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Efficacy of insecticidal seed treatment against pests of wheat

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ABSTRACT

Field experiments were conducted during *Rabi* 2012-13 to 2014-15 at Agricultural Research Station, Niphad, Maharashtra, India to determine the efficacy of promising insecticides used for seed treatment for the management of wheat pests. The insecticides were Thiamethoxam 30 FS @ 0.50, 0.75 and 1.00ml/kg seed, Clothianidin 50 WDG @ 0.50, 1.00 and 1.50 g/kg seed, Imidacloprid 48 FS @ 0.50 and 1.00ml/kg seed, Chlorantraniliprole 18.5 SC @ 0.50 and 1.00 ml/kg seed. Thiamethoxam 30 FS @1.0 ml/kg seed, Clothianidin 50 WDG @ 0.50, 1.00 and 1.50 g/kg seed and Imidacloprid 48 FS @ 0.50 and 1.00 ml/kg seed were found the most effective as they didn't show the aphid population as an untreated control recorded the maximum of 44.08 number of aphids/shoot/plant. The seed treated with thiamethoxam 30FS, clothianidin 50 WDG and Imidacloprid 48FS were found effective for the control of jassids and shoot fly. Thiamethoxam 30FS @ 1.00ml/kg seed recorded significantly highest yield of 55.26q/ha and also the highest (53.45g) 1000 grain weight. Lowest yield was observed from untreated control (34.12 q/ha). The additional yield and income over control was highest (21.14q/ha and Rs. 44480/ha) in thiamethoxam 30FS @ 1.00 ml/kg seed. The monetory returns, net profit and benefit cost ratio were maximum in treatment with thiamethoxam 30FS @ 1.00ml/kg seed (Rs.114607/-, 81377/ha and 3.44).

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INTRODUCTION

In *Rabi* season Wheat (*Triticum aestivum* L.) is the main cereal crop of India that plays major role in improving the economic condition and fulfilling the demand of food of such large population in India. During 2015-16, the area and production of wheat crop were and in India (Anonymous, 2016). Among the wheat pests, aphids are the most widely distributed and serious pest to wheat crop (Yadev, 2003). They cause direct damage by sucking cell sap of leaves, young shoots, causing distortion, stunting, leaf curling twisting. They also cause indirect damage by depositing honey dew which reduce the photosynthetic activity and cause development of black sooty mould (Ozder, 2002 and Akhtar *et al.*, 2006).

Different aphid species have been reported in India causing severe damage to the wheat crop. The aphid species like bird cherry oat aphid *Rhopalosiphum padi* (L.), grain aphid, *Sitobion miscanthi* (*Takahashi*), corn leaf aphid, *Rhopalosiphum maidis* (*fitch*) and green bug, *Schizaphis graminum* (*Rondani*) are reported on different cereals (Hamid, 1983). Bird cherry oat aphid is one of the most important and serious pest. Direct crop loss in wheat by aphid were in range of 10 to 50 per cent and indirect from 20 to 80 per cent (Trdan and Mileboj, 1999). In early growing stage of crop, the aphid devastating the crop. The population of aphid is mostly related with suitabl environmental conditions (Metcalf *et al.*, 1951). Therefore, a usual and regular monitoring of wheat crop is very important during situation of that particular ecological conditions.

Other than chemical insect controlling strategies, the biological agents provide an environmentally safe and effective control of insect pests including aphids (Patil *et al*., 2015). The natural enemies may help to reduce the aphid population from reaching the economic injury level. Coccinellid beetle (*Coccinella septempunctata* L.). However, their protection and conservation in agro ecosystem is narrow due to extensive and indiscriminate use of insecticides. These predators exposed to chemicals directly through insecticides applications or indirectly by consuming insecticides contaminated preys. Therefore, careful selection and doses of insecticides can be helpful to preserve the biocontrol agents of aphid (Oakley *et al.*, 1996 and Head *et al.*, 2000).

Insecticides are effectively use in the control of aphid (Ahmed *et al.*, 2010 and Wains *et al.*, 2010). Therefore, the impact of insecticides on natural enemies alongwith its required effects on target pests of wheat should be the complete component of the essential management. The present study was carried out to investigate the comparative efficacy of various insecticides as seed treatments against pests of wheat and its response to natural enemies under field.

