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Phytotoxicity of newer insecticides in spray formulations and their effect on natural enemies

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Abstract

Studies on the evaluation of phytotoxicity of insecticides in spray formulations on sorghum were conducted during 2014-15 at Main Agriculture Research Station, Dharwad. Results of the investigation revealed that the applications of insecticides viz., rynaxypyr 20 SC (0.3 ml/l), fipronil 5 SC (1 ml/l), imidacloprid 17.8 SL (0.3 ml/l), acetamiprid 20 SP (0.2 g/l) and carbofuran 3G (30 kg/ha) found safe as they did not show any of the phytotoxic symptoms like chlorosis, white blotch and bronzing on the leaf surface up to four times the recommended dosage. At four times recommended dosage cypermethrin 10EC (2ml/l) showed phytotoxicity by registered symptoms like chlorosis and white blotches.

Keywords: Phytotoxicity, newer insecticides

Introduction

Sorghum is a unique crop among the major cereals and the staple food and fodder crop of the world's poor and most food-insecure populations located primarily in the semi-arid tropics. It is one of the major cereal crops consumed in India after rice and wheat. India is the first largest producer of sorghum in the world followed by Mexico and Nigeria. It is grown over an area of 6.32 million hectares in India with an annual production of 6.03 mt and productivity 954 kg/ha. In Karnataka 13.63 lakh ha area is under sorghum cultivation of which *kharif* area is 2.46 lakh ha and *rabi* area is 11.17 lakh ha with a productivity of 1119 kg/ha and 1070 kg/ha in *kharif* and *rabi* respectively (Anon., 2014) ^[1]. In India the crop is primarily cultivated in Maharashtra, Andhra Pradesh and Karnataka, which together accounts for 80 Percent of India's production (Parthasarathy Rao *et al.*, 2010) ^[2]. In Karnataka, sorghum is mainly grown in Belgaum, Vijayapur, Bagalkot, Dharwad, Haveri and Gadag districts both in *kharif* and *rabi* seasons. India is the first largest producer of sorghum in the world followed by Mexico and Nigeria. Karnataka is the second largest sorghum producer in India after Maharashtra. It is the most important crop of Karnataka in terms of area accounting for about 36 Percent of the total area under food crops.

The productivity levels under subsistence farming conditions are quite low (500–800 kg/ha) mainly because of biotic and abiotic constraints. Sorghum is cultivated under diverse agro-ecosystem and grain yield is influenced by various biotic and abiotic factors which constitutes a major constraint for its production. The crop is vulnerable to over 150 insect species right from sowing till harvest (Jotwani *et al.*, 1980 and Sharma, 1985) ^[3, 4]. Because of infestation by sorghum pests, the grain and fodder yields are greatly reduced. Good crop cannot be harvested without the use of insecticides. It is reported that the phosphate insecticides, e.g. fenitrothion, monocrotophos and trichlorfon have caused phytotoxicity to sorghum in Australia. So it is necessary to know the bioefficacy of insecticides against shoot fly and simultaneously to assess the level of phytotoxicity to sorghum crop. The earlier recommendation of endosulfan is banned and hence there is an urgent need to find out an alternative to endosulfan.

Materials and Methods

The experiment was laid out in RBD with 24 treatments in three replications, along with untreated control and standard check. Plot size was of 2.7 X 1.8 m² leaving gangway of 1 m all around the plots. The sorghum cultivar DSV- 4 was sown with the spacing of 45 x 15 cm² during *rabi* i.e. mid October of 2014. Spraying was done at 12, 18 and 24 DAE (Days After Emergence), with three total numbers of sprays during the course of phytotoxicity assessment. All the recommended package of practices were followed except plant protection.

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Newer insecticides like rynaxypyr 20 SC (0.3 ml/l), fipronil 5 SC (1 ml/l), cypermethrin 10 EC (0.5 ml/l), imidacloprid 17.8 SL (0.3 ml/l) and acetamiprid 20 SP (0.2 g/l) were sprayed at recommended, two times the recommended, three times the recommended and four times the recommended dosages.

Percent phytotoxicity index (PPI)

The phytotoxicity scale was used to score phytotoxic symptoms. The data were subjected to analysis on Percent phytotoxicity index (PPI) and Percent recovery at three DAS (Days after spray) and five DAS by using the formulae given hereunder.

