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Phytotoxicity and their bio-efficacy of pesticides against key insect pests of *Rabi* sorghum [*Sorghum bicolor* (L.) Moench]

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Abstract
Totally 15 pesticides were evaluated consisting of 13 insecticides, 1 acaricide and 1 botonical, along with control at 3 dosages. The pesticides were applied at 20, 60 and 90 days after sowing. Observation on different phytotoxic symptoms was recorded based on visual score (1-10) later per cent phytotoxicity was calculated. Highest mean per cent phytotoxicity index was recorded in the profenophos @ 1.0, 2.0, 4.0 ml/litre treated plots (20.2, 44.1 and 56.1 PPI) at seedling, vegetative and reproductive stage of crop growth, followed by spiromesifen. Others such as malathion, methomyl, chlorphyriphos, cypermethrin, alphamethrin, imidacloprid produced the phytotoxic symptoms to a various level. Acephate, fipronil, carbofuran, phorate, chlorantraniliprole, emamectin benzoate and NSKE were found safe to sorghum. Among chemical pesticides evaluated, carbofuran and imidacloprid were found superior in reducing the shoot fly, where as acephate, fipronil, imidacloprid and NSKE were found superior in reducing the sucking pests.

Keywords: Phytotoxicity, bio-efficacy, pesticides, sorghum

1. Introduction

Sorghum [*Sorghum bicolor* (L.) Moench] is one of the important cereal crops of the world. Sorghum ranks fifth among the world cereals in the order of wheat, maize rice and barley (Anon., 2014) [1] It is the major source of food and fodder for millions of people and animals in tropics and semi-arid tropics (House, 1980) [2]. Karnataka is one of the leading states in sorghum cultivation after Maharashtra with an area of 18.91 lakh hectares and production of 12.38 lakh tonnes of grain (Parthasarathy Rao *et al.,* 2010) [3]. In the Karnataka state, sorghum is grown both in monsoon and post-monsoon seasons. The cultivation of sorghum is concentrated more in northern districts of Karnataka *viz.*, Vijayapur, Bagalkote, Kalaburgi, Dharwad, Gadag, Haveri, Raichur, Koppal and Bellary (Anon., 2014) [1].

The commonly recommended insecticide in sorghum was endosulfan against major pest *viz.,* shoot fly, shoot bug and aphids. As the endosulfan usage is banned in Karnataka, there are no alternative chemical insecticides available in the form of spray formulation against key pests of sorghum. Application of chemical pesticides has adverse effect by producing the various phytotoxic symptoms on sorghum, as the crop is very succulent and possess soft texture and highly sensitive to chemical insecticides (Ningaraj and Shekarappa, 2015) [4]. Thus, before recommending the pesticides based on efficacy there is an urgent need to know their phytotoxicity. Keeping this in view, to find alternate insecticide to endosulfan, the study was undertaken to assess the level of phytotoxicity of different pesticides in sorghum crop.

2. Material and Methods

The experiment was conducted at Regional Agricultural Research Station, Vijayapur. Crop was sown during September 2015-16 in a Randomized Block Design (RCBD) with 46 treatments and two replications, using M 35-1 variety of sorghum in a plot size of 3.15 x 4.0 m (7 rows of 4 m length) for each treatment. The crop was raised with a spacing of 45 x 15 cm by following all recommended package of practices of University of Agricultural Sciences, Dharwad (Anon., 2014) [5]except plant protection measures.

The pesticides were sprayed at an 20, 60 and 90 days after sowing by using manually hand operated knapsack sprayer. Sufficient care has been taken to avoid the drift hazard problem to adjacent rows (barrier creation). Observations on phytotoxic symptoms like chlorosis, white blotches and bronzing are recorded based on percentage leaf damage by visual score using the following scale (0-10) (Table I) as reported by Rajeswaran *et al.* (2004) [6]. And the phytotoxicity was assessed on low, medium and high based on mean percent plant damage (Table II). In the same plots the bio-efficacy of pesticides against insect pests of sorghum was evaluated by following the standard procedures individual insect pests separately, i.e., shoot fly (per cent dead hearts), shoot bug (damaging scale 0-9) and aphids (damaging scale 0-9, PAI).