MATERIAL AND METHODS

A field experiment was conducted during *Rabi* 2012-13, 2013-14 and 2014-15 on the research farm of Agricultural Research Station, Niphad, dist-Nasik (M.S.), India. A field experiment was carried out in Randomized Block Design with twelve treatments *viz*., Thiamethoxam 30% FS @ 0.50 ml or g/kg seed, Thiamethoxam 30% FS @ 0.75 ml or g/kg seed, Thiamethoxam 30% FS @1.0 ml or g/kg seed, Clothianidin 50 WDG @ 0.75 ml or g/kg seed, Clothianidin 50 WDG @ 1.00 ml or g/kg seed, Clothianidin 50 WDG @ 1.50 ml or g/kg seed, Imidacloprid 48% FS @ 0.50 ml or g/kg seed, Imidacloprid 48% FS @ 1.00 ml or g/kg seed, Chlorantraniliprole 18.5 SC @ 0.50 ml or g/kg seed, Chlorantraniliprole 18.5 SC @ 1.00 ml or g/kg seed, Recommended control measure (spray of thiamethoxam 25WG) 1g/10 lit of water and untreated control and three replications on wheat variety Godavari (NIDW-295) in plot size 6 x 1.35m (six rows of six meter row length).

Insecticidal treatments was done a day before sowing. Same quantity of formulations were diluted at each level of dose with 50 ml water while applying insecticide and sprayed over one kg seed uniformly spread in a tray. Seed was turned over frequently to ensure proper and uniform application and then was left overnight for drying. Germination count under field condition was taken. Observations were recorded on the basis of average population of survival aphids. The aphid population was recorded at 40, 50, 60, 70 and 80 days after sowing. Counting of aphids was done from five shoot from each treatment. The population of jassids was recorded on selected five plants and it was converted into number of jassids/plant. Regarding observation of shoot fly marking of 3 spot of one meter in each row length in each plot was done and recorded per cent dead hearts at 30 days after germination by counting the healthy and affected shoots. The data were analyzed statistically after appropriate transformation along with per cent reduction. The population of natural enemies was recorded by counting them on m^2 at three different locations in treatments. Data regarding 1000 grain weight was recorded at harvesting. Yield of each plot per treatment was recorded and converted it into q/ha.

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under the following heads:

Aphid :

The pooled data for three consecutive years (2012-13 to 2014-15) pertaining to effect of various insecticidal

seed treatments on aphids and other pests control in wheat is depicted in Table 1 and 2. The data indicated the significant differences among the treatment. The aphids population per shoot per plant at 40 days after sowing revealed that the seeds treated with thiamethoxam 30 FS @ 0.50, 0.75 and 1.00 ml/kg seed, clothianidin 50 WDG @ 0.50, 1.00 and 1.50 g/kg seed and imidacloprid 48 FS @ 0.50 and 1.00 ml/kg seed were found most effective as they did not show the aphids population. The maximum (26.88) aphids population per shoot per plant was recorded in untreated control where the seed was without seed treatment. It was followed by recommended spray of thiamethoxam 25WG @ 1.00 g/ lit water (25.13) and it was taken as pre count for undertaking the recommended control spray at ETL. Among the various insecticidal seed treatment and untreated control the treatments with thiamethoxam 30 FS @ 1.00 ml/kg seed, clothianidin 50 WDG @ 0.50, 1.00 and 1.50 g/kg seed and imidacloprid 48 FS @ 0.50 and 1.00 ml/kg seed were the most effective as they didn't show the aphids population as untreated control recorded the maximum of 44.08 number of aphids/ shoot/plant at 50 days after sowing. At 60, 70 and 80 days after sowing, significantly minimum (2.04, 4.66 and 2.55) number of aphids per shoot per plant were recorded in treatment with thiamethoxam 30 FS @ 1.00 ml/kg seed. It was followed by imidacloprid 48 FS @ 1.00 ml/kg seed (2.53, 5.10), clothianidin 50 WDG @ 1.50 g/kg seed (2.55, 9.22) and clothianidin 50 WDG @ 1.00 g/kg seed (2.82, 12.88) at 60 and 70 days after spray and clothianidin 50 WDG @ 1.50 g/ kg seed (4.48), thiamethoxam 30 FS @ 0.75 ml/kg seed (5.73) and imidacloprid 48 FS @ 1.00 ml/kg seed (5.86) at 80 days after spray, respectively. The untreated control recorded the maximum number of 26.88, 44.08, 165.66, 262.41 and 98.88 aphids per shoot per plant were recorded at 40, 50, 60, 70 and 80 days after spray.

Table 1: Efficacy of insecticidal seed treatment against foliage wheat aphids at 40, 50 and 60 days after sowing

