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MANAGEMENT OF SUCKING PESTS OF SOYBEAN (*GLYCINE MAX* L.) USING SEED DRESSING INSECTICIDES DURING *SUMMER* SEASON

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ABSTRACT

A field experiment was conducted during *summer* 2023 at Agricultural Research Station, Bidar to evaluate the efficacy of thiamethoxam 35 FS and imidacloprid 48 FS seed dressing insecticides at different doses against sucking pests of soybean. Among the different doses evaluated, higher doses of thiamethoxam 35 FS *i.e.*, at 7.5 ml/kg and 10 ml/kg of seeds and imidacloprid 48 FS at 5 ml/kg of seeds were proved superior in protecting the crop from the early season sucking pests *viz.*, whiteflies, thrips, aphids and leafhoppers up to 30-40 days after sowing and recorded significantly higher grain yield. Hence, considering the cost of plant protection, thiamethoxam 35 FS at 7.5ml/kg of seeds and imidacloprid 48 FS at 5 ml/kg of seeds can be used for managing the soybean early season sucking pests up to 30-40 days after sowing. Both the seed dressing chemicals were proved to be effective and also showed no phytotoxic effect on the crop when seeds were sown with sufficient moisture in the soil.

***Key words*:** Soybean, Sucking Pests, Seed dressing, Thiamethoxam 35 FS, Imidacloprid 48 FS

Introduction

Soybean (*Glycine max* (L.) Merrill) is a unique crop with high nutritional value, providing 40% protein and 20% edible oil, besides minerals and vitamins. Soybean protein is rich in amino acids like lysine, methionine and cystine. Soybean ranks first among the oilseeds in the world as well as in India. Globally, soybean is grown over an area of 136.03 m ha and annual production of 369.72 m t with a productivity of 2720 kg/ha (Anon., 2023). In India, it occupies an area of 13.00 m ha with a production of 12.04 m t and productivity of 930 kg/ha (Anon., 2023a), In Karnataka, soybean is cultivated in an area of 0.381 m ha with a production of 0.437 m t and productivity of 1147 kg/ha (Anon., 2022). In India, soybean productivity is lower than world average due to biotic as well as abiotic factors. Among the biotic factors, insect pests are of economically important. These insects cause damage to plant by sucking plant sap, secreting honeydew, which results in development of dark sooty mold inhibiting light penetration and thus reducing photosynthesis. In addition, these insects act as vectors of plant diseases. During *summer* soybean is prone to sucking pests and YMV disease which results in less productivity. The economic loss as high as 80 per cent was reported from YMV disease (Nene, 1972). In order to manage these sucking pests, experiment was conducted using different doses of seed dressing insecticide, thiamethoxam 35 FS and imidacloprid 48 FS at field condition. In general, for management of sucking pests, farmers go for foliar application of the insecticides after colonization of the sucking pests which was not only hazardous to environment but also alters the natural enemy population and causes diseases to the crop. Hence, we need to manage these sucking pests since from sowing of the crop. Among the two seed dressing insecticides, thiamethoxam (TIA; 3-[(2-chloro-1,3-thiazol-5-yl) methyl]- 5-methyl-N-nitro-1,3,5-oxadiazinan-4-imine) is synthetic and is known as a second-generation neonicotinoid compound belonging to the chemical subclass the thianicotinyls and is a broad-spectrum insecticide of the neonicotinoid group, used either as a foliar spray or as a seed treatment (Maienfisch *et al*., 2002; Nauen *et al*., 2003; Mourtzinis *et al*., 2019) for the management of sucking pests. Imidacloprid, a neonicotinoid compound belonging to the chloronicotinyl insecticide which has gut and contact activity against insects (Maienfisch *et al*., 2001) can be used for managing the sucking pests. In light of the foregoing and considering the seriousness of the pest infestation and damage to the soybean crop, the study was undertaken to manage the sucking pests of soybean with seed dressing insecticides.

Material and Methods

Studies on the management of sucking pests of soybean using seed dressing insecticides were carried out at Agricultural Research Station (ARS), Bidar (which is located in north eastern transition zone – 1 of agro-climatic zones of Karnataka) during *summer* 2023. The variety DSb 21 was sown with a spacing of 30 cm × 10 cm in Randomized Block Design (RBD) having nine treatments replicated thrice with the plot size 3 m × 4 m and leaving a gangway of one meter around the plots.

