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Effect of different doses of insecticides on germination percentage of sorghum seeds in pot culture method

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Abstract
Investigations on insecticidal approaches for the management of shoot fly *Atherigona soccata* Rondani with reference to management through seed dressers was carried out, simultaneously the phytotoxicity and bioefficacy of insecticides on sorghum crop carried out during *Rabi* 2014 at the Main Agricultural Research Station, Dharwad. The commonly recommended insecticide in sorghum is endosulfan against insect pests of sorghum. Application of chemical insecticides has adverse effect by producing the various phytotoxic symptoms on sorghum as the crop is very succulent and possessing soft texture and highly sensitive to chemical insecticides. It is also inevitable to know the bioefficacy of insecticides against shoot fly and simultaneously to assess level of phytotoxicity to the sorghum crop. Hence, the study was undertaken on bioefficacy of insecticides. Among all the tested insecticides chlorpyriphos 20 EC at 5 ml/kg recorded highest germination (86%) followed by 84 per cent germination in case of imidacloprid 70 WS (5 g/kg).

Keywords: Seed treatment, pot experiment, bioefficacy of insecticides

Introduction
Sorghum is an important crop in Asia, Africa, USA, Australia, and Latin America. Sorghum ranks fourth among the world cereals in the order of wheat, maize and rice. Sorghum grains are important as food and as livestock feed. The stem and foliage are used as green fodder, hay, silage and pasture. The stems are also used as fuel and building material. Sorghum is used in preparation of different types of food and unleavened bread is the most common food made from the sorghum flour. The dough is sometimes fermented before the bread is prepared and the grains are boiled to make the porridge or gruel. Sorghum is also used in the preparation of biscuits and beer in many parts of Africa.

Sorghum 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 per ha with a productivity of 1119 kg/ha and 1070 kg/ha in *kharif* and *rabi* respectively (Anon., 2014)[1]. 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. In India the crop is primarily cultivated in Maharashtra, Andhra Pradesh and Karnataka, which together accounts for 80 per cent 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. 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 per cent 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. Among 150 species of insect pests of sorghum crop, sorghum shoot fly (*Atherigona soccata* Rondani) is most important pest in Asia, Africa, and the Mediterranean Europe. About 32 per cent of the crop is lost due to insect pests in India (Board and Mittal, 1983) [3] of which 5 per cent of the loss have been attributed to sorghum shoot fly (Jotwani, 1983) [4]. In India, shoot fly has attained the status of a principal pest mainly because of its

high fecundity and shorter generation time resulted in rapid population build up. Sorghum shoot fly (*Atherigona soccata* Rondani) is an important seedling pest attacks sorghum crop up to 30 days from sowing. Though, Fletcher (1914) [5] reported for the first time incidence of shoot fly on sorghum in South India, keen observations were made by Ballard and Ramachandra Rao (1924) [6], who described some aspects on the behaviour and biology. In 1970's the shoot fly assumed the status of major pest with the introduction of high yielding cultivars of sorghum. The present recommendation for shoot fly is soil application of carbofuran 3G which is not remunerative to farmers which is costly. The earlier recommendation of endosulfan is banned and hence there is an urgent need to find out alternative to endosulfan. It is also inevitable to know the critical stages of the crop for application of chemicals to manage shoot fly effectively as the life cycle of shoot fly is very short.

Materials and Methods

Pot experiment was conducted at All India Coordinated Sorghum Improvement Project, Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during 2014. The experiment was laid out in completely randomized block design. Each pot was filled with compost rich soil. After proper filling of pots watering was done with rose-can. 100 g seeds of variety DSV-4 were treated with seven insecticides separately, in three different doses *viz.*, low, medium and high dose. Out of 100 g treated seeds, 50 seeds were sown in each treatment. Total 21 treatments in three replications along with standard check were maintained.

Table 1: Chemicals used for seed treatment

Sl. No.	Pesticides	Dose		
		I	II	III
1	T_1: Fipronil 5 SC	10 ml/kg	7.5 ml/kg	5 ml/kg
2	T_2: Spinosad45 SL	6 ml/kg	4 ml/kg	2 ml/kg
3	T_3: Imidacloprid 70 WS	10 g/kg	7.5 g/kg	5 g/kg
4	T_4: Emamectin benzoate 5 SG	10 g/kg	7.5 g/kg	5 g/kg
5	T_5: Acetamiprid 20 SP	10 g/kg	7.5 g/kg	5 g/kg
6	T_6: Neem oil	3%	2%	1%
7	T_7: Flubendiamide 480 SC	6 ml/kg	4 ml/kg	2 ml/kg
8	T_8 : Chlorpyriphos 20 EC (RPP)	5 ml + 20 ml water		

Germination percentage: The known numbers of seeds (50) were sown in each treatment. Number of seedlings germinated per treatment in pot was counted and per cent germination was calculated by using the formula,

$$\text{Germination (\%)} = \frac{\text{No of plants germinated}}{\text{Total number of seeds sown}} \times 100$$

Observations were made on 7, 8 and 9 days after sowing (DAS).