Sr. No.	Treatments	Dose g/ml per kg seed	Av. No. of aphids/shoot/plant at											
			40 DAS				50 DAS				60 DAS			
			12-13	13-14	14-15	Pooled	12-13	13-14	14-15	Pooled	12-13	13-14	14-15	Pooled
1.	Thiamethoxam 30 FS	0.50	0.0* (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.0 (1.00)	4.20 (2.28)	0.00 (1.00)	1.40 (1.55)	0.0 (1.00)	37.47 (6.20)	8.66 (3.10)	15.37 (4.05)
2.	Thiamethoxam 30 FS	0.75	0.0 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.0 (1.00)	2.93 (1.98)	0.00 (1.00)	0.97 (1.40)	0.0 (1.00)	17.87 (4.34)	0.00 (1.00)	5.95 (2.63)
3.	Thiamethoxam 30 FS	1.00	0.0 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.0 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.0 (1.00)	6.13 (2.67)	0.00 (1.00)	2.04 (1.74)
4.	Clothianidin 50 WDG	0.50	0.0 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.0 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.0 (1.00)	12.53 (3.68)	8.40 (3.07)	6.97 (2.82)
5.	Clothianidin 50 WDG	1.00	0.0 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.0 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.0 (1.00)	8.47 (3.08)	0.00 (1.00)	2.82 (1.95)
6.	Clothianidin 50 WDG	1.50	0.0 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.0 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.0 (1.00)	7.67 (2.94)	0.00 (1.00)	2.55 (1.88)
7.	Imidacloprid 48 FS	0.50	0.0 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.0 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.0 (1.00)	10.07 (3.33)	10.33 (3.37)	6.79 (2.79)
8.	Imidacloprid 48 FS	1.00	0.0 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.0 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.0 (1.00)	7.60 (2.93)	0.00 (1.00)	2.53 (1.88)
9.	Chlorantraniliprole 18.5 SC	0.50	3.93 (2.22)	11.80 (3.58)	7.13 (2.85)	7.62 (2.93)	8.46 (3.07)	25.67 (5.16)	14.73 (3.97)	16.28 (4.16)	16.13 (4.14)	134.00 (11.62)	188.20 (13.75)	112.77 (10.67)
10.	Chlorantraniliprole 18.5 SC	1.00	2.2 (1.79)	6.20 (2.68)	5.80 (2.61)	4.73 (2.39)	5.53 (2.55)	11.67 (3.56)	9.40 (3.22)	8.86 (3.14)	12.73 (3.71)	114.20 (10.73)	191.60 (13.88)	106.17 (10.35)
11.	Recommended spray of thiamethoxam 25WG	1g/10L water	28.4 (5.42)	35.87 (6.07)	11.13 (3.48)	25.13 (5.11)	0.0 (1.00)	0.00 (1.00)	29.80 (5.55)	9.93 (3.31)	0.0 (1.00)	3.53 (2.13)	0.00 (1.00)	1.17 (1.47)
12.	Untreated control	--	30.8 (5.64)	38.27 (6.27)	11.60 (3.55)	26.88 (5.28)	42.73 (6.61)	57.07 (17.62)	32.46 (5.78)	44.08 (6.71)	51.26 (7.23)	220.27 (14.88)	225.53 (15.05)	165.68 (12.91)
	S.E. ±		0.05	0.05	0.02	0.02	0.04	0.04	0.04	0.03	0.05	0.05	0.06	0.04
	C.D. (P=0.05)		0.14	0.14	0.07	0.07	0.10	0.11	0.11	0.07	0.15	0.16	0.17	0.11

* Figures in parentheses are $\sqrt{n+1}$ transformed values

Jassids:

The data presented in Table 3 revealed that the population of jassids/plant due to various insecticidal seed treatments were significant. The jassids population per plant at 40 days after sowing indicated that the seeds treatment with thiamethoxam 30 FS @, 0.75 and 1.00 ml/kg seed, clothianidin 50 WDG @ 1.00 and 1.50 g/kg seed and imidacloprid 48 FS @ 1.00 ml/kg seed were found most effective as they did not show the jassids population. The maximum (10.13 and 12.47) jassids population per plant was recorded in untreated control where the seed was without seed treatment at 40 and 50 days after sowing, respectively.

Shoot fly:

The data presented in Table 3 revealed that the percent infestation of shoot fly was significant during 2014-15. The infestation of shoot fly was not recorded during 2012-13 and 2013-14. The shoot fly infestation in treatments with thiamethoxam 30 FS @, 0.75ml/kg, thiamethoxam 30 FS @, 1.00 ml/kg, clothianidin 50 WDG @ 1.00 g/kg, clothianidin 50 WDG @ 1.50 g/kg and imidacloprid 48 FS @ 1.00 ml/kg was not recorded. It is noticed from the results that these treatments were highly effective against shoot fly. The maximum (21.46%) shoot fly infestation was recorded in treatment of without seed treatment (untreated control).

Germination:

The seed germination due to various insecticidal seed treatment and without seed treatment was not affected. The germination in various treatments was in the range of 94.44 to 96.11 per cent.

