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Effect of Seed Treatment on Sorghum Yield, Germination and Oviposition of *Atherigona soccata* Rondani

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ABSTRACT: The present investigation aims to examine the effectiveness of a few recently introduced systemic insecticide as seed dressers and their combined effect against the sorghum shoot fly. A field study carried out in three replications using a Randomized Block Design at the College of Agriculture's Sorghum Research Field in Indore, Madhya Pradesh, during the 2019–20 Kharif season. The sorghum variety CSV 15 was examined for *Atherigona soccata* oviposition, yield, and germination using six seed dressing chemicals, soil treatment of carbofuran 3G, and an untreated control. The highest germination rate (94.93%), maximum grain yield (23.67q-ha^{-1}), and most avoidable loss (64.93%) were observed by the seed treatment with Thiamethoxam + Cyantraniliprole. Seed treated with Thiamethoxam 30 FS, Fipronil 5 SC and Chlorantraniliprole 18.5 SC also recorded better germination and yield compare to control. The oviposition of shoot fly recorded (5.74 egg/plant) highest in treatment Thiamethoxam + Cyantraniliprole and lowest (3.77) in soil application of Carbofuran 3G as compare to control due to pytotonic effect. Due to variation in the agro climatic conditions of different regions, insects show varying trends in their incidence pattern and extent of damage to the crop. Chemical control solely shows costly and it requires continual applications against target pest. Therefore, the seed treatment seems to be a plausible option for pest management. Thus, it is concluded that for the management of shoot fly seed treatment with (T5) thiamethoxam (19.8 w/w) + cyantraniliprole (19.8 w/w) 6 ml/kg followed by thiamethoxam 30 FS 10 ml/kg (T4) can be recommended on sorghum.

Keywords: Germination, oviposition, shoot fly, sorghum, Thiamethoxam, Cyantraniliprole.

INTRODUCTION

Sorghum bicolor (L.) Moench, sometimes known as giant millet or jowar, is a member of the poaceae family and is one of the most widely grown cereals worldwide. In 2017–18, the estimated globally sorghum production was 58.77 million metric tonnes, farmed on 40.32 million hectares of cultivated land, with a productivity of 1456 kg/ha (Anonymous, 2019). Over 150 insect species have been reported as sorghum pests worldwide, with over 100 of those species coming from Africa (Kruger *et al.*, 2008). In India, sorghum ranks fourth in area and production after rice, wheat and maize. The total cultivable area in India is 5.86 million hectares, with production of 4.57 million metric tonnes and productivity 780 kg-ha^{1} (Anonymous, 2018). The variance in the agroclimatic conditions across various regions results in diverse patterns of insect incidence and crop damage severity. In addition, several meteorological conditions are important in determining the prevalence and dominance of a specific pest or pest complex (Meena *et al*., 2013). The shoot fly (*A. soccata* Rondani), among other insect pests, is one of the most destructive during the sorghum seedling stage(Sharma *et al.*, 2006a and 2006b). The most prevalent pest of both wild and farmed sorghum in Africa and Asia is the gray-colored fly, *A. soccata* (Balikai and Bhagwat 2010). Adult flies deposit 20–40 cigar-shaped eggs on the underside of leaves in a single batch. Within two days of the eggs hatching, pale yellow maggots emerge from their tunnels inside the plant whorl and migrate amongst the young leaves. The developing tip of leaf sheaths is severed by the 10–12 mm long maggot, which then consumes the decomposing tissue that results. When the central shoot is damaged, it results in dead heart, side tillers are then produced, giving the plants a bushy appearance. Flies are active in the morning and evening, and their life cycle takes 18 to 25 days to complete. Pupation may take place in the soil or in the plant tissue after the larvae have finished molting in the decomposed tissue. Feeding can result in decreased tiller sizes and stand density, the death of young seedlings, and occasionally total crop loss (Patil and Bagde 2017). Agronomic practices, natural enemies and synthetic insecticides have been used to reduce the losses caused by shoot fly, but implementation of all these practices is not always perceivable. The seed treatment seems to be a tenable option for pest management system in terms of modest and communion with other components of IPM in case of sorghum. Therefore, the experiment was conducted to study the germination, yield and oviposition of *A. soccata* on sorghum

MATERIALS AND METHODS

Under the All India Coordinated Sorghum Improvement Project (AICSIP), College of Agriculture, Indore, an experiment with a plot size of 4.0 × 2.25 m was laid out in three replications using a randomized block design. On July 1st, 2019, the sorghum variety CSV-15 was sowed with a 45 × 15 cm spacing. Insecticides and the necessary amount of sorghum seed with few drop of water were combined in a polythene bag and thoroughly mixed for seed treatment (Table 1). The mixture was constantly swirled to ensure that the chemical treatments were evenly distributed after that the treated seeds were spread on paper to dry.

