ shoot/ plant)			1 Day after spray (Mean no. of aphids/ shoot/ plant			3 Day after spray (Mean no. of aphids/ shoot/ plant		
			2014-15	2015-16	Pooled mean	2014-15	2015-16	Pooled mean	2014-15	2015-16	Pooled mean
T_1	Sulfoxaflor 12% SC	21	30.20 (5.54)*	30.33 (5.54)	30.27 (5.54)	8.40 (2.98)	2.73 (1.80)	5.57 (2.46)	3.07 (1.89)	1.67 (1.47)	2.37 (1.69)
T_2	Sulfoxaflor 12% SC	24	31.60 (5.66)	27.00 (5.24)	29.30 (5.46)	7.80 (2.88)	1.93 (1.55)	4.87 (2.32)	2.40 (1.70)	1.20 (1.30)	1.80 (1.52)
T_3	Sulfoxaflor 12% SC	27	32.53 (5.75)	31.33 (5.63)	31.93 (5.69)	7.00 (2.74)	1.87 (1.53)	4.43 (2.22)	1.60 (1.45)	1.00 (1.22)	1.30 (1.34)
T_4	Sulfoxaflor 12% SC	30	29.40 (5.45)	28.27 (5.36)	28.83 (5.41)	6.80 (2.70)	1.20 (1.30)	4.00 (2.12)	0.93 (1.19)	0.80 (1.14)	0.87 (1.17)
T_5	Thiamethoxam 25% WDG	12.5	32.07 (5.70)	31.33 (5.64)	31.70 (5.67)	8.40 (2.98)	2.20 (1.64)	5.30 (2.41)	3.93 (2.10)	1.47 (1.39)	2.70 (1.79)
T_6	Quinalphos 25% EC	250	32.80 (5.76)	28.27 (5.36)	30.53 (5.57)	11.60 (3.47)	4.20 (2.16)	7.90 (2.90)	7.67 (2.86)	1.87 (1.54)	4.77 (2.29)
T_7	Untreated Check	-	33.20 (5.80)	29.27 (5.45)	31.23 (5.63)	35.30 (5.97)	31.67 (5.66)	33.43 (5.82)	38.20 (6.22)	28.67 (5.40)	33.43 (5.82)
	SE ±		0.14	0.16	0.11	0.09	0.12	0.07	0.08	0.08	0.07
	CD (p=0.05)		NS	NS	NS	0.27	0.36	0.22	0.25	0.25	0.20

* Figures in parentheses $\sqrt{n+0.5}$ values

Table 2. Efficacy of doses of Sulfoxaflor 12%SC against foliar aphids in wheat

Sr. No.	Treatments	Dose (g a.i./ ha)	7 Days after spray (Mean no. of aphids/ shoot/ plant)			14 Days after spray (Mean no. of aphids/ shoot/ plant			Pooled mean population (2014-15 to 2015-16)	% reduction over control	*C. septempunctata*/ m^2 (Pooled mean 2014-15 to 2015-16)	
			2014-15	2015-16	Pooled mean	2014-15	2015-16	Pooled mean			Before spray	14 Day After Spray
T_1	Sulfoxaflor 12% SC	21	0.80 (1.14)*	1.13 (1.27)	0.97 (1.21)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	2.23	93.03	1.33 (1.35)	2.77 (1.81)
T_2	Sulfoxaflor 12% SC	24	0.00 (0.71)	0.60 (1.05)	0.30 (0.89)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	1.74	94.54	1.51 (1.42)	2.14 (1.62)
T_3	Sulfoxaflor 12% SC	27	0.00 (0.71)	0.60 (1.05)	0.30 (0.89)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	1.51	95.27	1.51 (1.42)	2.08 (1.61)
T_4	Sulfoxaflor 12% SC	30	0.00 (0.71)	0.40 (0.95)	0.20 (0.84)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	1.27	96.03	1.60 (1.45)	2.01 (1.58)
T_5	Thiamethoxam 25% WDG	12.5	1.13 (1.28)	1.60 (1.44)	1.37 (1.36)	2.00 (1.58)	0.00 (0.71)	1.00 (1.22)	2.59	91.88	1.27 (1.33)	1.50 (1.41)
T_6	Quinalphos 25% EC	250	7.53 (2.83)	2.40 (1.70)	4.97 (2.34)	4.33 (2.20)	0.00 (0.71)	2.17 (1.63)	4.95	84.48	1.45 (1.40)	1.57 (1.44)
T_7	Untreated Check	-	40.50 (6.38)	26.73 (5.22)	33.47 (5.83)	35.20 (5.97)	19.33 (4.44)	27.27 (5.27)	31.90	-	1.73 (1.49)	5.49 (2.45)
	SE ±		0.06	0.07	0.03	0.05	0.07	0.03	-	-	0.04	0.04
	CD (p=0.05)		0.18	0.20	0.10	0.17	0.23	0.11	-	-	NS	0.12