1000 grain weight:

The significantly highest (53.45g) 1000 grain weight

Table 2 : Efficacy of insecticidal seed treatment against foliage wheat aphids at 70 and 80 days after sowing

Sr. No.	Treatments	Dose g/ml perkg seed	Av. No. of aphids/shoot/plant at 70 DAS				80 DAS				Cumulative average no. of aphids/shoot/plant			
			12-13	13-14	14-15	Pooled	12-13	13-14	14-15	Pooled	12-13	13-14	14-15	Pooled
1.	Thiamethoxam 30 FS	0.50	4.66 *(2.38)	49.00 (7.07)	10.80 (3.43)	21.39 (4.73)	6.26 (2.69)	9.00 (3.07)	11.13 (3.48)	8.79 (3.13)	2.52 (1.88)	19.93 (4.57)	6.12 (2.67)	9.52 (3.24)
2.	Thiamethoxam 30 FS	0.75	3.8 (2.19)	36.80 (6.15)	0.00 (1.00)	13.53 (3.81)	5.53 (2.55)	7.00 (2.83)	4.66 (2.38)	5.73 (2.59)	1.87 (1.69)	12.92 (3.73)	0.93 91.39)	5.24 (2.50)
3.	Thiamethoxam 30 FS	1.00	1.6 (1.61)	12.40 (3.66)	0.00 (1.00)	4.66 (2.38)	3.93 (2.22)	3.73 (2.17)	0.00 (1.00)	2.55 (1.089)	1.11 (1.45)	4.45 (2.33)	0.00 (1.00)	1.85 (1.69)
4.	Clothianidin 50 WDG	0.50	6.06 (2.66)	46.00 (6.86)	11.46 (3.53)	21.17 (4.71)	7.80 (2.96)	10.13 (3.34)	11.26 (3.50)	9.73 (3.28)	2.77 (1.94)	13.73 (3.84)	6.22 (2.69)	7.57 (2.93)
5.	Clothianidin 50 WDG	1.00	5.33 (2.52)	33.33 (11.44)	0.00 (1.00)	12.88 (3.72)	7.13 (2.85)	7.33 (2.89)	6.86 (2.80)	7.10 (2.85)	2.49 (1.87)	9.83 (3.29)	1.37 (1.54)	4.56 (2.36)
6.	Clothianidin 50 WDG	1.50	3.46 (2.11)	24.20 (5.02)	0.00 (1.00)	9.22 (3.19)	5.40 (2.52)	5.67 (2.58)	2.40 (1.84)	4.48 (2.34)	1.77 (1.66)	7.51 (2.92)	0.50 (1.22)	3.26 (2.06)
7.	Imidacloprid 48 FS	0.50	4.60 (2.37)	26.87 (5.28)	11.66 (3.56)	14.39 (3.93)	6.46 (2.73)	8.80 (3.13)	13.80 (3.85)	9.68 (3.27)	2.21 (1.79)	9.15 (3.19)	7.16 (2.86)	6.17 (2.68)
8.	Imidacloprid 48 FS	1.00	2.93 (1.98)	13.27 (3.78)	0.00 (1.00)	5.10 (2.47)	5.53 (2.55)	7.27 (2.88)	4.46 (2.34)	5.86 (2.62)	1.69 (1.64)	5.63 (2.57)	0.90 (1.38)	2.74 (1.93)
9.	Chlorantraniliprole 18.5 SC	0.50	17.23 (4.27)	238.87 (15.49)	262.66 (16.24)	172.91 (13.19)	19.26 (4.50)	23.60 (4.96)	163.46 (12.82)	68.77 (8.35)	13.00 (3.74)	86.79 (9.37)	127.24 (11.32)	75.68 (8.76)
10.	Chlorantraniliprole 18.5 SC	1.00	7.8 (2.97)	271.00 (16.49)	303.80 (17.46)	194.19 (13.97)	17.80 (4.33)	18.67 (4.44)	199.53 (14.16)	78.66 (8.92)	9.21 (3.19)	84.35 (9.24)	142.03 (11.96)	78.53 (8.92)
11.	Recommended spray of thiamethoxam 25WG	1g/10L water	0.0 (1.00)	6.67 (2.77)	0.00 (1.00)	2.79 (1.95)	0.0 (1.00)	2.87 (1.97)	6.66 (2.77)	3.17 (2.04)	5.68 (2.58)	9.79 (3.28)	9.52 (3.24)	8.33 (3.05)
12.	Untreated control	--	56.66 (7.59)	405.67 (20.17)	324.93 (18.05)	262.41 (16.23)	62.60 (7.97)	51.53 (7.25)	182.53 (13.55)	98.88 (9.99)	48.81 (7.06)	154.56 (12.47)	155.41 (12.51)	119.59 (10.98)
	S.E. ±		0.20	0.10	0.15	0.06	0.03	0.04	0.04	0.03	-	-	-	-
	C.D. (P=0.05)		0.59	0.30	0.43	0.16	0.09	0.11	0.12	0.08	-	-	-	-

* Figures in parentheses are $\sqrt{n+1}$ transformed values

Table 3: Effect of insecticidal seed treatment on germination of seed, shoot fly infestation and population of jassids