Results and Discussion

At 7 days after sowing (DAS) all the tested insecticides at their lower dosage had given better germination percentage as compared to other two dosages. imidacloprid 70 WS at low dose 5 g/kg recorded 82 per cent germination, whereas at medium and higher dosages like 7.5 and 10 g/kg have recorded 82 and 80 per cent germination, respectively. Neem oil at 1, 2 and 3 per cent recorded 80, 79 and 78 per cent germination, respectively. 80 per cent germination was found in case of chlorpyriphos 20 EC (5 ml/kg). Flubendiamide 5 SG at its lower dosage (2 ml/kg) recorded 72 per cent germination and remaining two dosages of this insecticide (4 ml/kg and 6 ml/kg) recorded 70 and 64 per cent germination, respectively. Spinosad 45 SC at 2 ml/kg recorded 68 per cent germination, whereas 64 and 60 per cent germination was found in other two dosages (4 and 6 ml/kg, respectively). Fipronil 5 SC at 5 ml/kg showed 66 per cent germination but poor germination was recorded at 7.5 ml/kg and 10 ml/kg (54 and 50%, respectively). Emamectin benzoate 5 SG also recorded 66 per cent germination at 5 g/kg, but 54 and 52 per cent germination was obtained in other two dosages (7.5 g/kg and 10 g/kg, respectively). 54 per cent germination was found in acetamiprid 20 SP (5 g/kg), whereas at 7.5 and 10 g/kg much lower germination was recorded (50 and 46%, respectively). At 7 DAS among all the tested insecticides imidacloprid 70 WS (5 g/kg) recorded higher germination (82%) followed by chlorpyriphos 20 EC @ 5 ml/kg (80%) and the next best treatment was 1 per cent neem oil (78% germination) all three being on par with each other. Flubendiamide 480 SC (2 ml/kg) and spinosad 45 SL (2 ml/kg) recorded 70 and 68 per cent germination, respectively and on par with each other. This was followed by emamectin benzoate 5 SG (5 g/kg) and fipronil 5 SC (5 ml/kg) which recorded 66 per cent germination. Acetamiprid 20 SP (5 g/kg) recorded comparatively lower germination at 7DAS (54%). Same trend was followed at 8 DAS, all the tested insecticides at their lower dosage given higher per cent germination compared to other two dosages. Imidacloprid 70 WS at 5 g/kg recorded 84 per cent germination, whereas at remaining two dosages like 7.5 and 10 g/kg recorded 82 per cent germination. 84 per cent germination was found in case of chlorpyriphos 20 EC (5 ml/kg). Neem oil at 1 and 2 per cent recorded 82 per cent germination, whereas 81 per cent germination was found in 3 per cent neem oil treatment. Flubendiamide 5 SG at 2 and 4 ml/kg recorded 84 per cent germination, whereas at 6 ml/kg only 73.33 per cent germination was found. Spinosad 45 SC at 2 ml/kg recorded 70 per cent germination, whereas 68 and 66 per cent germination was found in other two dosages (4 and 6 ml/kg, respectively). Fipronil 5 SC at 5 ml/kg also showed 70 per cent germination but poor germination was recorded at 7.5 ml/kg and 10 ml/kg (60 and 56%, respectively). Emamectin benzoate 5 SG also recorded 70 per cent germination at 5 g/kg, 58 and 56 per cent germination was found in other two dosages (7.5 g/kg and 10 g/kg, respectively). 60 per cent germination was found in acetamiprid 20 SP (5 g/kg), whereas at 7.5 and 10 g/kg much lower germination was recorded (54 and 50%, respectively).

Among the different chemicals chlorpyriphos 20 EC at 5 ml/kg and imidacloprid 70 WS (5 g/kg) recorded highest germination (84%) followed by 1 per cent neem oil by

recording 82 per cent germination, and on par with them. 74 per cent germination was recorded in flubendiamide 480 SC. Whereas fipronil 5 SC (5 ml/l), spinosad 45 SC (2 ml/l) and emamectin benzoate 5 SG (5 g/kg) recorded 70 per cent germination, and on par with each other. At 8 DAS 60 per cent germination was found in case of acetamiprid 20 SP (5 g/kg).