Table 1: The treatment details are as given below.

Sr. No.	Treatment	Dose
T1	Imidacloprid 70 WS	3 ml/kg of seed
T2	Fipronil 5 SC	5 ml/kg of seed
T3	Chlorantraniliprole 18.5 SC	1 ml/kg of seed
T4	Thiamethoxam 30 FS	10 ml/kg of seed
T5	Thiamethoxam (19.8 w/w) + Cyantraniliprole (19.8 w/w)	6 ml/kg of seed
T6	Soil application of Carbofuran 3G	20 kg/ha.
T7	Untreated plot	-

Germination and oviposition of shoot fly. After 12 days of sowing, the observation was made by counting all of the seedlings from total seeds sown and calculating the germination percentage.

$$\text{Germination \%} = \frac{\text{No. of normal seedlings germinated}}{\text{No. of seeds put for germination}} \times 100$$

Five randomly chosen plants from each plot were utilized to investigate the sorghum shoot fly's preference for oviposition. The total number of eggs was counted, and the average of those figures was used to determine the number of eggs per plant. On seedlings in every plot, the number of eggs was counted at 7, 14, 21, and 30 days after germination (DAG).

Grain yield. The panicles from each plot were collected then threshed the grain and sun-dried. Thus, plot yield was recorded and converted into quintal per hectare for comparison of effect among the treatments.

$$\text{Yield q/ha} = \frac{\text{Yield per plot (kg)}}{\text{Area of Plot (m}^2\text{)}} \times 100$$

Every plot's grain yield was noted and converted to q/ha. Based on the highest yield, which was registered in treated plots was compared with other treatments including control, and avoidable loss was calculated. The following formula was also used to calculate the data on increase grain yield over the untreated plot of sorghum after various treatments.

$$\text{Avoidable loss (\%)} = \frac{\text{Yield in treated plot - Yield in untreated plot}}{\text{Yield in the treated plot}} \times 100$$

$$\text{Increase in yield (\%)} = \frac{\text{Yield in treatment - Yield in untreated plot}}{\text{Yield in untreated plot}} \times 100$$

The data obtained from germination and oviposition of shoot fly were subjected to arc sine and square root transformation. The data were tabulated and analysed by the method of Analysis of variance as suggested by Fisher and Yates (1963) using microsoft excel significant at 5% levels were determined using F-table.

RESULTS AND DISCUSSION

A. Effect of various seed treatments on sorghum germination %

The percentage of seeds that germinated data (Fig. 1) showed that, in relation to other seed dressers and the control, the treatment T5 Thiamethoxam (19.8 w/w) + Cyantraniliprole (19.8 w/w) 6ml/kg of seed documented the considerably greatest percentage of germination (94.23%). The next best treatments which recorded better germination T4 thiamethoxam 30 FS (92.95%) followed by T2 Fipronil 5 SC (92.31%), T3 Chlorantraniliprole 18.5 SC (91.02%), T6 Soil application of Carbofuran 3G (90.37%) as compared to T7 control (87.09).

Ahire (2008) discovered that seeds treated with thiamethoxam 70 WS @ 6 g/kg (90. 90%) had a greater germination percentage than seeds treated with imidacloprid 70 WS 2 g/kg (85.80%). The outcome was verified by Khandare *et al.* (2017), who found that thiamethoxam 35 FS @ 5 ml/kg had the maximum percentage of germination (92%) and that other treatments considerably outperformed the control (68%) in sorghum.