Sr. No.	Treatments	Dose g/ml kg seed	% seed germination				% infestation of shoot fly			No. of Jassids/plant						Av. mean
										40 DAS			50 DAS			
			12-13	13-14	14-15	Pooled	12-13	13-14	14-15	12-13	13-14	14-15	12-13	13-14	14-15	
1.	Thiamethoxam 30 FS	0.50	93.33** (75.00)	93.33 (75.00)	96.66 (79.53)	94.44 (76.31)	Infestation of shoot fly was not recorded	Infestation of shoot fly was not recorded	4.26** (11.97)	Infestation of shoot fly was not recorded	Infestation of shoot fly was not recorded	1.67 *(1.63)	Incidence of jassids was not recorded	Incidence of jassids was not recorded	7.07 (2.84)	4.37 (2.32)
2.	Thiamethoxam 30 FS	0.75	95.00 (77.08)	96.66 (79.53)	96.66 (79.53)	96.11 (78.61)			0.00 (0.00)			0.00 (1.00)			0.00 (1.00)	0.00 (1.00)
3.	Thiamethoxam 30 FS	1.00	95.00 (77.08)	96.66 (79.53)	98.33 (82.51)	96.66 (79.53)			0.00 (0.00)			0.00 (1.00)			0.00 (1.00)	0.00 (1.00)
4.	Clothianidin 50 WDG	0.50	93.33 (75.00)	96.66 (79.53)	98.33 (82.51)	96.11 (78.61)			4.52 (12.25)			1.33 (1.53)			6.73 (2.78)	4.03 (2.24)
5.	Clothianidin 50 WDG	1.00	93.33 (75.00)	95.00 (77.08)	96.66 (79.53)	94.99 (76.95)			0.00 (0.00)			0.00 (1.00)			0.00 (1.00)	0.00 (1.00)
6.	Clothianidin 50 WDG	1.50	95.00 (77.08)	96.66 (79.53)	96.66 (79.53)	96.11 (78.61)			0.00 (0.00)			0.00 (1.00)			0.00 (1.00)	0.00 (1.00)
7.	Imidacloprid 48 FS	0.50	95.00 (77.08)	98.33 (82.51)	96.66 (79.53)	96.66 (79.53)			3.32 (10.47)			1.60 (1.61)			6.40 (2.72)	4.00 (2.24)
8.	Imidacloprid 48 FS	1.00	93.33 (75.00)	96.66 (79.53)	95.00 (77.08)	94.99 (76.95)			0.00 (0.00)			0.00 (1.00)			0.00 (1.00)	0.00 (1.00)
9.	Chlorantraniliprole 18.5 SC	0.50	93.33 (75.00)	93.33 (75.00)	96.66 (79.53)	94.44 (76.31)			21.20 (27.42)			8.60 (3.10)			12.60 (3.69)	10.60 (3.41)
10.	Chlorantraniliprole 18.5 SC	1.00	95.00 (77.08)	96.66 (79.53)	96.66 (79.53)	96.11 (78.61)			20.80 (27.13)			8.73 (312)			12.27 (3.64)	10.50 (3.39)
11.	Rec. spray of thiamethoxam 25WG	1g/10 lit water	95.00 (77.08)	95.00 (77.08)	98.33 (82.51)	96.11 (78.61)			18.00 (25.10)			9.53 (3.24)			1.40 (1.55)	5.47 (2.54)
12.	Untreated control	--	93.33 (75.00)	96.66 (79.53)	96.66 (79.53)	95.44 (77.61)			21.46 (27.63)			10.13 (3.34)			12.47 (3.67)	11.30 (3.51)
	S.E. ±		1.24	3.80	4.43	0.88	-	-	0.33	-	-	0.03	-	-	0.05	-
	C.D. (P=0.05)		NS	NS	NS	NS	-	-	0.96	-	-	0.10	-	-	0.14	-

** Figures in parentheses arearc sin transformed values * Figures in parentheses are √ n+1 transformed values
NS=Non-significant

Table 4 : Effect of insecticidal seed treatment on 1000 grain weight and yield of wheat