The seeds of the soybean var. DSb 21 were taken in a polythene bag and required quantity of the imidacloprid 48 FS @ 1, 1.25, 2.5 and 5 ml/kg of seeds and thiamethoxam 35 FS @ 2.5, 5, 7.5 and 10 ml/kg of seeds were accordingly added to this and stirred carefully. If necessary few ml of water can be added to get uniform coating of the chemical on the seeds and dried in shade before sowing.

Before sowing the treated seeds, there should be sufficient moisture in the soil. All the recommended package of practices were followed to raise the crop. At 40 DAS one blanket spray of flonicamid 50 WG @ 0.3g/ Lt was sprayed in all the experimental plots except in untreated control to manage the later season sucking pests. Wherever necessary a spray was given to control leaf eating caterpillar and pod borers.

Observations on incidence of sucking pests *viz*., aphids, thrips, whiteflies and leafhopper were made at 10, 20, 30 and 40 days after sowing. The incidence of the sucking pest population in each replication was recorded by counting the number of aphids, thrips and leafhopper, from top three leaves per ten plants in each treatment. Number of whiteflies (nymphs and adults) on three leaves per plant (upper, middle and lower leaf) in ten plants was recorded from each treatment in all the replications.

The data was subjected for square root transformation and statistical analysis. The seed yield was recorded plot wise at the time of harvest and converted to hectare basis and subjected for statistical analysis. The mean comparisons were made by duncan's multiple range test (DMRT). Visual observations were made for phytotoxic effects if any, expressed after germination.

Result and Discussion

During *summer* season crop is prone to sucking pests and YMV disease which results in less productivity. The economic loss as high as 80 per cent was reported from YMV disease (Nene, 1972). The most economical way to deal with these insect pests, diseases and to avoid yield losses is to cultivate insect pests and disease resistant or tolerant varieties (Awasthi *et al*., 2003) and also effectively managing the insect pests during *summer* season.

The data on the effectiveness of different doses of thiamethoxam 35 FS and imidacloprid 48 FS seed treatment for the management of sucking pests of soybean under field condition during *summer* 2023 was presented below.

Whitefly

At ten days after sowing, among the different doses of seed dressing insecticides, thiamethoxam 35 FS (@ 10 ml/kg of seeds) was significantly superior in recording the lowest number of 0.21 whiteflies/three leaves/plant. This treatment was on par with thiamethoxam 35 FS (@ 7.5 ml/kg of seeds) with 0.38 whiteflies/three leaves/plant. The next best treatment was imidacloprid 48 FS (@ 5 ml/kg of seeds) with 0.59 whiteflies/three leaves/plant and was on par with imidacloprid 48 FS (@ 2.5 ml/kg of seeds) and thiamethoxam 35 FS (@ 5 ml/kg of seeds) with 0.64 and 0.67 whiteflies/three leaves/plant respectively. Further, imidacloprid 48 FS (@ 1.25 ml/kg of seeds) and 1 ml/kg of seeds recorded 1.05 and 1.08 whiteflies/three leaves/plant respectively. However, untreated control recorded highest number of 1.52 whiteflies/three leaves/plant at 10 days after sowing. Same trend was followed at 20, 30 and 40 days after sowing with respect to whiteflies population (Table 1). However, the population of the whiteflies increased gradually as the crop growth progressed.

Leafhopper

Leafhopper population at 10 days after sowing was found significantly lower in the plot (Table 1) where, seed

Table 1: Bio-efficacy of seed dressing chemicals against whiteflies and leafhoppers of soybean during *summer*, 2023.