The PPI was calculated by,

$$PPI = \frac{\text{Sum of numerical ratings}}{\text{Total no. of plants observed} \times \text{Max. phytotoxicity rating}} \times 100$$

No. of plants = 5

Total score = 10

The Percent recovery was calculated by,

$$\text{Percent recovery at 3 DAS} = 100 \frac{100 \times 3 \text{ DAS (PPI)}}{1 \text{ DAS (PPI)}}$$

$$\text{Percent recovery at 5 DAS} = 100 \frac{100 \times 3 \text{ DAS (PPI)}}{1 \text{ DAS (PPI)}}$$

At 14, 21 and 28 DAE observation was taken in the field for natural enemy population.

Phytotoxicity scale

Scale	Percent phytotoxicity
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

Results and Discussion

The studies on phytotoxicity of various insecticides after first spray on sorghum revealed that the applications of insecticides viz., rynaxypyr 20 SC (0.3 ml/l), fipronil 5 SC (1 ml/l), imidacloprid 17.8 SL (0.3 ml/l), acetamiprid 20 SP (0.2 g/l) and carbofuran 3G (30 kg/ha) found safe as they did not show any of the phytotoxicity symptoms like chlorosis, white blotch and bronzing on the leaf surface up to four times the recommended dosage (Table 1). Among different chemicals cypermethrin 10 EC (2 ml/l) treated plots produced the symptoms like, chlorosis and white blotch at four times higher the recommended dosage. The PPI with respect to chlorosis was 3, 3 and 1.5 after one, three and five days after spray, respectively with 0 and 50 Percent recovery of plants at three and five days after spray and the Percent white blotch index was 10, 10 and 10 after one, three and five days after spray, respectively. The Percent recovery of plants was 0 at both three and five days after spray, respectively (Table 1).

Similarly data depicted in Table 2, with respect to phytotoxicity of different insecticides on sorghum after the second spray revealed that the spraying up to four times the recommended dosage did not produce any of the phytotoxicity symptoms like chlorosis, white blotch and bronzing on the leaf surface. The insecticides viz., rynaxypyr 20 SC (0.3 ml/l), fipronil 5 SC (1 ml/l), imidacloprid 17.8 SL (0.3 ml/l), acetamiprid 20 SP (0.2 g/l) and carbofuran 3G (30 kg/ha) which were found safe to sorghum. Application of cypermethrin 10 EC (2 ml/l) at the four times higher the

recommended dosage produced the symptoms like, chlorosis and white blotch. The PPI with respect to chlorosis was 4.2, 4.2 and 2.1 after one, three and five days after spray, respectively with 0 and 50 Percent recovery of plants at three and five days after spray and the Percent white blotch index was 10, 10 and 10 after one, three and five days after spray, respectively. The Percent recovery of plants was 0 at both three and five days after spray, respectively (Table 2).

After third spray application of cypermethrin 10 EC (2 ml/l) at the four times higher the recommended dosage produced the symptoms like, chlorosis and white blotch. The PPI with respect to chlorosis was 8, 8 and 4 after one, three and five days after spray, respectively with 0 and 50 Percent recovery of plants at three and five days after spray and the Percent white blotch index was 12.80, 12.80 and 12.80 after one, three and five days after spray, respectively. The Percent recovery of plants was 0 at both three and five days after spray, respectively (Table 3). All other insecticides viz., rynaxypyr 20 SC (0.3 ml/l), fipronil 5 SC (1 ml/l), imidacloprid 17.8 SL (0.3 ml/l), acetamiprid 20 SP (0.2 g/l) and carbofuran 3G (30 kg/ha) which were found safe to sorghum plants up to four times higher the recommended dosage (Table 3).

These results are in agreement with Ningaraj (2013) who reported that spraying of cypermethrin 10 EC (2 ml/l) exhibited phytotoxic symptoms like chlorosis and white blotch, where as acetamiprid 20 SP (0.8 g/l) was found safe to sorghum plants even up to four times higher the recommended dosages.

Table 1: Evaluation of insecticides for their phytotoxic studies in sorghum after first spray (12 days after emergence)