Sr. No.	Treatments	Dose g/ml per kg seed	1000 grain weight (g)				Yield q/ha				% increased in yield over control			
			12-13	13-14	14-15	Pooled	12-13	13-14	14-15	Pooled	12-13	13-14	14-15	Pooled
1.	Thiamethoxam 30 FS	0.50	52.07	52.46	52.54	52.36	44.72	46.36	51.68	47.62	15.4	45.42	62.87	41.23
2.	Thiamethoxam 30 FS	0.75	52.83	53.15	53.07	53.03	48.97	53.28	56.68	52.97	26.37	67.12	78.63	57.37
3.	Thiamethoxam 30 FS	1.00	52.70	53.41	54.23	53.45	50.80	56.78	58.21	55.26	31.1	78.11	83.45	64.22
4.	Clothianidin 50 WDG	0.50	49.37	48.37	52.26	50.00	45.86	52.51	51.10	49.82	18.35	64.71	61.05	48.04
5.	Clothianidin 50 WDG	1.00	50.83	51.30	52.30	51.48	47.93	52.60	57.82	52.78	23.69	64.99	82.23	56.97
6.	Clothianidin 50 WDG	1.50	51.44	51.49	53.20	52.04	48.16	54.20	57.61	53.32	24.28	70.01	81.56	58.62
7.	Imidacloprid 48 FS	0.50	52.23	52.93	52.17	52.45	46.68	47.60	51.50	48.59	20.46	49.30	62.31	44.02
8.	Imidacloprid 48 FS	1.00	52.80	53.05	53.10	52.99	49.72	57.85	58.05	55.21	28.31	81.46	82.90	64.22
9.	Chlorantraniliprole 18.5 SC	0.50	49.73	50.17	49.20	49.70	38.65	32.63	37.01	36.10	0.0	2.35	16.64	6.33
10.	Chlorantraniliprole 18.5 SC	1.00	50.53	50.73	49.80	50.35	38.69	33.74	39.74	37.39	0.0	5.83	25.24	10.36
11.	Recommended spray thiamethoxam 25WG	1g/10L water	52.75	53.09	53.50	53.11	54.58	63.35	62.03	59.99	40.85	98.71	95.49	78.35
12.	Untreated control	--	48.75	48.78	48.05	48.72	38.75	31.88	31.73	34.12	0.0	0.0	0.0	0.0
	S.E. ±		0.40	0.31	0.07	0.23	2.18	2.81	1.99	1.64	-	-	-	-
	C.D. (P=0.05)		1.18	0.92	0.21	0.67	6.39	8.22	5.84	4.80	-	-	-	-

Table 5 : Economics of the treatments

Sr. No.	Treatments	Dose g/ml per kg seed	Yield (q/ha)				Additional yield over control (q/ha)				Additional income over control (Rs.)				Cost of cultivation + cost of insecticides (Rs.)			
			12-13	13-14	14-15	Pooled	12-13	13-14	14-15	Pooled	12-13	13-14	14-15	Pooled	12-13	13-14	14-15	Pooled
1.	Thiamethoxam 30 FS	0.50	44.72	46.36	51.68	47.62	5.97	14.48	19.95	13.47	11343	30408	43890	28547	29543	33524	34634	32567
2.	Thiamethoxam 30 FS	0.75	48.97	53.28	56.68	52.97	10.22	21.4	24.95	18.86	19418	44940	54890	39749	29843	33849	35009	32900
3.	Thiamethoxam 30 FS	1.00	50.80	56.78	58.21	55.26	12.05	24.9	26.48	21.14	22895	52290	58256	44480	30143	34174	35384	33234
4.	Clothianidin 50 WDG	0.50	45.86	52.51	51.10	49.82	7.11	20.63	19.37	15.70	13509	43323	42614	33149	29593	33574	34684	32617
5.	Clothianidin 50 WDG	1.00	47.93	52.60	57.82	52.78	9.18	20.72	26.09	18.66	17442	43512	57398	39451	30243	34274	35484	33334
6.	Clothianidin 50 WDG	1.50	48.16	54.20	57.61	53.32	9.41	22.32	25.88	19.20	17879	46872	56936	40562	30893	34974	36284	34050
7.	Imidacloprid 48 FS	0.50	46.68	47.60	51.50	48.59	7.93	15.72	19.77	14.47	15067	33012	43494	30524	29543	33574	34634	32584
8.	Imidacloprid 48 FS	1.00	49.72	57.85	58.05	55.21	10.97	25.97	26.32	21.09	20843	54537	57904	44428	30143	34274	35384	33267
9.	Chlorantraniliprole 18.5 SC	0.50	38.65	32.63	37.01	36.10	0.0	0.75	5.28	2.01	0.0	1575	11616	4397	29443	33499	34584	32509
10.	Chlorantraniliprole 18.5 SC	1.00	38.69	33.74	39.74	37.39	0.0	1.86	8.01	3.29	0.0	3906	17622	7176	29943	34124	35284	33117
11.	Recomd spray thiamethoxam 25 WG	1g/ 10 lit	54.58	63.35	62.03	59.99	15.83	31.47	30.3	25.87	30077	66087	66660	54275	30883	35134	36194	34070
12.	Untreated control	--	38.75	31.88	31.73	34.12	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	28903	32824	33824	31850
	S.E. ±		2.18	2.81	1.99	1.64	-	-	-	-	-	-	-	-	-	-	-	-
	C.D. (P=0.05)		6.39	8.22	5.84	4.80	-	-	-	-	-	-	-	-	-	-	-	-

Table 5 contd...