Table I: Phytotoxicity scale using for determining the Per cent Phytotoxicity

Rating	Per cent Phytotoxicity (leaf injury)
0	**No phytotoxicity**
1	1-10
2	11-20
3	21-30
4	31-40
5	41-50
6	51-60
7	61-70
8	71-80
9	81-90
10	91-100

The per cent phytotoxicity index (PPI) was computed using the following formula,

$$\text{PPI (\%)} = \frac{\text{Sum of all numerical ratings}}{\text{Total no. of plants observed} \times \text{Max. Phytotoxicity rating}} \times 100$$

The observations were recorded at seedling, vegetative and reproductive stages of the crop growth of randomly selected 5 plants per treatment, at one, three, five, seven, nine, eleven and fifteen days after spraying of pesticides and following scale was used for assessing the phytotoxicity level.

Table II: Assesing the level of phytotoxicity (Based on PPI)

Sl.no	Per cent phytotoxicity index (PPI)	Level
1	0	Nil (N)
2	1-5	Low (L)
3	5-10	Medium (M)
4	>10	High (H)

Percent Aphid index (PAI)

For calculating per cent aphid index, the aphid population density was recorded on five randomly selected plants in each treatment. Six leaves in each plant from apex to downward excluding flag leaf as well as dried leaves at the bottom were observed for aphid colonies and rated using 0-9 scale (Mote and Kadam, 1983) [7].

Based on the scores (0-9 scale), the per cent aphid index (PAI) was worked out by the following formula generally used for computing per cent disease index (Balikai and Lingappa, 2004) [8].

$$\text{PAI} = \frac{\text{Sum of all numerical ratings}}{\text{Number of plants observed} \times \text{Number of leaves per plant} \times \text{Maximum rating}} \times 100$$

Shoot bug damage

Total number of plants in each treatment were recorded and number of plants showing yellowing, girdling and stunted growth were recorded at 95 days after emergence and percentage of plant damage was worked out. The data was subjected to arcsin transformations before statistical analysis and also rated using (0-9) scale.

3. Results and Discussion

Among the different pesticides tested at recommended dosage, malathion 50 EC (2 ml/litre), profenophos 50 EC (1 ml/litre), chlorpyriphos 20 EC (2.5 ml/litre), alphamethrin 10 EC (0.25 ml/litre), imidacloprid 17.8 SL (0.3 ml/litre) and spiromesifen 240 SC (2ml/litre) produced the per cent phytotoxicity index of 1.88, 20.2, 2.11, 1.61, 0.5 and 10.3, respectively. Other pesticides such as acephate 75 SP (1 g/litre), methomyl 40 SP (0.6 g/litre), cypermethrin 10EC (0.5 ml/litre), fipronil 5 SC (0.5 ml/litre), carbofuran 3G (30 kg/ha), phorate 10G (40 kg/ha), chlorantraniliprole 18.5 SC (0.15 ml/litre), emamectin benzoate 0.5 SG (0.2 g/litre) and NSKE 5% were found safe to the sorghum at recommended dosage (Table III).

At two times the recommended dosage, malathion 50 EC (4 ml/litre), profenophos 50 EC (2 ml/litre), methomyl 40 SP (1.2 g/litre), chlorpyriphos 20EC (5 ml/litre), alphamethrin 10EC (0.5 ml/litre), imidacloprid 17.8 SL (0.6 ml/litre) and spiromesifen 240 SC (4 ml/litre) produces the per cent phytotoxicity index of 3.55, 44.1, 1.58, 8.18, 3.27, 1.62 and 13.5, respectively. Other pesticides such as acephate 75 SP (2 g/litre), cypermethrin 10EC (1 ml/litre), fipronil 5 SC (1 ml/litre), carbofuran 3G (60 kg/ha), phorate 10G (80 kg/ha), chlorantraniliprole 18.5 SC (0.3 ml/litre), emamectin benzoate 0.5 SG (0.4 g/litre) and NSKE 10% were found safe to the sorghum at two times the recommended dosage (Table III).