Tr. No.	Treatment details	Dosage /Kg seed	No. of whiteflies/three leaves/plant					No. of leafhoppers/top three leaves/plant				
			10 DAS	20 DAS	30 DAS	40 DAS	Mean	10 DAS	20 DAS	30 DAS	40 DAS	Mean
T_1	Imidacloprid 48 % FS	1 ml	1.08 (1.25)^{d}	3.38 (1.94)^{e}	4.56 (2.24)^{e}	5.34 (2.36)^{e}	3.60 (1.94)^{e}	1.20 (1.29)^{d}	2.78 (1.79)^{c}	3.80 (2.04)^{d}	4.10 (2.11)^{d}	2.97 (1.81)^{e}
T_2	Imidacloprid 48 % FS	1.25 ml	1.05 (1.22)^{cd}	3.30 (1.88)^{de}	4.47 (2.22)^{e}	5.20 (2.29)^{de}	3.50 (1.90)^{de}	1.11 (1.24)^{d}	2.74 (1.74)^{c}	3.75 (1.98)^{cd}	4.04 (2.05)^{d}	2.91 (1.75)^{de}
T_3	Imidacloprid 48 % FS	2.5 ml	0.64 (1.06)^{bc}	2.25 (1.63)^{bc}	3.53 (1.97)^{cd}	3.98 (2.07)^{cd}	2.60 (1.68)$^{b-d}$	0.62 (1.05)^{bc}	1.75 (1.48)^{b}	2.56 (1.72)^{bc}	2.96 (1.82)^{bc}	1.97 (1.52)^{cd}
T_4	Imidacloprid 48 % FS	5 ml	0.59 (1.03)^{b}	2.08 (1.56)^{bc}	2.72 (1.74)$^{a-c}$	2.86 (1.78)^{ab}	2.06 (1.53)^{ab}	0.37 (0.93)^{b}	1.52 (1.39)^{b}	1.96 (1.53)^{ab}	2.02 (1.54)^{a}	1.47 (1.35)$^{a-c}$
T_5	Thiamethoxam 35 % FS	2.5 ml	0.96 (1.20)^{cd}	2.55 (1.74)^{cd}	4.18 (2.16)^{de}	4.47 (2.22)^{de}	3.04 (1.83)$^{c-e}$	0.95 (1.20)^{cd}	2.43 (1.70)^{c}	3.29 (1.94)^{cd}	3.49 (1.99)^{cd}	2.54 (1.71)^{de}
T_6	Thiamethoxam 35 % FS	5 ml	0.67 (1.08)^{bc}	2.06 (1.59)^{bc}	3.27 (1.92)^{bc}	3.40 (1.96)^{bc}	2.35 (1.64)^{bc}	0.46 (0.98)^{b}	1.60 (1.44)^{b}	2.18 (1.62)^{ab}	2.69 (1.77)^{b}	1.73 (1.45)^{bc}
T_7	Thiamethoxam 35 % FS	7.5 ml	0.38 (0.93)^{ab}	1.94 (1.54)^{b}	2.51 (1.71)^{ab}	2.58 (1.73)^{ab}	1.85 (1.48)^{ab}	0.09 (0.77)^{a}	1.26 (1.31)^{b}	1.54 (1.41)^{a}	1.73 (1.47)^{a}	1.16 (1.24)^{ab}
T_8	Thiamethoxam 35 % FS	10 ml	0.21 (0.84)^{a}	1.28 (1.33)^{a}	2.20 (1.63)^{a}	2.40 (1.69)^{a}	1.52 (1.37)^{a}	0.00 (0.71)^{a}	0.73 (1.11)^{a}	1.31 (1.34)^{a}	1.31 (1.34)^{a}	0.84 (1.12)^{a}
T_9	Untreated control	-	1.52 (1.42)^{e}	4.10 (2.14)^{f}	5.81 (2.50)^{f}	6.10 (2.64)^{f}	4.38 (2.19)^{f}	1.62 (1.46)^{e}	3.54 (2.01)^{d}	4.96 (2.35)^{e}	5.05 (2.37)^{e}	3.79 (2.07)^{f}
S.Em±			0.05	0.06	0.05	0.06	0.07	0.05	0.06	0.05	0.06	0.10
CD at 5%			0.16	0.19	0.16	0.19	0.23	0.15	0.19	0.15	0.19	0.30

