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# Evaluation of different insecticides for seed treatments against sorghum shoot fly, *Atherigona soccata* Rondani

**DC Shid, UK Kadam and PR Palande**

**Abstract**
The present study entitled, Evaluation of different insecticides for seed treatments against Sorghum shoot fly *Atherigona soccata* Rondani was carried out during *Rabi* 2020-21. Observations were made on plant population per cent, seedling vigour, days required to 50% flowering, shoot fly eggs per five plants, shoot fly dead hearts, height and yield. The results of experiment revealed that, among the seven treatments at 28 DAE, the seed treatments with Thiamethoxam 30 FS @ 10 ml/kg seed (19.76%), Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS (21.00%) and Imidacloprid 17.8 SL (21.46%) recorded the lowest dead hearts caused due to shoot fly indicating that treatments were effective in controlling shoot fly infestation. The maximum ICBR 1:43.80 was obtained in seed treatment with Imidacloprid 17.8 SL @ 3 ml/kg of seeds followed by Fipronil 5 SC @ 5 ml/kg of seed treatment (1:41.69) and Thiamethoxam 30 FS @ 10 ml/kg of seeds (1:37.43).

**Keywords:** Sorghum shoot fly, *Atherigona soccata*, dead hearts

## Introduction
Sorghum is one of the foremost significant cereal crop in semi-arid tropics (SAT) and therefore the fifth most vital cereal crop universally after wheat, rice, maize as well as barley (Bantilan *et al*., 2004) [8]. More than half of the world's sorghum is grown in the semi-arid regions and it is fundamental food for over 500 million people who live in the semi-arid tropics (Mohammed *et al.*, 2015) [15]. The USA, Nigeria, Ethiopia, India and Mexico are the top sorghum producers, producing 8.67, 6.66, 5.20, 4.73 and 4.32 million tons production respectively (Anonymous, 2020) [3]. *Rabi* sorghum is largely grown in Deccan plateau regions of states Maharashtra, Karnataka and Andhra Pradesh in India. India is the largest sorghum grower in the world with an average area 4824 thousand hectares, production 4772 thousand tons and productivity 989 kg/ha (Anonymous, 2020) [3] and according to the third advance estimates of 2020-21, the sorghum production in India is 4800 thousand tons. Among the different pests of sorghum Shoot Fly *Atherigona soccata* (Diptera: Muscidae), is one of the major constraint in production of sorghum during the seedling stage of the crop (Aruna and Padmaja, 2009) [4]. Shoot fly infests the sorghum seedlings at seventh days after emergence, while the infestation lasts till the 30 DAE of the crop (Vadariya, 2014) [18]. The present work was carried out keeping in view seriousness of this pest and the importance of evaluation of efficacy of different insecticides for seed treatments to reduce the indiscriminate use of insecticides.

## Materials and Methods
### Experimental details
A field study was conducted to evaluate the different insecticides for seed treatments against sorghum shoot fly during *Rabi* 2020-21 under randomized block design (RBD) at Sorghum Improvement Project, MPKV, Rahuri, Dist. Ahmednagar (M.S.) with seven treatments including an untreated control and were replicated thrice. A popular sorghum variety Swarna was sown during *Rabi* 2020-21 with a spacing of 45 cm x 15 cm in the plot size of 4 m x 2.7 m. From each plot ten plants were selected randomly and observations were recorded on plant population percentage, seedling vigour, days required to 50% flowering, oviposition, dead hearts percentage, height as well as yield.

Treatments

| Tr. No. | Treatments | Dose |
|---|---|---|
| $T_1$ | Imidacloprid 17.8 SL | 3 ml/kg of seeds |
| $T_2$ | Fipronil 5 SC | 5 ml/kg of seeds |
| $T_3$ | Chlorantraniliprole 18.5 SC | 1 ml/kg of seeds |
| $T_4$ | Thiamethoxam 30 FS | 10 ml/kg of seeds |
| $T_5$ | Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS | 6 ml/kg of seeds |
| $T_6$ | Soil application of Carbofuran 3G | 20 kg/ha |
| $T_7$ | Untreated Control | - |