Four times the recommended dosage, malathion 50 EC (8 ml/litre), profenophos 50 EC (4 ml/litre), methomyl 40 SP (2.4 g/litre), chlorpyriphos 20 EC (10 ml/litre), cypermethrin 10 EC (2 ml/litre), alphamethrin 10 EC (1 ml/litre), imidacloprid 17.8 SL (1.2 ml/litre) and spiromesifen 240 SC (8 ml/litre) produced the per cent phytotoxicity index of 6.35, 56.1, 3.38, 10.2, 3.38, 8.96, 1.14 and 16.7, respectively. Other pesticides such as acephate 75 SP (4 g/lire), fipronil 5 SC (2 ml/litre), carbofuran 3G (120 kg/ha), phorate 10G (160 kg/ha), chlorantraniliprole 18.5 SC (0.6 ml/litre), emamectin benzoate (0.8 g/litre) and NSKE 20 % were found safe to the sorghum at four times the recommended dosage (Table III).

Among the different chemicals tested the lowest per cent dead hearts due to shoot fly (7.9, 7.2, 7.1) at recommended, two times and four times the recommended dose at 45 days after sowing, were recorded in the carbofuran 3 G was superior in control over the other chemicals followed by imidacloprid 17.8 SL. Whereas highest per cent dead hearts were recorded in the control plot (27.6) at 45 days after sowing. Hence carbofuran 3G and imidacloprid 17.8 SL was promising and systemic insecticide for controlling the shoot fly and it was non phytotoxic (safe) to sorghum crop (Table IV).

Acephate 75 SP, fipronil 5 SC, imidacloprid 17.8 SL and NSKE were found superior in reducing the shoot bug and aphid infestation. Whereas highest insect damage was recorded in the treatments such as control, spiromesifen, carbofuran were found to be on far with each other. Acephate 75 SP, fipronil 5 SC and NSKE were new and systemic insecticides, safe (non phytotoxic) and promising insecticides for shoot bug and aphid management at recommended, two and four times higher doses also (Table IV).

Yield parameters are inversely correlated with the phytotoxicity of pesticides. The lowest yield was recorded in the spiromesifen 240 SC (21.0, 19.6, 17.86 q/ha) at recommended, two and four times the recommended dose treatments, respectively and was followed by profenophos 50

EC (21.4, 21.0, 18.1) at recommended, two and four times the recommended dose. The highest yield was recorded in the fipronil 5 SC (29.2, 29.5, 29.8 q/ha) at recommended, two and four times the recommended dose followed by NSKE treated plots. Among the different chemicals tested for phytotoxicity, the spiromesifen 240 SC recorded the highest per cent phytotoxicity index at the seedling stage. It will leads to the reduction in the chlorophyll content of the plant, and hence yield will be reduced. The profenophos 50 EC produced the phytotoxic symptoms (bronzing) and white blotches at all stages of the crop growth resulting reduction in the chlorophyll content and hence the yield will automatically reduce. Hence the phytotoxicity of pesticides is inversely related with grain yield of sorghum (Table V).

The present results are agreement with findings of Ningaraj and Shekarappa (2015) [4] reported that six chemical insecticides *viz.*, lambda cyhalothrin 5 EC (0.5 ml/l), alphamethrin 10 EC (0.5 ml/l), fenvalerate 20 EC (0.5 ml/l), quinalphos 25 EC (2 ml/l), dimethoate 30 EC (1.7 ml/l) and malathion 50 EC (2 ml/l) exhibited phytotoxicity symptoms like white blotch and bronzing at various levels in *kharif* sorghum. Similarly Balikai and Lingappa (2003) [9] also reported that application of dimethoate caused phytotoxicity to sorghum leaves.

There is a scanty work on bio-efficacy of insecticides against insects pests in sorghum. However, the present results are closely related with the findings of Shrinivas 2006 [10]., who reported that NSKE 5 per cent spray recorded 0.40 eggs of sorghum shoot fly per plant and significantly superior over other botanicals but carbofuran 3G (30 kg/ha) was on par with NSKE 5 per cent by recording 0.53 eggs per plant.

Kumar and Prabhuraj (2007) [11] reported that seed treatment with thiamethoxam 70 WS at 2 g/kg recorded lower infestation of dead hearts (7.9%) with less shoot bug population (5.83/5 plant), and higher grain yield (31.93 q/ha); Besides higher fodder yield (56.92 q/ha), imidacloprid 70 WS at 5 g per ha, endosulfan 35 EC seed soaking (8 hrs) at 2 ml per 1 kg and carbosulfan 25 DAS at 40 g per kg were the next best treatments.