B. Effect of distinct seed dressers on sorghum shoot fly oviposition

Results of oviposition on sorghum seedlings revealed (Fig. 2) that T6 soil application of carbofuran 3G (3.77 eggs/plant) closely followed the lowest number of eggs recorded in the control (3.47 eggs/plant). Eggs laid in T1 Imidacloprid 70 WS and T2 Fipronil 5 SC were comparable to one another. T5 Thiamethoxam (19.8 w/w) + Cyantraniliprole (19.8 w/w) 6ml/kg of seed (5.74) had the greatest number of eggs reported, followed by T4 Thiamethoxam 30 FS (5.17 egg/plant). According to the research, treated plots are preferred by female flies for egg laying over untreated ones. It could be because of the shoot fly attracted to healthy plants as a consequence of the insecticide or molecule's phytotonic action.

The findings of the study were consistent with those of Aghav and Sable (2003) made similar observations and confirmed that the plots treated with thiamethoxam 70WS @ 0.75% had the highest percentage of plants within the egg. In contrast, the plot treated with imidacloprid 70WS @ 1.2 ST (2.88) showed the maximum number of eggs laid per seedling, followed by thiamethoxam 70WS @ 0.75% ST (2.81).

According to Siddique *et al*. (2010), the highest rate of shoot fly oviposition was observed in the thiamethoxam 5 gm/kg seed treatment, which was comparable to the imidacloprid 10 g/kg seed treatment. The investigation was partial agreement with Kudale (2002), who found that the highest egg laying was observed on seedlings grown from carbosulfan-treated seed (32.66), followed by seed treated with imidacloprid (25.33 to 33.33 eggs per 5 seedlings).

C. Effect of different seed dressers on grain yield and avoidable losses

Sorghum yield data (23.67 q-ha^{-1}) highest in treatment T5 Thiamethoxam (19.8 w/w) + Cyantraniliprole (19.8 w/w) 6ml/kg of seed, which was considerably better than all other treatments and comparable to treatment T4 Thiamethoxam 30 FS (21.50 q-ha^{-1}) shown in Fig. 3. The next best seed dresser which recorded maximum yield in treatment T2 Fipronil 5 SC (20.08 q-ha^{-1}) followed by T3 Chlorantraniliprole 18.5 SC (18.54 q ha^{-1}), T1 Imidacloprid 70 WS (14.90q-ha^{-1}) and T6 soil application of Carbofuran 3G (13.71 q-ha^{-1}) compared to untreated plot (8.30 q-ha^{-1}).

The seeds treated with Thiamethoxam (19.8 w/w) + Cyantraniliprole (19.8 w/w) 6ml/kg of seed, followed by T4 Thiamethoxam 30 FS (61.40%), was provide the highest yield and prevent the loss, which was 64.93 percent (Fig. 4). Increased grain yield of 185.14 percent was recorded in seed treated by treatment T5, followed by T4 (159.08%). Increased grain yield over untreated plot of sorghum under different treatments showed that all the treatments reported percent increase in grain yield over untreated plot. However, the application of carbofuran 3G to the soil produced the lowest grain yield, measuring 65.15 percent.

According to Wadghule (2005); Balkai (2007); Kumar and Prabhuraj (2007), seed plots treated with thiamethoxam produced greater grain yields. Similar findings were noted by Balikai (2011), who found that the sorghum seed treatment with thiamethoxam 70WS @ 3g/kg seeds outperformed the other treatments and proved to be highly effective against shoot fly. These results partially corroborate the current investigation, since the most successful seed treatment used a combination of Thiamethoxam (19.8 w/w) + Cyantraniliprole (19.8 w/w) 6 ml/kg. This combination was novel and had not been studied before.