Figures in parentheses are $\sqrt{x + 0.5}$ transformed values. DAS- Days after sowing

treatment with thiamethoxam 35 FS (@ 10 ml/kg of seeds) and (7.5 ml/kg of seeds) showed significantly superior in recording the lowest number 0 and 0.09 leafhoppers/ top three leaves respectively. These two treatments were followed by imidacloprid 48 FS (@ 5 ml/kg of seeds) and thiamethoxam 35 FS (@ 5 ml/kg of seeds) with 0.37 and 0.46 leafhoppers/ top three leaves respectively. These two treatments were on par with imidacloprid 48 FS (@ 2.5 ml/kg of seeds) with 0.62 leafhoppers/ top three leaves. The next best treatment was thiamethoxam 35 FS (@ 2.5 ml/kg of seeds) with 0.95 leafhoppers/ top three leaves. Further, the plots treated with imidacloprid 48 FS (@ 1.25 ml/kg of seeds) and (1 ml/kg of seeds) recorded 1.11 and 1.20 leafhoppers/ top three leaves respectively. However, untreated control recorded the highest number of 1.62 leafhoppers/ top three leaves at 10 days after sowing. The same trend was followed at 20, 30 and 40 days after sowing with increase in leafhopper population in all treatments.

Aphid

Aphids population at 10 days after sowing, among the different doses of seed dressing insecticides, thiamethoxam 35 FS (@ 10 ml/kg of seeds), (7.5 ml/kg of seeds) showed significantly superior in recording the lowest number 0.40, 0.60 aphids/top three leaves respectively, followed by imidacloprid 48 FS (@ 5 ml/kg of seeds) with 1.32 aphids/top three leaves and it was on par with thiamethoxam 35 FS (@ 5 ml/kg of seeds) and imidacloprid 48 FS (@ 2.5 ml/kg of seeds) with 1.40 and 1.58 aphids/top three leaves respectively. These two treatments were on par with thiamethoxam 35 FS (@ 2.5 ml/kg of seeds) and imidacloprid 48 FS (@ 1.25 ml/ kg of seeds) with 1.80 and 2.00 aphids/top three leaves respectively. Further, the plots treated with imidacloprid 48 FS (@ 1 ml/kg of seeds) recorded 2.05 aphids/top three leaves. However, untreated control recorded highest number of 2.99 aphids/top three leaves at 10 days after sowing. Similar trend was followed in all treatment at 20, 30 and 40 days after sowing respectively (Table 2).

Thrips

Thrips population was varied among the different treatments in 10 to 40 days. At 10 days after sowing, among the different doses of seed dressing insecticides, thiamethoxam 35 FS (@ 10 ml/kg of seeds) showed significantly superior in recording the lowest number of 0.66 thrips/top three leaves. The next best treatment was thiamethoxam 35 FS (@ 7.5 ml/kg of seeds) with 0.94 thrips/top three leaves and it was on par with imidacloprid 48 FS (@ 5 ml/kg of seeds) and thiamethoxam 35 FS (@ 5 ml/kg of seeds) with 1.40 and 1.51 thrips/top three leaves respectively. These two treatments were followed

Table 2: Bio-efficacy of seed dressing chemicals against aphids and thrips of soybean during *summer*, 2023.