## Results and Discussion

### Per cent Plant Population (12 DAE)

Population of plants in each treated plot was recorded at 12 days after emergence (DAE) and noted in per cent. Data obtained was organized in Table 1 which was statistically significant. Population of plants in plots ranged from 96.80% to 81.41% in various treatments. The higher per plot per cent population of plants was observed in plots treated with $T_4$ : Seed treatment with Thiamethoxam 30 FS @ 10 ml/kg (96.80%) followed by $T_5$: Seed treatment with Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS @ 6 ml/kg of seed (94.87%) which was at par with $T_2$: Seed treatment with Fipronil 5 SC @ 5 ml/kg seed (93.59%) and $T_1$: Seed treatment with Imidacloprid 17.8 SL @ 3 ml/kg (90.38%) while $T_3$: Seed treatment with Chlorantraniliprole 18.5 SC @ 1 ml/ kg (87.82%) and $T_6$: Soil application with Carbofuran 3G @ 20 kg/ha (89.74%) were at par with each other whereas untreated plot recorded minimum plant population (81.41%). Present outcomes are in line with Biradar and Shekharappa (2018) [8] who reported that among tested insecticides Imidacloprid 70 WS (5 g/kg) seed treatment indicate higher germination (82%) and the present results could be backed up by the outcomes of Alisson *et al*. (2014) [2] who reported that Imidacloprid (0.600 kg a.i./ha) and fipronil (0.025 kg a.i./ha) seed treatments recorded 84.25 and 87.75 germination percentage, respectively.

### Seedling Vigour

At 12 DAE, seedling vigour was recorded on 1 to 5 scale. There was a non-significant variation into seedling vigour between the treatments (Table 1). The seedling vigour ranged from 1.67 to 3.33. Seedling vigour (1.67) was maximum in $T_4$: Thiamethoxam 30 FS @ 10 ml/kg followed by $T_5$: Seed treatment with Cyantraniliprole 19.8% + Thiamethoxam 19.8% @ 6 ml/kg of seed (2.00). The next higher seedling vigour (2.33) was recorded in seed treatments $T_1$: Imidacloprid 17.8 SL @ 3 ml/kg of seed and T2: Fipronil 5 SC @ 5 ml/kg of seed as well as seed treatment $T_3$: Chlorantraniliprole 18.5 SC @ 1ml/kg of seed recorded the seedling vigour 2.67. Among the treatments, $T_6$: Soil application with Carbofuran 3G @ 20 kg/ha and untreated control recorded lower seedling vigour of 3.33.

### Days Required to 50% Flowering

The days required to 50% flowering were recorded when half of the plants in treated plot attained 50% anthesis stage and the data recorded was statistically significant which was varied from 85.00 to 88.66 days. Among the seven treatments, $T_3$: Seed treatment with Chlorantraniliprole 18.5 SC @ 1ml/kg of seed and $T_5$: Seed treatment with Cyantraniliprole 19.8% + Thiamethoxam 19.8% @ 6 ml/kg of seed recorded the minimum days (85.00 days) which were at par with the seed treatments, $T_2$: Fipronil 5 SC @ 5 ml/kg of seed and $T_4$: Thiamethoxam 30 FS @ 10 ml/kg which recorded the 85.33 days as well as the seed treatment $T_1$: Imidacloprid 17.8 SL @ 3ml/kg (86.33 days) and $T_6$: soil application with Carbofuran 3G @ 20kg/ha (87.66 days) recorded the next minimum days. The maximum days required for 50% flowering were recorded in the untreated control (88.66 days).

### Shoot Fly Eggs per Five Plants (No.) at 14 DAE

There was significant difference between the treatments in the terms of number of eggs laid per five plants. It was noticed that average number of eggs per five plants at 14 DAE varied from 4.00 to 8.67. The minimum number of eggs per five plants were recorded in treatment $T_4$: seed treatment with Thiamethoxam 30 FS @ 10 ml/kg of seed (4.00) followed by $T_5$: seed treatment with Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS @ 6 ml/kg (4.33) indicating were at par with treatment $T_1$: seed treatment with Imidacloprid 17.8 SL @ 3 ml/kg of seed (5.00), $T_6$: soil application with Carbofuran 3G @ 20kg/ha (5.33), $T_2$: seed treatment with Fipronil 5 SC @ 5 ml/kg of seed (6.00). The next minimum number of eggs per five plants were observed in $T_3$: seed treatment with Chlorantraniliprole 18.5 SC @ 1 ml/kg seed (6.67). The maximum number of eggs per five plants was recorded by untreated plot (8.67). The current conclusions are in correspondence with Kumar and Tiwana (2018)[14] who registered the data on number of eggs laid per five plants at 14 DAE and found that fecundity varies between 3.7 to 6.0 across different treatments but revealed non-significant differences among the treatments.