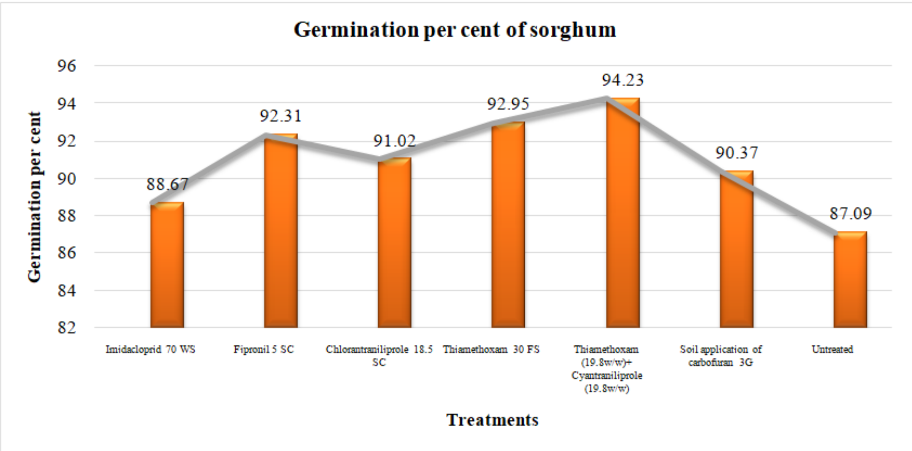
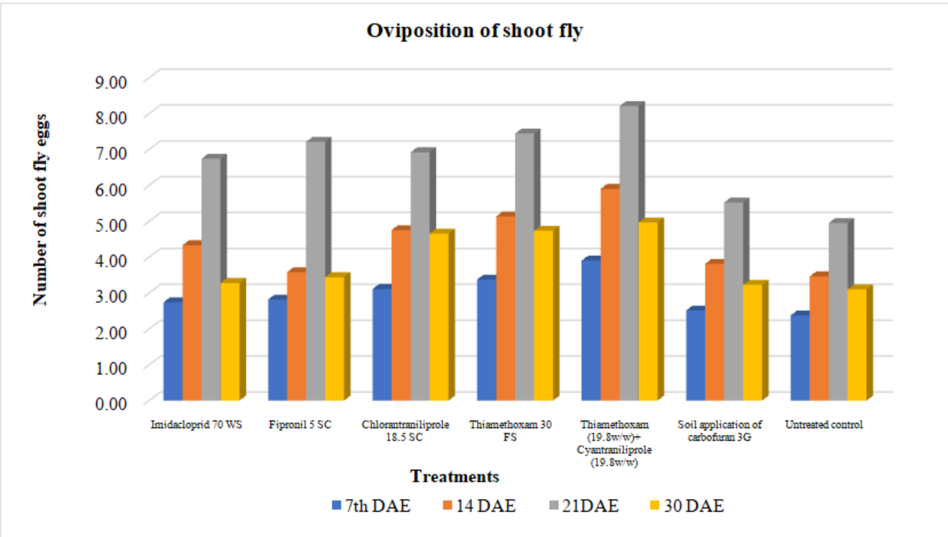


Fig. 1. Effect of different treatment on germination of sorghum variety CSV-15.



DAE= Days after emergence

Fig. 2. Impact of oviposition on various treatment at different days after emergence of plant.