Tr. No.	Treatment details	Dosage /Kg seed	No. of aphids/top three leaves/plant					No. of thrips/top three leaves/plant				
			10 DAS	20 DAS	30 DAS	40 DAS	Mean	10 DAS	20 DAS	30 DAS	40 DAS	Mean
T_1	Imidacloprid 48 % FS	1 ml	2.05 (1.58)^{d}	3.96 (2.08)^{c}	6 (2.54)^{c}	6.41 (2.59)^{c}	4.61 (2.20)^{f}	3.04 (1.86)^{f}	4.4 (2.18)^{c}	6.04 (2.52)^{e}	8.11 (2.89)^{d}	5.4 (2.36)^{d}
T_2	Imidacloprid 48 % FS	1.25 ml	2 (1.53)^{cd}	3.89 (2.01)^{c}	5.86 (2.41)^{bc}	5.96 (2.43)^{bc}	4.43 (2.10)^{ef}	2.65 (1.71)^{ef}	4.37 (2.12)^{c}	5.7 (2.38)$^{c-e}$	8.01 (2.79)^{cd}	5.18 (2.25)^{d}
T_3	Imidacloprid 48 % FS	2.5 ml	1.58 (1.42)$^{b-d}$	2.29 (1.64)^{b}	4.69 (2.23)^{b}	4.96 (2.29)^{b}	3.38 (1.89)^{de}	1.77 (1.48)$^{c-e}$	2.56 (1.72)^{b}	4.86 (2.27)$^{b-d}$	6.12 (2.52)^{bc}	3.83 (2.00)^{bc}
T_4	Imidacloprid 48 % FS	5 ml	1.32 (1.32)^{b}	2.11 (1.57)^{b}	2.98 (1.81)^{a}	3.18 (1.86)^{a}	2.4 (1.64)^{bc}	1.4 (1.35)^{bc}	2.13 (1.58)^{b}	4.38 (2.13)^{ab}	4.89 (2.24)^{ab}	3.2 (1.82)^{ab}
T_5	Thiamethoxam 35 % FS	2.5 ml	1.8 (1.51)^{cd}	3.29 (1.94)^{c}	5.5 (2.43)^{bc}	5.74 (2.48)^{bc}	4.08 (2.09)^{ef}	2.22 (1.64)$^{d-f}$	3.62 (2.02)^{c}	5.51 (2.44)^{de}	7.31 (2.79)^{cd}	4.69 (2.22)^{cd}
T_6	Thiamethoxam 35 % FS	5 ml	1.4 (1.37)^{bc}	2.14 (1.61)^{b}	4.38 (2.19)^{b}	4.56 (2.23)^{b}	3.12 (1.85)^{cd}	1.51 (1.41)$^{b-d}$	2.33 (1.67)^{b}	4.39 (2.19)^{bc}	5.62 (2.45)^{ab}	3.46 (1.93)^{b}
T_7	Thiamethoxam 35 % FS	7.5 ml	0.6 (1.04)^{a}	1.8 (1.50)^{b}	2.62 (1.74)^{a}	2.8 (1.79)^{a}	1.96 (1.52)^{ab}	0.94 (1.19)^{ab}	1.87 (1.52)^{ab}	4.08 (2.10)^{ab}	4.74 (2.25)^{ab}	2.91 (1.76)^{ab}
T_8	Thiamethoxam 35 % FS	10 ml	0.4 (0.95)^{a}	1.14 (1.27)^{a}	2.18 (1.63)^{a}	2.25 (1.65)^{a}	1.49 (1.37)^{a}	0.66 (1.07)^{a}	1.11 (1.26)^{a}	3.18 (1.90)^{a}	4.03 (2.11)^{a}	2.25 (1.59)^{a}
T_9	Untreated control	-	2.99 (1.86)^{e}	4.8 (2.32)^{d}	7.71 (2.85)^{d}	7.84 (2.87)^{d}	5.83 (2.47)^{g}	4.3 (2.18)^{g}	5.49 (2.47)^{d}	7.09 (2.77)^{f}	10.25 (3.26)^{e}	6.78 (2.65)^{e}
S.Em±			0.05	0.06	0.06	0.07	0.06	0.07	0.1	0.07	0.09	0.07
CD at 5%			0.16	0.19	0.18	0.22	0.18	0.22	0.3	0.23	0.27	0.23

Figures in parentheses are $\sqrt{x+0.5}$ transformed values. DAS- Days after sowing

by imidacloprid 48 FS (@ 2.5 ml/kg of seeds) and thiamethoxam 35 FS (@ 2.5 ml/kg of seeds) with 1.77 and 2.22 thrips/top three leaves respectively. Further, the plots treated with imidacloprid 48 FS (@ 1.25 ml/kg of seeds) and (1 ml/kg of seeds) recorded 2.65 and 3.04 thrips/top three leaves respectively. However, untreated control recorded highest number of 4.30 thrips/top three leaves at 10 days after sowing. Similar trend was followed in all the treatment at 20, 30 and 40 days after sowing in all the treatment (Table 2).

The results revealed that, higher doses of thiamethoxam 35 FS at (10 ml/kg of seeds) and (7.5 ml/kg of seeds) and imidacloprid 48 FS at (5 ml/kg of seeds) were found to be effective in reducing the population of sucking pests of soybean up to 30-40 days with gradual increasing in the sucking pests population and recorded highest grain yield.