The perusal of literature revealed that there is scanty work on effect of phytotoxicity of yield of sorghum. However, the present findings can be compared with the reports of Meisch *et al*. (1970) [12] who reported that parathion and methyl parathion (0.5 and 1.0 a.i/acre) caused greatest visual leaf damage and resulted in significant yield losses when applied to TE77 variety of sorghum. Methyl parathion (1.0 ai/acre) also reduced yields of RS 626 variety of sorghum. Mishra *et al*. (2014) [13] reported that, profenophos 50 EC (curacron) 0.02, 0.05, 0.08, 0.1 and 0.2 per cent, all morphological traits and pigments were significantly reduced with increase in pesticide concentration in the *Vigna radiata.* Similarly, Freeman (1978) [14] reported that, combination of herbicide eradicance and fonofos insecticide caused 29 per cent malformation of ear heads in maize. The injury ranged from slight to severe curvature of the ear together with shortening and twisting of the husk.

Table III: Evaluation of pesticides for their phytotoxic studies in sorghum (mean of all 3 sprays)

Pesticides	Per cent phytotoxicity index (PPI)														
	Dosage (g/ml/litre/ha)			Seedling stage			Vegetative stage			Reproductive stage			Mean of all stages		
	X	2X	4X	X	2X	4X	X	2X	4X	X	2X	4X	X	2X	4X
Acephate 75 SP	1.0	2.0	4.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Malathion 50 EC	2.0	4.0	8.0	3.66	5.66	10.3	2.00	5.00	6.00	0.00	0.00	2.75	1.88	3.55	6.35
Profenophos 50 EC	1.0	2.0	4.0	8.76	14.8	35.0	9.66	52.0	64.8	42.3	65.6	68.6	20.2	44.1	56.1
Methomyl 40 SP	0.6	1.2	2.4	0.00	3.00	5.90	0.00	1.75	2.75	0.00	0.00	1.50	0.00	1.58	3.38
Chlorpyriphos 20EC	2.5	5.0	10.0	3.00	12.8	18.6	2.33	10.0	10.0	1.00	1.75	2.25	2.11	8.18	10.2
Cypermethrin 10EC	0.5	1.0	2.0	0.00	0.00	4.83	0.00	0.00	3.33	0.00	0.00	2.00	0.00	0.00	3.38
Alphamethrin 10EC	0.25	0.5	1.0	2.33	4.58	13.0	1.50	4.00	9.30	1.00	1.25	4.60	1.61	3.27	8.96
Fipronil 5 SC	0.5	1.0	2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carbofuran 3G	30	60	120	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phorate 10G	40	80	160	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Imidacloprid 17.8 SL	0.3	0.6	1.2	1.50	2.33	3.40	0.00	1.50	3.33	0.00	1.00	2.40	0.50	1.62	1.14
Chlorantrailiprole18.5SC	0.15	0.3	0.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E.benzoate 0.5 SG	0.2	0.4	0.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spiromesifen 240 SC	2.0	4.0	8.0	21.6	29.2	36.0	9.33	11.5	14.1	0.00	0.00	0.00	10.3	13.5	16.7
NSKE (%)	5.0	10.0	20.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Control (water spray)	-	-	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

X= recommended dose, 2X= two times the recommended, 4X= four times the recommended dose

Table IV: Bio-efficacy of pesticides on shoot fly (*Atherigona soccata*), shoot bug *Peregrinus maidis* and aphid *Melanaphis*