### Shoot Fly Dead Hearts (%)

On the 14th and 28th days after emergence, the prevalence of shoot fly was measured in terms of dead heart symptoms given as a percentage of total dead hearts.

### Shoot Fly Dead Heart Per cent at 14 DAE

The dead hearts per cent caused due to shoot fly varied from 9.67 to 28.00 per cent at 14 DAE and significantly varied among the treatments. Among the seven treatments, seed treatments $T_4$: Thiamethoxam 30 FS @ 10 ml/kg of seed (9.67%) and $T_1$: Imidacloprid 17.8 SL @ 3 ml/kg of seed (10.81%) recorded the lowest dead hearts per cent. The next lower dead hearts per cent recorded by the seed treatment $T_5$: Cyantraniliprole 19.8%+Thiamethoxam 19.8% FS @ 6 ml/kg of seed (11.00%) followed by $T_6$: soil application with Carbofuran 3G @ 20 kg/ha (11.33%), $T_2$: seed treatment with Fipronil 5 SC @ 5 ml/kg seed (11.54%) which were at par with each other followed by treatment with $T_3$: Chlorantraniliprole 18.5 SC @ 1ml/kg (14.46%). The higher dead hearts percentage was recorded by the untreated control (28.00%).

### Shoot Fly Dead Heart Per cent at 28 DAE

The dead hearts per cent caused by shoot fly varied from 19.76 to 57.30 per cent at 28 DAE and significantly varied among the treatments. Among the seven treatments, seed treatment $T_4$: Thiamethoxam 30 FS @ 10 ml/kg of seed recorded lowest dead hearts per cent (19.76%) indicating at par with seed treatments $T_5$: Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS @ 6 ml/kg of seed (21.00%). The next lower per cent of dead heart was recorded by the treatments, $T_1$: Imidacloprid 17.8 SL @ 3 ml/kg seed and $T_2$: Fipronil 5 SC @ 5 ml/kg of seed, 21.46% and 22.80% dead hearts, respectively and were at par with each other. The next lower per cent of dead heart was recorded by the treatments T6: soil application with Carbofuran 3G @ 20 kg/ha and $T_3$: seed treatment with Chlorantraniliprole 18.5 SC @ 1 ml/kg recorded 24.16% and 25.27% dead hearts, respectively which were at par with each other. The greater dead hearts per cent was recorded by the untreated control plot (57.30%).

The present outcomes are in correspondence with Sandhu (2016) [16] who concluded that seed treatments with Thiamethoxam 30 FS @ 5 ml/kg and Imidacloprid 600 FS @ 7 ml/kg of seed were found effective in minimizing the shoot fly incidence in sorghum. According to Balikai and Bhagwat (2009) [6] the seed treatment with Thiamethoxam 70 WS @ 3g/kg of seed was very efficient in minimizing shoot fly incidence and also Karibasavaraja *et al.* (2005) [13] publicized that seed treatment Thiamethoxam 70 WS @ 5 and 4 g/kg of seeds reduced shoot fly dead hearts by 9.6 and 13.6 per cent, respectively compared to 60.3 per cent in soil application with Carbofuran 3G @ 3g/m row standard check. G. Shyam Prasad *et al.* (2019) [12] publicized that seed treatment with mixture of Thiamethoxam (19.8w/w) + Cyantraniliprole (19.8w/w) @ 6 ml/kg of seed reduced shoot fly and stem borer dead hearts by 26.7% and 12.1% respectively.

**Height**

**Seedling Height**

The data on seedling height was recorded at 14 DAE and there was non-significant difference in seedling height between the treatments. Data recorded on seedling height ranged from 12.53 to 16.60 cm. The maximum seedling height (16.60 cm) was recorded in $T_4$: Seed treatment with Thiamethoxam 30 FS @ 10 ml/kg seed treatment followed by the $T_5$: seed treatment with Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS @ 6 ml/kg of seed (15.67 cm). The next maximum heights were recorded in the treatments $T_6$: soil application with Carbofuran 3G @ 20kg/ha, $T_3$: seed treatment with Chlorantraniliprole 18.5 SC @ 1 ml/kg of seed, $T_2$: seed treatment with Fipronil 5 SC @ 5 ml/kg and $T_1$: seed treatment with Imidacloprid 17.8 SL @ 3 ml/kg of seed were 14.57, 14.27, 14.07 and 13.10 cm respectively. The minimum height was recorded by untreated control plot (12.53 cm). From the current findings, treatments with higher seedling height were observed to be less susceptible to shoot fly infestation than the treatments with a lower seedling height. Similar results were recorded by Borse (2000) [9], Ashok Kumar *et al.* (2008) [5], Chikkarugi and Balikai (2011) [10].

