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Management of sucking insect pests of carrot *Dacus carota* L. in Karnataka

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Abstract
A field experiment was conducted during *rabi*/*summer* 2021-22 at Nagaral village of Ron taluka in Gadag district, Karnataka to know the incidence and to assess the field efficiency of different insecticide molecules against sucking insect pests. The experiment was laid out in randomized block design with 11 treatments replicated thrice. The crop was cultivated during 1st January 2022 as per the recommended package of practices except the insect protection measures. Observations on population of sucking insect pests were recorded soon after appearance on the crop from 15 to 75 days after sowing at fortnightly interval. Number of sucking insect pests were counted from three leaves (one each from top, middle and bottom canopy of crop) in each plant and three spots in each field, each spot consists of five plants and mean number of sucking insect pests per three leaves was recorded. Percent reduction over control was calculated and data was subjected to one-way ANOVA and Duncan's Multiple Range Test. Result indicated that lowest mean population and highest reduction in the population of sucking insect pets was recorded in seed treated with cyantraniliprole 19.8% + thiamethoxam 19.8% @ 10 ml/kg seed followed by seed treated with thiamethoxam 30 FS @ 10 ml/kg seed, seed treated with imidacloprid 600 FS @ 10 ml/kg seed.

Keywords: Carrot, incidence, management, sucking pests

1. Introduction
Carrot *Daucus carota* L. is an important vegetable, ranking among top ten widely cultivated vegetables globally, particularly in India. Where it is prominently grown as an edible vegetable crop. The carrot is an annual or biennial herb that belongs to the family Apiaceae (Peirce 1987) [13]. It is thought to be a native of the Mediterranean region (Shinohara 1984) [17] and is primarily grown in temperate climates, but it is also cultivated in tropical and subtropical regions. Carrot can withstand a wide range of temperatures to some extent, but it prefers agroclimatic circumstances where the temperature ranges between 15.60 ºC to 21.10 ºC during the growth period (Rubatzky *et al.* 1999) [16]. Carrot is an essential root crop from a nutritional perspective. Significant amounts of thiamine, riboflavin and carotene are present in it. Iron, vitamin A, vitamin B, vitamin C and Sugar are abundant in this food (Yawalkar 1985) [20]. Carrot is used in pickles, preserves, sweets, carrot powder, kanji, salads, cooked vegetables and other delectable beverages (Chadha 2003) [5]. Carrot is planted throughout India, with a total area of 0.6433 million hectares and a production of 4.14 million tonnes. It is grown mostly in Punjab, Haryana, Uttar Pradesh, Andhra Pradesh, Karnataka and Assam in India on an area of 88,000 hectares, producing 1446 million tonnes and yielding 1.6 tonnes per hectare. Haryana holds a 20.23 percent share with respect to total production with a production of 386.39 million tonnes and Karnataka holds only a 5.06 percent share with respect to total production with a production of 96.63 million tonnes (Anonymous 2021) [1]. The major carrot-growing districts in Karnataka are Belagavi, Gadag, Dharwad, Bengaluru, Bagalkot and other districts (Neeru 2021) [12]. Where carrot cultivation is carried out throughout the year with assured irrigation, with a crop duration of 80-90 days.
Production and productivity in carrot are restricted by a variety of obstacles, including both biotic and abiotic factors. The prevalence of pests and diseases during the crop season is a prominent issue among these biotic factors. Since carrot is grown primarily in tropical and subtropical climates, insect pests play an important role in the successful production of the crop.

carrot can be attacked by many insect pests at any stage of development, from seedling to harvest stage of the crop. The crop's succulent nature and fleshy growth encourages insect pests to multiply. Various insect pests are known to attack carrot crop, among these insect pest complex, root bores cause significant economic damage to the crop especially during *rabi/summer*. Some of the most serious insect pests which attack carrot are as follows: carrot weevil, *Listronotus oregonensis* LeConte; carrot rust fly, *Psila rosae* Fabricius; carrot psyllid *Trioza apicalis* Forster; aster leaf hopper, *Macrosteles quadrilineatus* Forbes; willow carrot aphid, *Cavariella aegopodii* Scopoli; cutworm, *Agrotis segetum* Denis; pale striped flea beetle, *Systena blanda* Melsheimer; aphid *Myzus persicae* sulzer, from United States of America (Delahaunt and Newenhouse 1998) [7]; semilooper, *Thysanoplusia orichalcea* Fabricius; and thrips, *Aeolothrips meridionalis* Bagnall from Jammu and Kashmir (Bhat and Ahangar 2018) [4]. However, none of the studies ascertained the economic damage caused by these pests on carrot.