Sl. no	Pesticides	Shoot fly (per cent dead hearts)			Shoot bug damage			Percent aphid index			Phytotoxicity level		
		40 DAS			95 DAS			95 DAS					
		X	2X	4X	X	2X	4X	X	2X	4X	X	2X	4X
1	Acephate 75 SP	16.4 (23.8)^{b}	15.07 (22.7)^{b}	13.85 (21.8)^{b}	1.96 (7.8)^{g}	1.35 (6.6)^{g}	1.31 (6.2)^{f}	0.95 (5.6)$^{b-d}$	0.76 (4.7)$^{c-f}$	0.67 (4.7)$^{c-e}$	N	N	N
2	Malathion 50 EC	12.9 (21.0)^{bc}	12.2 (20.4)^{b}	11.9 (20.0)^{b}	5.85 (13.8)^{e}	3.85 (11.2)$^{c-f}$	2.98 (9.7)$^{c-f}$	2.06 (8.2)$^{a-d}$	2.01 (8.0)^{bc}	1.47 (7.0)^{bc}	L	L	M
3	Profenophos 50 EC	16.2 (23.7)^{b}	13.22 (21.2)^{b}	11.85 (20.1)^{b}	4.15 (11.7)^{f}	3.35 (10.4)$^{d-g}$	2.49 (9.0)$^{d-f}$	2.69 (9.2)^{ab}	0.39 (3.5)^{ef}	0.38 (3.5)^{e}	H	H	H
4	Methomyl 40 SP	15.85 (23.4)^{b}	14.2 (22.1)^{b}	12.1 (20.1)^{b}	10.57 (18.7)^{c}	8.67 (17.1)^{b}	7.69 (16.0)^{bc}	2.15 (7.8)$^{b-d}$	0.53 (4.1)^{ef}	0.39 (3.5)^{e}	N	L	L

5	Chlorphyriphos 20 EC	13.8 (21.7)^{bc}	13.45 (21.4)^{b}	12.35 (20.4)^{b}	5.67 (13.8)^{e}	3.25 (9.9)$^{e-g}$	3.23 (10.0)$^{c-f}$	0.61 (4.5)^{cd}	0.59 (4.4)$^{d-f}$	0.55 (4.2)^{de}	L	M	H
6	Cypermethrin 10 EC	13.95 (21.7)^{bc}	12.32 (20.5)^{b}	11.9 (20.1)^{b}	6.35 (14.4)^{de}	6.07 (14.1)$^{b-d}$	5.98 (14.1)$^{c-e}$	1.07 (5.9)$^{b-d}$	1.20 (6.3)$^{b-e}$	0.99 (5.5)$^{b-e}$	N	N	L
7	Alphamethrin 10 EC	14.5 (22.3)^{bc}	13.85 (21.8)^{b}	10.7 (19.0)^{b}	7.32 (15.6)^{de}	6.32 (14.5)$^{b-d}$	5.25 (13.1)$^{c-e}$	2.32 (8.88)$^{a-c}$	1.90 (7.9)$^{b-d}$	1.1 (6.0)$^{b-d}$	L	L	M
8	Fipronil 5% SC	9.99 (18.4)^{bc}	9.55 (18.0)^{b}	9.2 (17.6)^{b}	4.07 (11.5)^{f}	2.05 (7.9)^{fg}	2.05 (8.0)$^{d-f}$	0.52 (4.2)^{d}	0.20 (2.6)^{f}	0 (0.0)^{f}	N	N	N
9	Carbofuran 3 G	7.9 (16.1)^{c}	7.2 (15.5)^{b}	7.1 (15.3)^{b}	15.35 (23.0)^{b}	14.45 (22.1)^{a}	13.40 (21.4)^{ab}	2.08 (8.3)$^{a-d}$	2.02 (8.0)^{bc}	1.7 (7.5)^{b}	N	N	N
10	Phorate 10 G	11.2 (19.5)^{bc}	11.2 (19.5)^{b}	10.75 (19.1)^{b}	6.7 (14.8)^{de}	6.6 (14.7)^{bc}	4.15 (11.7)$^{c-f}$	2.32 (8.8)$^{a-c}$	2.25 (8.6)^{b}	1.75 (7.6)^{b}	N	N	N
11	Imidacloprid 17.8 SL	10.55 (18.9)^{bc}	10.20 (18.5)^{b}	9.55 (18.0)^{b}	3.87 (11.3)^{f}	2.91 (9.8)$^{e-g}$	1.97 (8.1)$^{d-f}$	0.65 (4.3)^{d}	0.55 (4.0)^{ef}	0.375 (3.4)^{e}	L	L	L
12	Chlorantraniliprole18.5 SC	15.35 (22.9)^{bc}	13.85 (21.7)^{b}	12.5 (20.6)^{b}	6.6 (14.8)^{de}	4.75 (12.5)$^{c-e}$	4.25 (11.9)$^{c-f}$	1.25 (6.2)$^{b-d}$	1.15 (6.1)$^{b-f}$	1.14 (6.1)$^{b-d}$	N	N	N
13	E. benzoate 0.5 SG	15.35 (23.04)^{bc}	14.1 (21.87)^{b}	11.8 (20.08)^{b}	8.05 (16.38)^{d}	4.55 (12.22)$^{c-e}$	4.05 (11.36)$^{c-f}$	3.0 (9.86)^{ab}	1.89 (7.88)$^{b-d}$	1.4 (6.78)^{bc}	N	N	N
14	Spiromesifen 240 SC	15 (22.72)^{bc}	14.8 (22.60)^{b}	14.35 (22.24)^{b}	16.15 (23.65)^{ab}	14.3 (22.07)^{a}	6.15 (14.22)^{cd}	1.8 (7.60)$^{b-d}$	1.45 (6.79)$^{b-e}$	1.15 (6.08)$^{b-d}$	H	H	H
15	NSKE	10.3 (18.66)^{bc}	10.24 (18.56)^{b}	9.85 (18.10)^{b}	2.95 (9.73)^{f}	1.97 (7.87)^{fg}	1.95 (7.60)^{ef}	1.22 (6.34)$^{b-d}$	0.95 (5.43)$^{b-f}$	0.695 (4.76)$^{c-e}$	N	N	N
16	Control	27.6 (31.66)^{a}	27.6 (31.66)^{a}	27.6 (31.66)^{a}	18.3 (25.17)^{a}	18.3 (25.17)^{a}	18.30 (25.17)^{a}	4.62 (12.39)^{a}	4.62 (12.39)^{a}	4.62 (12.39)^{a}	N	N	N
	SEm±	2.09	2.10	2.06	0.61	1.24	1.89	1.27	1.03	0.71			
	C.D. (P= 0.05)	6.29	6.34	6.20	1.85	3.75	5.71	3.83	3.10	2.13			
	CV (%)	13.51	14.07	14.36	5.65	12.90	21.70	23.72	23.09	18			