Sr. No.	Treatments	Dose g/ml/kg seed	Cost of insecticidal treatments (Rs.)				Monetary returns (Rs.)				Net income (Rs.)			
			12-13	13-14	14-15	Pooled	12-13	13-14	14-15	Pooled	12-13	13-14	14-15	Pooled
1.	Thiamethoxam 30 FS	0.50	640	700	810	717	84968	97356	113696	98673	55425	63832	79082	66113
2.	Thiamethoxam 30 FS	0.75	940	1025	1185	1050	93043	111888	124696	109876	63200	78039	89687	76975
3.	Thiamethoxam 30 FS	1.00	1240	1350	1560	1384	96520	119238	128062	114607	66377	85064	92678	81373
4.	Clothianidin 50 WDG	0.50	690	750	860	767	87134	110271	112420	103275	57541	76697	77736	70658
5.	Clothianidin 50 WDG	1.00	1340	1450	1660	1484	91067	110460	127204	109577	60824	76186	91720	76243
6.	Clothianidin 50 WDG	1.50	1990	2150	2460	2200	91504	113820	126742	110689	60611	78846	90458	76638
7.	Imidacloprid 48 FS	0.50	640	750	810	734	88692	99960	113300	100650	59149	66386	78656	68067
8.	Imidacloprid 48 FS	1.00	1240	1450	1560	1417	94468	121485	127710	114554	64325	87211	92326	81287
9.	Chlorantraniliprole 18.5 SC	0.50	540	675	760	659	73435	68523	81422	74460	43992	35024	46838	41951
10.	Chlorantraniliprole 18.5 SC	1.00	1040	1300	1460	1267	73511	70854	87428	77264	43568	36730	52144	44147
11.	Recommended spray thiamethoxam 25WG	1g/ 10L	1980	2310	2370	2220	103702	133035	136466	124401	72819	97901	00272	90331
12.	Untreated control	--	0	0	0	0	73625	66948	69806	70126	44722	34124	35982	38276

Table 5 contd..

Sr. No.	Treatments	Dose g/ml per kg seed	Net profit 12-13	Net profit 13-14	Net profit 14-15	Net profit Pooled	Benefit cost ratio 12-13	Benefit cost ratio 13-14	Benefit cost ratio 14-15	Benefit cost ratio Pooled	ICBR 12-13	ICBR 13-14	ICBR 14-15	ICBR Pooled
1.	Thiamethoxam 30 FS	0.50	10703	29708	43080	27830	2.88	2.90	3.28	3.02	16.72	42.44	53.19	38.81
2.	Thiamethoxam 30 FS	0.75	18478	43915	53705	38699	3.12	3.31	3.56	3.33	19.66	42.84	45.32	36.86
3.	Thiamethoxam 30 FS	1.00	21655	50940	56696	43096	3.20	3.49	3.62	3.44	17.46	37.73	36.34	31.14
4.	Clothianidin 50 WDG	0.50	12819	42573	41754	32382	2.94	3.28	3.24	3.16	18.58	56.76	48.55	42.22
5.	Clothianidin 50 WDG	1.00	16102	42062	55738	37967	3.01	3.22	3.58	3.27	12.02	29.01	33.58	25.58
6.	Clothianidin 50 WDG	1.50	15889	44722	54476	38362	2.96	3.25	3.49	3.24	7.98	20.80	22.14	17.44
7.	Imidacloprid 48 FS	0.50	14427	32262	42684	29791	3.00	2.98	3.27	3.08	22.54	43.01	52.70	39.41
8.	Imidacloprid 48 FS	1.00	19603	53087	56344	43011	3.13	3.54	3.61	3.43	15.81	36.61	36.12	30.35
9.	Chlorantraniliprole 18.5 SC	0.50	-540	900	10856	3738	2.49	2.05	2.35	2.30	0.0	1.33	14.28	5.67
10.	Chlorantraniliprole 18.5 SC	1.00	-1040	2606	16162	5909	2.46	2.08	2.48	2.34	0.0	2.00	11.07	4.66
11.	Recommended spray thiamethoxam 25WG	1g/ 10L	28097	63777	64290	52055	3.36	3.79	3.77	3.64	14.19	27.61	27.13	23.45
12.	Untreated control	--	0	0	0	0	2.55	2.04	2.06	2.22	0.0	0.0	0.0	0.0

Cost of insecticides : for year 2012-13, 2013-14 and 2014-15

1.	Thiamethoxam 30 FS	Rs. 60/5g, Rs. 65/5g, Rs. 75/5g	4.	Chlorantraniliprole 18.5 SC	Rs. 600/60ml, Rs.750/60ml, Rs.840/60ml
2.	Clothianidin 50 WDG	Rs. 650/50g, Rs.700/50g, Rs.800/50g	5.	Thiamethoxam 25WG	Rs. 3200/kg, Rs.3400/kg, Rs.3800/kg
3.	Imidacloprid 48 FS	Rs. 60/5g, Rs. 65/5g, Rs. 75/5g		Price of wheat grains	Rs. 1900/q, Rs. 2100/q, Rs. 2200/q

was obtained in treatment with thiamethoxam 30 FS @ 1.00 ml/kg seed. However, it was at par with thiamethoxam 30 FS @ 0.75 ml/kg seed (53.03g) and imidacloprid 48 FS @ 1.00 ml/kg seed (52.99g).