**Plant Height**

At maturity plant height was recorded and the data recorded on plant height tabulated in Table 4.8 which was varied from 161.00 to 252.33 cm. The maximum plant heights were recorded in the treatments, $T_2$: seed treatment with Fipronil 5 SC @ 5 ml/kg seed (252.33 cm), $T_4$: seed treatment with Thiamethoxam 30 FS @ 10 ml/kg (250.83 cm) and $T_5$: seed treatment with Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS @ 6 ml/kg (250.17 cm) followed by $T_6$: soil application with Carbofuran 3G @ 20 kg/ha (248.33 cm) along with the $T_1$: seed treatment Imidacloprid 17.8 SL @ 3ml/kg seed and $T_3$: seed treatment Chlorantraniliprole 18.5 SC @ 1 ml/kg of seed recorded 246.33 cm plant height. The minimum height was observed in the untreated control plot (161.00 cm).

**Yield**

**Grain Yield**

Data recorded on the grain yield ranged from 8.20 to 15.70 q/ha and there was a significant difference between the treatments in relation to the grain yield. It could be seen that significantly greater grain yield was obtained in the plot of seed treatment with Thiamethoxam 30 FS @ 10 ml/kg of seed (15.70 q/ha) which was superior to all other treatments. The next best grain yield was registered in the plot of seed treatment with Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS @ 6 ml/kg of seed (14.00 q/ha) which was at par with the plot of seed treatment with Imidacloprid 17.8 SL @ 3 ml/kg of seed (13.87 q/ha) and plot seed treatment with Fipronil 5 SC @ 5 ml/kg of seed (13.36 q/ha). The plot of soil application with Carbofuran 3G @ 20kg/ha as well as the plot of seed treatment with Chlorantraniliprole 18.5 SC @ 1 ml/kg of seed registered the grain yield 12.37 q/ha and 11.19 q/ha respectively and lower grain yield was obtained in untreated control plot that is 8.20 q/ha.

**Fodder Yield**

Data recorded on fodder yield varied from 90.92 to 135.46 q/ha and there was a significant difference between the treatments in recording the fodder yield. It was concluded that significantly maximum fodder yield was recorded by $T_4$: plot of seed treatment with Thiamethoxam 30 FS @ 10 ml/kg of seed (135.46q/ha) which was superior to all other treatments. The next best yield of fodder was recorded in $T_5$: plot of seed treatment with Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS @ 6 ml/ kg of seed (131.38 q/ha) followed by $T_1$: plot of seed treatment Imidacloprid 17.8 SL @ 3 ml/kg (125.27 q/ha), $T_2$: plot of seed treatment Fipronil 5 SC @ 5 ml/kg of seed (112.77q/ha), $T_6$: plot of soil application with Carbofuran 3G @ 20 kg/ha (109.72q/ha). $T_3$: Chlorantraniliprole 18.5 SC @ 1 ml/kg seed treated plot recorded the 91.34 q/ha fodder yield and the minimum fodder yield was recorded in plot of untreated control that is 90.92 q/ha

The findings of this study are very close to those of Daware *et al.* (2011) [11] who found that seed treatments with Thiamethoxam @ 3.1 g a.i./kg and Imidacloprid @ 8.75 g a.i./kg resulted in considerably higher grain production. According to Aghav and Sable (2003) [1], imidacloprid @ 1.22% ST treated plots gave the maximum grain and fodder yields, closely followed by thiamethoxam @ 0.75% ST. G. Shyam Prasad *et al.* (2019) [12] reported that seed treatment with mixture of Thiamethoxam (19.8w/w) + Cyantraniliprole (19.8w/w) @ 6 ml/kg of seed was beneficial in minimizing shoot fly along with stem borer dead hearts and also in increasing grain yield by 44.6 per cent over the untreated control.