Figures in the parentheses are arcsine transformations, DAS - days after sowing, L=Low, M=Medium, H=High, N=Nil

Table V: Effect of phytotoxicity of different pesticides on grain yield of sorghum

Sl.no	**Pesticides**	**Grain yield (q/ha)**			**percent phytotoxicity (Mean of all stages)**			**Phytotoxicity level**		
		X	**2X**	**4X**	**X**	**2X**	**4X**	**X**	**2X**	**4X**
1	Acephate 75 SP	25.6^{a-e}	27.8^{ab}	27.8^{ab}	0.00	0.00	0.00	N	N	N
2	Malathion 50 EC	26.2^{a-d}	24.8^{a-e}	20.6^{de}	1.88	3.55	6.35	L	L	M
3	Profenophos 50 EC	21.4^{c-e}	21.0^{ef}	18.1^{e}	20.2	44.1	56.1	H	H	H
4	Methomyl 40 SP	23.4^{b-e}	22.2^{c-f}	20.7^{de}	0.00	1.58	3.38	N	L	L
5	Chlorphyriphos 20EC	24.4^{a-e}	23.6^{b-f}	21.4^{c-e}	2.11	8.18	10.2	L	M	H
6	Cypermethrin 10 EC	25.6^{a-e}	21.9^{d-f}	21.0^{de}	0.00	0.00	3.38	N	N	L
7	Alphamethrin 10 EC	24.0^{a-e}	23.7^{b-f}	22.3^{b-e}	1.61	3.27	8.96	L	L	M
8	Fipronil 5% SC	29.2^{a}	29.5^{a}	29.8^{a}	0.00	0.00	0.00	N	N	N
9	Carbofuron 3G	26.4^{a-c}	27.0^{a-c}	27.2^{ab}	0.00	0.00	0.00	N	N	N
10	Phorate 10G	26.2^{a-d}	26.4^{a-d}	26.9^{a-c}	0.00	0.00	0.00	N	N	N
11	Imidacloprid 17.8 SL	27.0^{ab}	24.1^{b-f}	21.4^{c-e}	0.50	1.62	1.14	L	L	L
12	Chlorantraniliprole18.5 SC	25.9^{a-e}	26.1^{a-d}	27.7^{ab}	0.00	0.00	0.00	N	N	N
13	E. benzoate 0.5 SG	24.05^{a-e}	24.2^{b-f}	24.4^{a-d}	0.00	0.00	0.00	N	N	N
14	Spiromesifen 240 SC	21.00^{de}	19.6^{f}	17.86^{e}	10.3	13.5	16.7	H	H	H
15	NSKE	29.13^{a}	29.5^{a}	29.08^{a}	0.00	0.00	0.00	N	N	N
16	Control	20.72^{e}	20.72^{ef}	20.72^{de}	0.00	0.00	0.00	N	N	N
	SEm±	1.53	1.43	1.70						
	C.D. (P= 0.05)	4.61	4.31	5.11						
	CV (%)	8.65	8.24	10.19						