*Figures in parentheses √ n+0.5 values

Table 3. Economics of treatments (pooled data, 2014-15, 2015-16)

Sr. No.	Treatments	Dose (g a.i./ ha)	Yield (q/ ha)	Additional yield over control q/ ha	Additional income over control (Rs.)	*Cost of cultivation (Rs.)	Gross income (Rs.)	Net income (Rs.)	B:C ratio
T_1	Sulfoxaflor 12% SC	21	50.29	6.52	8802	26207	67892	41685	1: 2.59
T_2	Sulfoxaflor 12% SC	24	52.21	8.44	11394	26467	70484	44017	1 : 2.66
T_3	Sulfoxaflor 12% SC	27	52.62	8.85	11947	26812	71037	44225	1 : 2.65
T_4	Sulfoxaflor 12% SC	30	54.32	10.55	14242	27187	73332	46145	1 : 2.70
T_5	Thiamethoxam 25% WDG	12.5	49.87	6.10	8235	26567	67325	40758	1 : 2.53
T_6	Quinalphos 25% EC	250	47.73	3.96	5346	26422	64436	38014	1 : 2.44
T_7	Untreated Check	-	43.77	-	-	23937	59090	35153	1 : 2.47
	SE ±		1.26	-					
	CD (p=0.05)		3.88	-					

Total cost of cultivation except insecticide control: Rs. 23495/-; Rs. 24378/- (Avg. Rs. 23937/-); Price of wheat grains: Rs. 1200/q; Rs.500/- (Avg. Rs.1350/-); *Cost of cultivation = Cost of insecticide + labour + insecticide application + machine charges; Cost of insecticides: 1. Sulfoxaflor 12% SC: (Rs. 2270, 2530, 2875, 3250/ha) 2. Thiamethoxam 25% WDG: (Rs.2630/ha) 3. Quinalphos 25% EC: (Rs. 2485/ha)

alternatively with other insecticides for the control of wheat aphids (Babcock et al., 2011; Xin et al., 2019). Annetts et al. (2012) observed that sulfoxaflor demonstrated very good control of all major species of aphids infesting cereals, like oat aphid (*R. padi*), corn aphid (*R. maidis*), grain aphid (*S. miscanthi*) and rose grain aphid (*Metopolophium dirhodum*). The pooled data revealed that among the treatments % reduction of aphids ranged between 84.48 to 96.03%, with maximum being with T_4 (96.03); and standard check T_5 (thiamethoxam 25WDG @ 12.5 g a.i./ ha) and T_6 (quinalphos 25EC @ 250 g a.i./ ha) led to 84.15 and 76.37% reduction, respectively (Table 2). The data for phytotoxicity were observed at 1, 7 and 14 DAT. The observations for the specific parameters like chlorosis, necrosis, wilting, hyponasty and epinasty were noted. There were no adverse effects of higher doses of sulfoxaflor 12% SC @ 30 and 60 g a.i/ ha on plants.

The pooled data showed that yield was significantly higher in treated plots, and significantly higher yield was obtained in T_4, T_3 and T_2 (54.32, 52.62 and 52.21q/ ha, respectively) and was at par with standard T_5 (49.87 q/ha) and T_6 (47.73 q/ha). Considering incremental cost benefit ratio (1:2.70) T_4 (sulfoxaflor 12%SC @ 30 g a.i/ ha) was found economical (Table 3). Therefore, present study revealed that being safer and economically cheapest, sulfoxaflor 12SC @ 30 g a.i./ ha can be used for the effective management of foliar aphids in wheat crop.

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