Table 2: Effect of different seed dressers at varied dosages on germination (%) of *rabi* sorghum at 7 DAS

Sl. No.	Insecticides	Dose			Germination (%)		
		I (H)	II (M)	III (L)	I	II	III
1	Fipronil 5 SC	10 ml/kg	7.5 ml/kg	5 ml/kg	50.00	54.00	66.00
2	Spinosad 45 SC	6 ml/kg	4 ml/kg	2 ml/kg	60.00	64.00	68.00
3	Imidacloprid 70 WS	10 g/kg	7.5 g/kg	5 g/kg	80.00	82.00	82.00
4	Emamectin benzoate 5 SG	10 g/kg	7.5 g/kg	5 g/kg	52.00	54.00	66.00
5	Acetamiprid 20 SP	10 g/kg	7.5 g/kg	5 g/kg	46.00	50.00	54.00
6	Neem oil	3%	2%	1%	78.00	79.00	80.00
7	Flubendiamide 480 SC	6 ml/kg	4 ml/kg	2 ml/kg	64.00	70.00	72.00
8	Chlorpyriphos 20 EC (RPP)	5 ml + 20 ml water			80.00		

DAS: Days after sowing
L: Lower dose
M: Medium dose
H: High dose
RPP: Recommended package of practice

Similarly at 9 DAS also all the treatments at their lower dosage given better per cent germination compared to other two dosages. Imidacloprid 70 WS at low dose 5 g/kg recorded 84.33 per cent germination, whereas at remaining two dosages like 7.5 and 10 g/kg recorded 84 per cent germination. 86 per cent germination was found in case of chlorpyriphos 20 EC (5 ml/kg). Neem oil at 1 and 2 per cent recorded 84 per cent germination, and 83.67 per cent germination was seen in 3 per cent Neem oil treatment. Flubendiamide 5 SG at its lower dosage (2 ml/kg) recorded 78 per cent germination and remaining two dosages of this insecticide (4 ml/kg and 6 ml/kg) recorded 73 and 72 per cent germination, respectively. Spinosad 45 SC at 2 ml/kg recorded 78 per cent germination, whereas 74 and 70 per cent germination was found in other two dosages (4 and 6 ml/kg, respectively). Acetamiprid 20 SP (5 g/kg) recorded 76 per cent germination, whereas at 7.5 and 10 g/kg much lower germination was recorded (64 and 56%, respectively). Fipronil 5 SC at 5 ml/kg showed 74 per cent germination but poor germination was recorded at 7.5 ml/kg and 10 ml/kg (64 and 60% germination, respectively). Emamectin benzoate 5 SG recorded 72 per cent germination at 5 g/kg, but 62 and 60 per cent germination was found in other two dosages (7.5 g/kg and 10 g/kg, respectively).

Among all the tested insecticides chlorpyriphos 20 EC at 5 ml/kg recorded highest germination (86%) followed by 84 per cent germination in case of imidacloprid 70 WS (5 g/kg) and 1 per cent neem oil, and both are on par with it. Next best treatments were flubendiamide 480 SC (2 ml/kg) and spinosad 45 SL (2 ml/kg) which recorded 78 per cent germination, and on par with each other. Whereas acetamiprid 20 SP (5 g/kg) and fipronil 5 SC (5 ml/kg) recorded 76 and 74 per cent germination, respectively and on par with each other. Least germination (72%) was recorded in emamectin benzoate 5 SG (5 g/kg).

At 7 days after sowing (7DAS) all the tested insecticides at their lower dosage given better germination percentage compared to other two dosages. Among all the tested insecticides imidacloprid 70 WS (5 g/kg) recorded higher germination (82%) followed by chlorpyriphos 20 EC @ 5 ml/kg (80%). Next best treatment was neem oil (1%), which recorded 78 per cent germination. Flubendiamide 480 SC (2 ml/kg), spinosad 45 SL (2 ml/kg) recorded 70 and 68 per cent germination respectively, followed by emamectin benzoate 5 SG (5 g/kg) and fipronil 5 SC (5 ml/kg) 66 per cent germination. Acetamiprid 20 SP (5 g/kg) recorded least per cent germination (54%). The same trend remained on 8 and 9 DAS (Fig. 1). There are no much reviews available to support the present findings. However, these results can be supported by the findings of Alisson *et al.* (2014) [7] who reported that imidacloprid (0.600 kg ai/ha) and fipronil (0.025 kg ai/ha) seed treatments recorded 84.25 and 87.75 per cent germination, respectively. However the per cent germination percentage declined in all the treatments as the dosage increased. The decline in germination percentage might be due to toxicity of insecticides which has hampered the same.