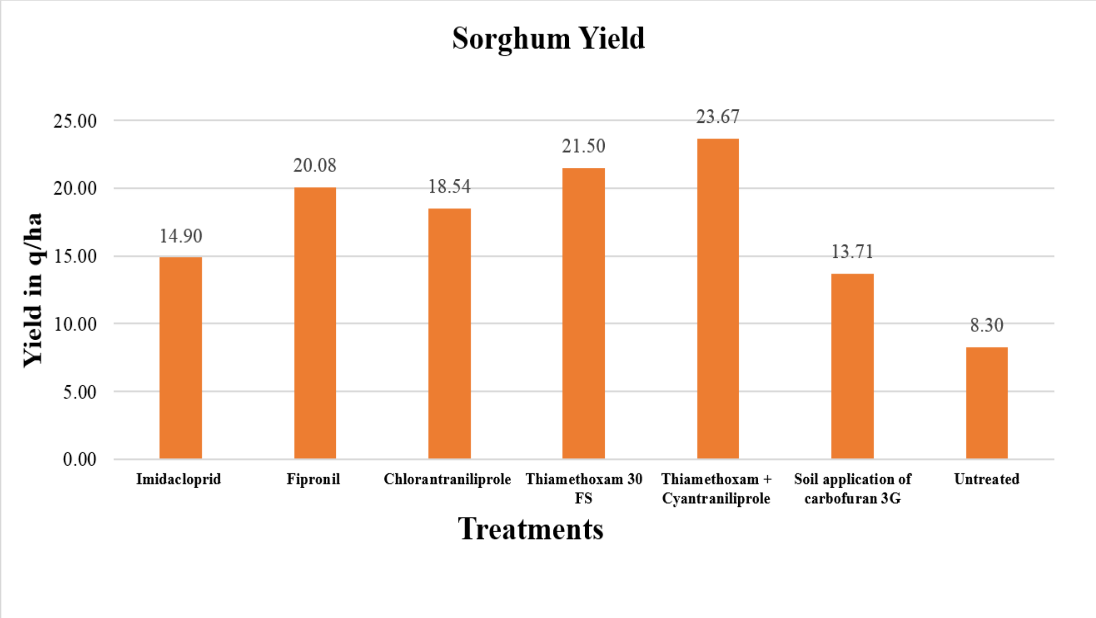


Fig. 3. Effect of different treatments on sorghum yield (q/ha).

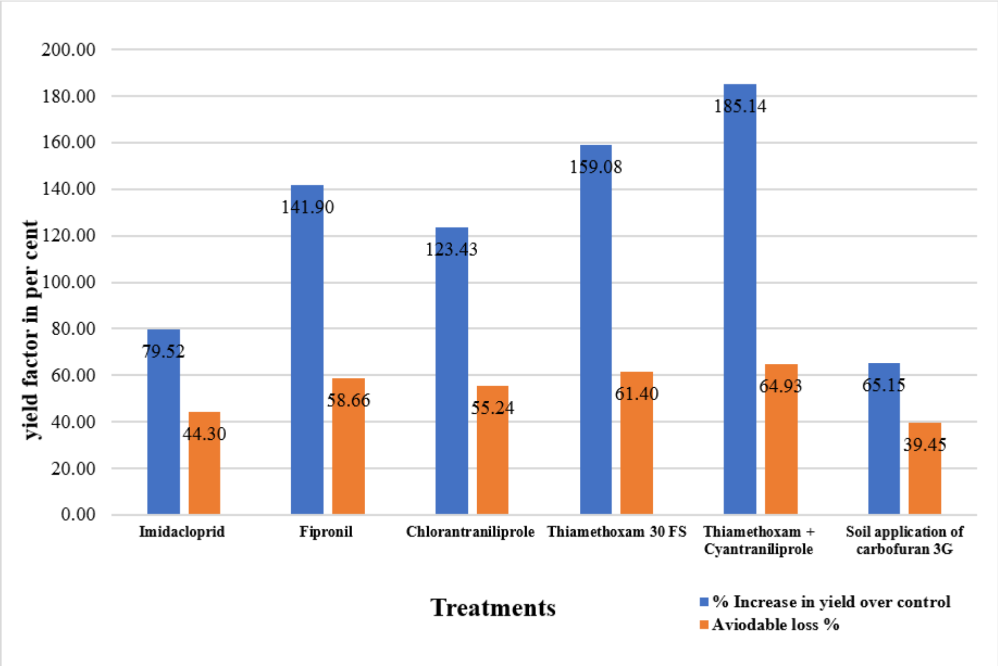


Fig. 4. Per cent increase in yield over control and avoidable loss.

CONCLUSIONS

The seed treated with thiamethoxam (19.8 w/w) + cyantraniliprole (19.8 w/w) 6 ml/kg of seed increased germination percent and grain production, according to the results of the field investigations. Thiamethoxam 30 FS 10 ml/kg was the next treatment to achieve these same results. The shoot fly's mean preference for oviposition revealed that the ready-mix combination of Thiamethoxam (19.8 w/w) + Cyantraniliprole (19.8 w/w) 6 ml/kg found maximum number of eggs, followed by seed treated with Thiamethoxam 30 FS 10 ml/kg. The phytotonic impact caused the lowest number of eggs to be detected in untreated plots. Consequently, it can be said that (T5) Thiamethoxam (19.8 w/w) + Cyantraniliprole (19.8 w/w) 6 ml/kg demonstrated the most successful control of shoot fly seed treatment, which is justified because it is a novel combination that has not been evaluated before.

FUTURE SCOPE

The efficiency of the ready-mix molecule, which the current investigations found to be promising, may be combined with certain discovered chemicals as a seed dresser to identify the source of resistance against the main sorghum shoot pests.

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