**Incremental Cost Benefit Ratio**

Incremental cost benefit ratio presented in Table 4. The maximum incremental cost benefit ratio that is 1:43.80 was obtained in Imidacloprid 17.8 SL @ 3 ml/kg seed treatment. The next maximum ICBR was obtained in Fipronil 5 SC @ 5 ml/kg seed treatment (1:41.69) followed by Thiamethoxam 30 FS @ 10 ml/kg seed treatment (1:37.43). The seed treatment with Chlorantraniliprole 18.5 SC @ 1 ml/kg of seeds and Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS @ 6 ml/kg of seeds recorded 1:20.76 and 1:9.78 ICBR respectively, while 1:3.08 ICBR was estimated in treatment of soil application with Carbofuran 3G @ 20 kg/ha.

The current outcomes are in correspondence with the findings of Daware *et al.* (2011) [11] who noticed that the Imidacloprid seed treatment was efficient against infestation of sorghum shoot fly and recorded highest 1:12.83 ICBR. Sonalkar *et al.* (2018) [17] also noticed that seed treatment of imidacloprid 70 WS @ 10 ml/kg seed gave notably maximum grain yield and cost savings.

**Table 1:** Effect of different seed treatments on plant population (%), seedling vigour and days required to 50% flowering

| Tr. No. | Treatments | Plant population (%) 12 DAE* | Seedling Vigour (1-5 Scale) 12 DAE | Days required to 50% flowering |
|---|---|---|---|---|
| $T_1$ | Imidacloprid 17.8 SL @ 3 ml/kg of seeds | 90.38 (72.10) | 2.33 | 86.33 |
| $T_2$ | Fipronil 5 SC @ 5 ml/kg of seeds | 93.59 (75.61) | 2.33 | 85.33 |
| $T_3$ | Chlorantraniliprole 18.5 SC @ 1 ml/kg of seeds | 87.82 (69.62) | 2.67 | 85.00 |
| T4 | Thiamethoxam 30 FS @ 10 ml/kg of seeds | 96.80 (79.88) | 1.67 | 85.33 |
| $T_5$ | Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS @ 6 ml/kg of seeds | 94.87 (76.93) | 2.00 | 85.00 |
| $T_6$ | Soil application of Carbofuran 3G @ 20 kg/ha | 89.74 (71.37) | 3.33 | 87.66 |
| $T_7$ | Untreated Control | 81.41 (64.45) | 3.33 | 88.66 |
| | S.Em± | 1.48 | 0.51 | 1.02 |
| | C.D. at 5% | 4.60 | NS | 3.19 |

DAE: Days after emergence
*The values in parentheses indicate arcsine value

**Table 2:** Effect of different seed treatments on oviposition and dead hearts caused by shoot fly (*Atherigona soccata* Rondani)

| Tr. No. | Treatments | Shoot fly eggs/5 plants (No.) 14DAE** | Shoot fly dead hearts (%)* | |
|---|---|---|---|---|
| | | | 14 DAE | 28 DAE |
| $T_1$ | Imidacloprid 17.8 SL @ 3 ml/kg of seeds | 5.00 (2.44) | 10.81 (19.19) | 21.46 (27.58) |
| $T_2$ | Fipronil 5 SC @ 5 ml/kg of seeds | 6.00 (2.63) | 11.54 (19.85) | 22.80 (28.51) |
| $T_3$ | Chlorantraniliprole 18.5 SC @ 1 ml/kg of seeds | 6.67 (2.76) | 14.46 (22.34) | 25.27 (30.17) |
| $T_4$ | Thiamethoxam 30 FS @ 10 ml/kg of seeds | 4.00 (2.21) | 9.67 (18.10) | 19.76 (26.38) |
| $T_5$ | Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS @ 6 ml/kg of seeds | 4.33 (2.31) | 11.00 (19.36) | 21.00 (27.24) |
| $T_6$ | Soil application of Carbofuran 3G @ 20 kg/ha | 5.33 (2.52) | 11.33 (19.66) | 24.16 (29.43) |
| $T_7$ | Untreated Control | 8.67 (3.10) | 28.00 (31.93) | 57.30 (49.19) |
| | S.Em ± | 0.14 | 0.32 | 0.63 |
| | C.D. at 5% | 0.44 | 1.01 | 1.95 |

DAE: Days After Emergence
*The values in parentheses indicate arcsine values.
**The values in parentheses indicate $\sqrt{n+0.5}$ value.