Sl. No.	Insecticides	Chlorosis			Percent recovery		White blotch			Percent recovery		Bronzing			Percent recovery	
		% phytotoxicity index					% phytotoxicity index					% phytotoxicity index				
		1 DAS	3 DAS	5 DAS	3 DAS	5 DAS	1 DAS	3 DAS	5 DAS	3 DAS	5 DAS	1 DAS	3 DAS	5 DAS	3 DAS	5 DAS
1	Rynaxypyr 20 SC (0.3 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	Rynaxypyr 20 SC (0.6 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Rynaxypyr 20 SC (0.9 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	Rynaxypyr 20 SC (1.2 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	Fipronil 5 SC (1 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	Fipronil 5 SC (2 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	Fipronil 5 SC (3 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	Fipronil 5 SC (4 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	Cypermethrin 10 EC (0.5 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	Cypermethrin 10 EC (1 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	Cypermethrin 10 EC (1.5 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	Cypermethrin 10 EC (2 ml/l)	3.00	3.00	1.50	0.00	50.00	10.00	10.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	Imidacloprid 17.8 SL (0.3 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	Imidacloprid 17.8 SL (0.6 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	Imidacloprid 17.8 SL (0.9 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	Imidacloprid 17.8 SL (1.2 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	Acetamiprid 20 SP (0.2 g/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	Acetamiprid 20 SP (0.4 g/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	Acetamiprid 20 SP (0.6 g/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	Acetamiprid 20 SP (0.8 g/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	Carbofuran 3G (30 kg/ha)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	Untreated control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

*DAS – Days after Spray

Table 2: Evaluation of insecticides for their phytotoxic studies in sorghum after second spray (18 days after emergence)

Sl. No.	Insecticides	Chlorosis			Percent recovery		White blotch			Percent recovery		Bronzing			Percent recovery	
		% phytotoxicity index					% phytotoxicity index					% phytotoxicity index				
		1 DAS	3 DAS	5 DAS	3 DAS	5 DAS	1 DAS	3 DAS	5 DAS	3 DAS	5 DAS	1 DAS	3 DAS	5 DAS	3 DAS	5 DAS
1	Rynaxypyr 20 SC (0.3 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	Rynaxypyr 20 SC (0.6 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Rynaxypyr 20 SC (0.9 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	Rynaxypyr 20 SC (1.2 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	Fipronil 5 SC (1 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	Fipronil 5 SC (2 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	Fipronil 5 SC (3 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	Fipronil 5 SC (4 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	Cypermethrin 10 EC (0.5 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	Cypermethrin 10 EC (1 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	Cypermethrin 10 EC (1.5 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

12	Cypermethrin 10 EC (2 ml/l)	4.20	4.20	2.10	0.00	50.00	11.25	11.25	11.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	Imidacloprid 17.8 SL (0.3 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	Imidacloprid 17.8 SL (0.6 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	Imidacloprid 17.8 SL (0.9 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	Imidacloprid 17.8 SL (1.2 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	Acetamiprid 20 SP (0.2 g/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	Acetamiprid 20 SP (0.4 g/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	Acetamiprid 20 SP (0.6 g/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	Acetamiprid 20 SP (0.8 g/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	Carbofuran 3G (30 kg/ha)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	Untreated control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

*DAS – Days after Spray

Table 3: Evaluation of insecticides for their phytotoxic studies in sorghum after third spray (24 days after emergence)

Sl. No.	Insecticides	Chlorosis			Percent recovery		White blotch			Percent recovery		Bronzing			Percent recovery	
		% phytotoxicity index					% phytotoxicity index					% phytotoxicity index				
		1 DAS	3 DAS	5 DAS	3 DAS	5 DAS	1 DAS	3 DAS	5 DAS	3 DAS	5 DAS	1 DAS	3 DAS	5 DAS	3 DAS	5 DAS
1	Rynaxypyr 20 SC (0.3 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	Rynaxypyr 20 SC (0.6 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Rynaxypyr 20 SC (0.9 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	Rynaxypyr 20 SC (1.2 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	Fipronil 5 SC (1 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	Fipronil 5 SC (2 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	Fipronil 5 SC (3 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	Fipronil 5 SC (4 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	Cypermethrin 10 EC (0.5 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	Cypermethrin 10 EC (1 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	Cypermethrin 10 EC (1.5 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	Cypermethrin 10 EC (2 ml/l)	8.00	8.00	4.00	0.00	50.00	12.80	12.80	12.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	Imidacloprid 17.8 SL (0.3 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	Imidacloprid 17.8 SL (0.6 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	Imidacloprid 17.8 SL (0.9 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	Imidacloprid 17.8 SL (1.2 ml/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	Acetamiprid 20 SP (0.2 g/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	Acetamiprid 20 SP (0.4 g/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	Acetamiprid 20 SP (0.6 g/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	Acetamiprid 20 SP (0.8 g/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	Carbofuran 3G (30 kg/ha)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	Untreated control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

*DAS – Days after Spray



Chlorosis



White blotch

Natural enemies

At 14, 21 and 28 days after emergence (DAE) the observations were made on predators *viz.*, coccinellids and chrysoperla, which clearly indicated that there was no population of the same, except in untreated control and soil application of carbofuran 3G (30 kg/ha). The perusal of literature revealed that these studies neither can be compared nor discussed, hence such study is wanting.

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