Percent disease incidence of yellow mosaic virus

The per cent disease incidence of yellow mosaic virus (YMV) disease was observed in all the treated and untreated plots at 45 days of crop growth. Among all the treatments, lowest per cent disease incidence of yellow mosaic virus disease was observed in thiamethoxam 35 FS (@ 10 ml/kg of seeds), (7.5 ml/kg of seeds), imidacloprid 48 FS (@ 5 ml/kg of seeds), and thiamethoxam 35 FS (@ 5 ml/kg of seeds) with 20.37 %, 22.64 %, 23.64 %, 24.76 % and recorded the lowest population of 1.52, 1.85, 2.06 and 2.35 mean number of whiteflies/ three leaves/ plant respectively. The next best treatment was thiamethoxam 35 FS (@ 2.5 ml/kg of seeds) with 26.97 % disease incidence with 3.04 mean number of whiteflies/ three leaves/ plant. Further, the plot treated with imidacloprid 48 FS (@ 2.5 ml/kg of seeds) recorded 36.56 % disease incidence. Highest per cent disease incidence of yellow mosaic virus was observed in imidacloprid 48 FS (@ 1 ml/kg of seeds) with 42.68 % disease incidence and recorded the highest whitefly population of 3.49 mean number of whiteflies/ three leaves/ plant. However untreated control recorded highest 58.05 % yellow mosaic virus disease incidence with 4.38 mean number of whiteflies/ three leaves/ plant (Table 3).

Yield

Among the different treatments, thiamethoxam 35 FS (@ 10 ml/kg of seeds) recorded significantly highest grain yield of 11.78 q/ha, followed by thiamethoxam 35 FS (@ 7.5 ml/kg of seeds) with 11.19 q/ha. The next best treatments were imidacloprid 48 FS (@ 5 ml/kg of seeds) and thiamethoxam 35 FS (@ 5 ml/kg of seeds) with 10.82 and 10.28 q/ha respectively. The plots treated with imidacloprid 48 FS (@ 2.5 ml/kg of seeds) and thiamethoxam 35 FS (@ 2.5 ml/kg of seeds) recorded

Table 3: Effect of seed dressing insecticides against yellow mosaic virus disease of soybean during summer.

Tr. No.	Treatment details	Dosage/Kg seed	Mean No. of whiteflies on three leaves/plant*	Per cent disease incidence of YMV**	Yield (q/ha)
T_1	Imidacloprid 48 % FS	1 ml	3.49(1.93)^{d}	42.68(40.79)^{c}	7.75
T_2	Imidacloprid 48 % FS	1.25 ml	3.41(1.88)^{cd}	36.82(37.36)^{bc}	8.25
T_3	Imidacloprid 48 % FS	2.5 ml	2.60(1.68)^{bc}	36.56(37.20)^{bc}	9.96
T_4	Imidacloprid 48 % FS	5 ml	2.06(1.53)^{ab}	23.64(29.09)^{a}	10.82
T_5	Thiamethoxam 35 % FS	2.5 ml	3.04(1.83)^{cd}	26.97(31.28)^{ab}	9.6
T_6	Thiamethoxam 35 % FS	5 ml	2.35(1.64)^{bc}	24.76(29.84)^{a}	10.28
T_7	Thiamethoxam 35 % FS	7.5 ml	1.85(1.48)^{ab}	22.64(28.41)^{a}	11.19
T_8	Thiamethoxam 35 % FS	10 ml	1.52(1.37)^{a}	20.37(26.83)^{a}	11.78
T_9	Untreated control	-	4.38(2.19)^{e}	58.05(49.63)^{d}	5.78
S.Em±			0.08	2.10	0.08
CD at 5%			0.24	6.32	0.24

* Figures in parentheses are square root transformed values.; ** Figures in parentheses are arc sine transformed values.