Yield:

The data presented in Table 4 revealed that yield differences due to various insecticidal seed treatments were significant. Among the various insecticidal seed treatments thiamethoxam 30 FS @ 1.00 ml/kg seed recorded significantly highest yield of 55.26 q/ha. It was at par with imidacloprid 48 FS @ 1.00 ml/kg seed, clothianidin 50 WDG @ 1.50 g/kg seed, thiamethoxam 30 FS @ 0.75 ml/kg seed, clothianidin 50 WDG @ 1.00 g/kg seed and imidacloprid 48 FS @ 0.50 ml/kg seed which recorded 55.21, 53.32, 52.97, 52.78 and 50.59 q/ha grain yield, respectively. However, maximum yield of 59.99 q/ha was obtained in plot treated with thiamethoxam 25 WG @ 1g/10 liter of water as a recommended insecticidal spray treatment. The lowest (34.12 q/ha) yield was recorded in untreated control. The highest (64.22) per cent increased in yield over control was recorded in treatments with thiamethoxam 30 FS @ 1.00 ml/kg seed and imidacloprid 48 FS @ 1.00 ml/kg seed. It was followed by clothianidin 50 WDG @ 1.50 g/kg seed (58.62%), thiamethoxam 30 FS @ 0.75 ml/kg seed (57.37%) and clothianidin 50 WDG @ 1.00 g/kg seed (56.97%).

Economics:

The data in respect of economics on different treatments are presented in Table 5. Among the treatments with insecticidal seed treatment, the additional yield and income over control was highest (21.14 q/ha and Rs. 44480/ha) in thiamethoxam 30 FS @ 1.00 ml/kg seed. It was followed by imidacloprid 48 FS @ 1.00 ml/kg seed (21.09 q/ha and Rs. 44428/ha), clothianidin 50 WDG @ 1.50 g/kg seed (19.20 q/ha and Rs. 40562/ha), thiamethoxam 30 FS @ 0.75 ml/kg seed (18.86 q/ha and Rs. 39749/ha) and clothianidin 50 WDG @ 1.00 g/kg seed (18.66 q/ha and Rs. 39451/ha). The monetary returns and net profit over control were maximum in treatment with thiamethoxam 30 FS @ 1.00 ml/kg seed (Rs. 114607 and 81373/ha). It was followed by imidacloprid 48 FS @ 1.00 ml/kg seed (Rs.114554/-), clothianidin 50 WDG @ 1.50 g/kg seed (Rs.110689/-), thiamethoxam 30 FS @ 0.75 ml/kg seed (Rs.109876/-)

and clothianidin 50 WDG @ 1.00 g/kg seed (Rs.109577/-) for monetary returns whereas for net profit it was imidacloprid 48 FS @ 1.00 ml/kg seed (Rs.81287/-), thiamethoxam 30 FS @ 0.75 ml/kg seed (Rs.76975/-), clothianidin 50 WDG @ 1.50 g/kg seed (Rs.76638/-) and clothianidin 50 WDG @ 1.00 g/kg seed (Rs.76243/-). The maximum benefit cost ratio was found in thiamethoxam 30 FS @ 1.00 ml/kg seed (3.44). However, it was followed by imidacloprid 48 FS @ 1.00 ml/kg seed (3.43) and thiamethoxam 30 FS @ 0.75 ml/kg seed (3.33). The highest (42.22) ICBR was recorded in clothianidin 50 WDG @ 0.50 g/kg seed. It was followed by imidacloprid 48 FS @ 0.50 ml/kg seed (39.41), thiamethoxam 30 FS @ 0.50 ml/kg seed (38.81) and thiamethoxam 30 FS @ 0.75 ml/kg seed (36.86).

Our results are in accordance with the findings of (Macharia *et al.*, 1999) who reported significant efficacy of seed treatment of insecticides for the control of anoxia. (Ahmed *et al.*, 2010) also reported the effective impact of pesticide and seed dressing for the control of aphid. Similarly, Royer *et al.* (2005); Patil *et al.* (2003); Patil *et al*. (2009) and Sohail *et al.* (2014 a and b) found that seed dressing with Imidacloprid 48 per cent FS and Thiamethoxam 30 per cent FS decreased the population of sucking pests on wheat that are also supporting to our results.

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