Table 3: Effect of seed dressers on per cent seed germination in *rabi* sorghum at 7 DAS

Sl. No.	Insecticides	Dose	Germination (%)
1	Fipronil 5 SC	5 ml/kg	66.00 (54.33)^{c}
2	Spinosad 45 SC	2 ml/kg	68.00 (55.65)^{bc}
3	Imidacloprid 70 WS	5 g/kg	82.00 (64.90)^{a}
4	Emamectin benzoate 5 SG	5 g/kg	66.00 (54.33)^{c}
5	Acetamiprid 20 SP	5 g/kg	54.00 (47.29)^{d}
6	Neem oil	1%	78.00 (62.03)^{a}
7	Flubendiamide 480 SC	2 ml/kg	70.00 (56.79)^{b}
8	Chlorpyriphos 20 EC (RPP)	5 ml + 20 ml water	80.00 (63.44)^{a}

*Figures in parentheses are arc sine transformed values
Means followed by same alphabet in a column do not differ significantly (0.05) by DMRT.
DAS: Days after sowing.
RPP: Recommended package of practice

Table 4: Effect of different seed dressers at varied dosages on germination (%) of *rabi* sorghum at 8 DAS

Sl. No.	Insecticides	Dose			Germination (%)		
		I (H)	II (M)	III (L)	I	II	III
1	Fipronil 5 SC	10 ml/kg	7.5 ml/kg	5 ml/kg	56.00	60.00	70.00
2	Spinosad 45 SC	6 ml/kg	4 ml/kg	2 ml/kg	66.00	68.00	70.00
3	Imidacloprid 70 WS	10 g/kg	7.5 g/kg	5 g/kg	82.00	82.00	84.00
4	Emamectin benzoate 5 SG	10 g/kg	7.5 g/kg	5 g/kg	56.00	58.00	70.00
5	Acetamiprid 20 SP	10 g/kg	7.5 g/kg	5 g/kg	50.00	54.00	60.00
6	Neem oil	3%	2%	1%	81.00	82.00	82.00
7	Flubendiamide 480 SC	6 ml/kg	4 ml/kg	2 ml/kg	73.33	74.00	74.00
8	Chlorpyriphos 20 EC (RPP)	5 ml + 20 ml water			84.00		

DAS: Days after sowing
L: Lower dose
M: Medium dose
H: High dose
RPP: Recommended package of practice

Table 5: Effect of seed dressers on per cent seed germination in *rabi* sorghum at 8 DAS

Sl. No.	Insecticides	Dose	Germination (%)
1	Fipronil 5 SC	5 ml/kg	70.00 (56.79)[c]
2	Spinosad 45 SC	2 ml/kg	70.00 (56.79)[c]
3	Imidacloprid 70 WS	5 g/kg	84.00 (66.50)[a]
4	Emamectin benzoate 5 SG	5 g/kg	70.00 (56.79)[c]
5	Acetamiprid 20 SP	5 g/kg	60.00 (50.77)[d]
6	Neem oil	1%	82.00 (65.06)[a]
7	Flubendiamide 480 SC	2 ml/kg	74.00 (59.35)[b]
8	Chlorpyriphos 20 EC (RPP)	5 ml + 20 ml water	84.00 (66.43)[a]

*Figures in parentheses are arc sine transformed values
Means followed by same alphabet in a column do not differ significantly (0.05) by DMRT.
DAS - Days after sowing.
RPP: Recommended package of practice

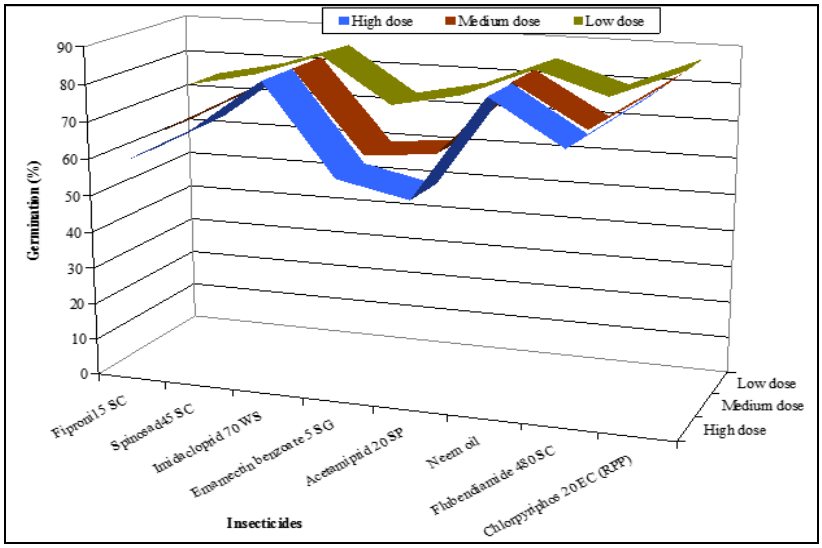

Fig 1: Effect of different seed dresser at varied dosages on (%) of *rabi* sorghum at 9 das

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