**Table 3:** Effect of different seed treatments on seedling height, plant height, grain yield and fodder yield

| Tr. No. | Treatments | Height | | Grain yield (q/ha) | Fodder yield (q/ha) |
|---|---|---|---|---|---|
| | | Seedling height (cm) (14 DAE) | Plant height At harvesting (cm) | | |
| $T_1$ | Imidacloprid 17.8 SL @ 3 ml/kg of seeds | 13.10 | 246.33 | 13.87 | 125.27 |
| $T_2$ | Fipronil 5 SC @ 5 ml/kg of seeds | 14.07 | 252.33 | 13.36 | 112.77 |
| $T_3$ | Chlorantraniliprole 18.5 SC @ 1 ml/kg of seeds | 14.27 | 246.33 | 11.19 | 91.34 |
| $T_4$ | Thiamethoxam 30 FS @ 10 ml/kg of seeds | 16.60 | 250.83 | 15.70 | 135.46 |
| $T_5$ | Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS @ 6 ml/kg of seeds | 15.67 | 250.17 | 14.00 | 131.38 |
| $T_6$ | Soil application of Carbofuran 3G @ 20 kg/ha | 14.57 | 248.33 | 12.37 | 109.72 |
| $T_7$ | Untreated Control | 12.53 | 161.00 | 8.20 | 90.92 |
| | S. E.m± | 1.23 | 27.58 | 0.46 | 0.89 |
| | C.D. at 5% | NS | NS | 1.44 | 2.76 |

**Table 4:** Economics of insecticidal seed treatments used in the experiment

| Tr. No. | Treatments | Quantity of insecticides required/ha | Total cost (Insecticides + Labour) (Rs.) | Grain yield (q/ha) | Increase in yield over control (q/ha) | Gross Income (Rs.) | Net profit (Rs.) | Net Monitoring Benefit | ICBR |
|---|---|---|---|---|---|---|---|---|---|
| $T_1$ | Imidacloprid 17.8 SL @ 3 ml/kg of seeds | 30 ml | 443 | 13.87 | 5.67 | 48,545 | 19,845 | 19,402 | 1:43.80 |
| $T_2$ | Fipronil 5 SC @ 5 ml/kg of seeds | 50 ml | 423 | 13.36 | 5.16 | 46,760 | 18,060 | 17,637 | 1:41.69 |
| $T_3$ | Chlorantraniliprole 18.5 SC @ 1 ml/kg of seeds | 10 ml | 481 | 11.19 | 2.99 | 39,165 | 10,465 | 9,984 | 1:20.76 |
| $T_4$ | Thiamethoxam 30 FS @ 10 ml/kg of seeds | 100 ml | 683 | 15.70 | 7.50 | 54,950 | 26,250 | 25,567 | 1:37.43 |
| $T_5$ | Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS @ 6 ml/kg of seeds | 60 ml | 1883 | 14.00 | 5.80 | 49,000 | 20,300 | 18,417 | 1:9.78 |
| $T_6$ | Soil application of Carbofuran 3G @ 20 kg/ha | 20 kg | 3569 | 12.37 | 4.17 | 43,295 | 14,595 | 11,026 | 1:3.08 |
| $T_7$ | Untreated control | - | | 8.20 | | 28,700 | | | |

Cost of insecticides (Rs.):
Imidacloprid 17.8 SL – Rs.200/50 ml
Thiamethoxam 30 FS – Rs.180/50ml
Fipronil 5 SC – Rs.200/100ml
Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS – Rs.780/30ml
Chlorantraniliprole 18.5 SC – Rs.950/60ml
Carbofuran 3G – Rs.130/kg
Labour charges- Rs. 323/day
Market price of sorghum- Rs. 3500/q

## Conclusions

Among the seven treatments at 28 DAE, the seed treatments with Thiamethoxam 30 FS @ 10 ml/kg seed (19.76%), Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS (21.00%) and Imidacloprid 17.8 SL (21.46%) recorded the lowest dead hearts caused due to shoot fly indicating that treatments effective in controlling shoot fly infestation. The maximum ICBR 1:43.80 was obtained in seed treatment with Imidacloprid 17.8 SL @ 3 ml/kg of seeds followed by Fipronil 5 SC @ 5 ml/kg of seed treatment (1:41.69) and Thiamethoxam 30 FS @ 10 ml/kg of seeds (1:37.43). It could be interpreted from the current results that although there was low net profit in seed treatment Imidacloprid 17.8 SL @ 3 ml/kg of seeds, the highest ICBR was observed because of low cost on plant protection measures.

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