9.96 and 9.60 q/ha. Further, the plots treated with imidacloprid 48 FS (@ 1.25 ml/kg of seeds), (1 ml/kg of seeds) recorded 8.25 and 7.75 q/ha respectively. The lowest grain yield of 5.78 q/ha was recorded from untreated check. (Table 4)

B:C ratio

All the treatments, recorded highest benefit: cost ratio compared to untreated check. The treatment with thiamethoxam 35 FS (@ 10 ml/kg of seeds), (7.5 ml/ kg of seeds) and imidacloprid 48 FS (@ 5 ml/kg of seeds) recorded benefit cost ratio of 1.61, 1.55 and 1.50 respectively. The next best treatments were thiamethoxam 35 FS (@ 5 ml/kg of seeds) (1.44), imidacloprid 48 FS (@ 2.5 ml/kg of seeds) (1.40) and thiamethoxam 35 FS (@ 2.5 ml/kg of seeds) (1.36) benefit: cost ratio respectively. The plots treated with imidacloprid 48 FS (@ 1.25 ml/kg of seeds) and imidacloprid 48 FS (@ 1 ml/kg of seeds) recorded 1.17 and 1.10 benefit: cost ratio respectively. However, the lowest B: C ratio of 0.84 was recorded from untreated control (Table 4).

Effect on natural enemies

The activity of the natural enemies was reduced in the treated plots compared to the untreated control as the population of the sucking pests was very low in treated plots.

Phytotoxicity

There was no phytotoxicity symptoms were noticed on the crop after imposing the treatments. Further, it should be kept in the mind that, we need to sow the thiamethoxam 35 FS and imidacloprid 48 FS treated seeds when we have the optimum moisture/ enough moisture in the soil. As this is the first study by using seed treatment chemicals to manage the sucking pests of soybean, no reviews related to this topic is available in soybean. However, the other reviews are available by using thiamethoxam and imidacloprid as a seed treatment to manage early stage sucking pests in cotton and bhendi; hence those reviews are used to compare the present results.

The result revealed that, higher doses of thiamethoxam 35 FS and imidacloprid 48 FS proved to be effective in managing the sucking pests in soybean crop. These findings are in accordance with the results of netam *et al.*, (2013) reported that imidacloprid 600 FS

Table 4: Cost economics of seed dressing insecticides on soybean during *summer.*

Tr. No.	Treatment details	Dosage /Kg seed	Seed Yield (q/ha)	Cost of cultivation (Rs/ha)	Treatment cost (Rs/ha)	Total cost (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
T_1	Imidacloprid 48 % FS	1 ml	7.75	38,488	879	39,367	43400	4,033	1.10
T_2	Imidacloprid 48 % FS	1.25 ml	8.25	38,488	949	39,437	46200	6,763	1.17
T_3	Imidacloprid 48 % FS	2.5 ml	9.96	38,488	1298	39,786	55776	15,991	1.40
T_4	Imidacloprid 48 % FS	5 ml	10.82	38,488	1995	40,483	60592	20,109	1.50
T_5	Thiamethoxam 35 % FS	2.5 ml	9.60	38,488	1050	39,538	53760	14,222	1.36
T_6	Thiamethoxam 35 % FS	5 ml	10.28	38,488	1500	39,988	57568	17,580	1.44
T_7	Thiamethoxam 35 % FS	7.5 ml	11.19	38,488	1950	40,438	62664	22,226	1.55
T_8	Thiamethoxam 35 % FS	10 ml	11.78	38,488	2400	40,888	65968	25,080	1.61
T_9	Untreated control	-	5.78	38,488	0	38,488	32368	-6,120	0.84

seed treatment @ 0.75 g *a.i*/kg seed found most effective against the sucking pests of soybean upto four weeks of seed germination. Sreenivas *et al*., (2019a) who reported that higher dosage of the imidacloprid 60 FS (10 ml/kg seed) and thiamethoxam 35 FS (15 ml/kg seed) proved effective in reducing thrips and leafhopper population in okra up to 40 DAS. Sreenivas *et al*., (2019b) who reported that thiamethoxam 35 FS @ 30 ml per kg seed treatment showed significantly lower population of thrips (3.13/leaf) in chilli. Further, shobharani *et al.*, (2017b) who reported that imidacloprid 60 FS @ 10 ml/kg seed was most effective in controlling sucking pests up to 40-45 days after sowing with highest grain yield and cost effective in green gram crop.

Thiamethoxam 35 FS @ 10 ml, 7.5 ml/kg seeds and imidacloprid 48 FS @ 5 ml/kg of seeds when applied as seed treatment was most effective in controlling the sucking pests up to 30-40 days after germination with highest grain yield and cost effective.

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