X= Recomended dose; 2X= 2 times the recommended dose; 4X=4 times the recommended dose
L= Low; M=Medium; H=High; N=Nil

4. Conclusion

Among the different chemicals tested, malathion 50 EC, profenophos 50 EC, methomyl 40 SP, chlorphyriphos 20 EC, cypermethrin 10 EC, alphamethrin 10 EC, imidacloprid 17.8 SL and spiromesifen 240 SC produces the different phytotoxic symptoms like chlorosis, white blotches, and bronzing to a various extent. The pesticides such as acephate 75 SP, fipronil 5 SC, carbofuran 3 G, phorate 10 G, chlorantraniliprole 18.5 SC, emamectin benzoate 0.5 SG, and NSKE did not exhibit any type of phytotoxic symptoms at recommended, two times the recommended and four times the recommended dosage and found safe to the sorghum. Acephate, fipronil, NSKE and imidacloprid were found effective against the sucking insect pests of sorghum.

5. References

1. www.millets research.com
2. House LR. A Guide to Sorghum Breeding. International Crop Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh, India. 1980, 238.

3. Parthasarathy Rao P, Basavaraj G, Ahmad W, Bhagavatula S. An analysis of availability and utilization of sorghum grain in India. J. Stat. Agric. Res., 2010; 8:1-8.
4. Ningaraj, Shekarappa. Studies on the phytotoxicity of botanicals and chemical insecticides in kharif sorghum. Karnataka J Agric. Sci. 2015; 28(1):110-111.
5. Anonymous. Package of practices for field crops, University of Agricultural Sciences, Dharwad, 2014.
6. Rajeswaran J, Santharam G, Chandrasekran S. Studies on compatibility and phytotoxocity of carbosulfan 25 EC with certain agrochemicals on cotton. J Ent. Res. 2004; 28(3):247-252.
7. Mote UN, Kadam JR. Evaluation of some sorghums for corn leaf aphid resistance. Sorghum Newsltr, 1983; 26:74.
8. Balikai RA, Lingappa S. Loss estimation due to yellow sugarcane aphid, Melanaphis sacchari (Zehntner) on rabi season. Indian J Ent. 2004; 66(2):159-164.
9. Balikai RA, Lingappa S. Effect of insecticides on aphid predators and sorghum plants. Ann. Pl. Protec. Sci., 2003; 11(2):371-373.
10. Shrinivas M. Evaluation of Eco friendly techniques for the management of sorghum shoot fly, Atherigona soccata Rondani. M.Sc. (Agri.) Thesis, Uni. Agric. Sci., Dharwad (India), 2006.
11. Kumar LV, Prabhuraj A. Bio-efficacy of chemicals for seed treatment against sorghum shoot fly, Atherigona soccata and shoot bug, Peregrinus maidis. Ann. Plant Prot. Sci. 2007; 15(2):312-315.
12. Meisch MV, Teetes GL, Randolph NM, Bockholt AJ. Phytotoxic effects of insecticides on six varieties of grain sorghum. J Econ. Ent. 1970; 63:1516-1517.
13. Mishra IP, Sabat G, Mohanty BK. Phytotoxocity of profenophos 50% EC to Vigna radiata L. seedlings: I. Studies on morphology and pigments. International journal of advanced biological research. 2014; 4(3):265-270.
14. Freeman JA. Evidence of a phytotoxic interaction between the herbicide eradicane and the insecticide fonofos in sweet corn. Can. J Plant Sci. 1978; 58:1119-1121.