2. Materials and Methods

An experiment to assess field efficiency of different insecticides and biorationals against sucking insect pests was carried out at Nagaral village of Ron taluk in Gadag district. The experiment was laid out in randomized block design with eleven treatments replicated thrice in 1.83 × 1.23 m^2 plot size. The carrot was sown during 1st January 2022 as per the recommended package of practices (Anon., 2013) [2] except the plant protection measures. The treatment details are presented in table 1.

$$\text{Reduction over control (\%)} = \frac{\text{Percent infestation in UTC - Percent infestation in respective treatment}}{\text{Percent infestation in UTC}} \times 100$$

Where, UTC-Untreated control.

Table 1: Treatment details for management of insect pests of carrot

Treatment No.	Treatments
1.	Seed treatment with thiamethoxam 30% FS @ 10 ml/kg
2.	Seed treatment with cyantraniliprole 19.8% + Thiamethoxam 19.8% @ 10 ml/kg
3.	Seed treatment with imidacloprid 600 FS 10 ml/kg
4.	Soil drenching with chlorpyriphos 20% EC @ 3 ml/l at 35 DAS
5.	Soil application of chlorantraniliprole 0.4% GR @ 10 kg/ha at 35 DAS
6.	Soil application with fipronil 0.3% GR @ 20 kg/ha at 35 DAS
7.	Foliar spray with chlorantraniliprole 18.5% @ 0.3 ml/l at 25 DAS
8.	Soil application of *Metarhizium anisopliae* (cfu 2 × 10^8/g) @ 7.50 kg/ha at sowing
9.	Soil application of pongamia cake @ 250 kg/ha at sowing
10.	Soil application of neem cake @ 250 kg/ha at sowing
11.	Untreated control

* DAS – Days after Sowing

The data on percent infestation of agromyzid fly, mean number of sucking pests and yield parameters were subjected to one-way ANOVA, after angular and square root transformation, respectively. The differences in the observations among the different treatments were compared by following Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984) [8].

3. Results and Conclusion

3.1 Aphids, *Aphis* sp.

The lowest mean population of aphids was recorded in seed treated with cyantraniliprole 19.8% + thiamethoxam 19.8% @ 10 ml/kg seed (0.94 aphids/3 leaves) followed by seed treated with thiamethoxam 30 FS @ 10 ml/kg seed (1.13 aphids/3 leaves), seed treated with imidacloprid 600 FS @ 10 ml/kg seed (1.18 aphids/3 leaves). However, the highest mean population of aphids was recorded in soil application of *M. anisopliae* (cfu 2 × 10^8/g) @ 7.50 kg/ha at sowing and untreated control with mean of 6.76 aphids per three leaves (Table 2).

The highest reduction in the population of aphids was recorded in seed treated with cyantraniliprole 19.8% + thiamethoxam 19.8% @ 10 ml/kg seed with 86.09 percent reduction over untreated control. The seed treated with thiamethoxam 30 FS @ 10
ml/kg seed (83.31%), seed treated with imidacloprid 600 FS @ 10ml/kg seed (82.54%), soil application of chlorantraniliprole 0.4% GR @ 10 kg/ha at 35 DAS (67.46%) and foliar spray with chlorantraniliprole 18.5% @ 0.3 ml/l at 25 DAS with 67.22 percent reduction of aphids over control were proved to be effective treatments to manage aphids in carrot (Table 2).

Literature on evaluation of either seed treatment insecticides, or efficacy of biorational/foliar/granular application of insecticides on carrot aphid are lacking. Hence, the reviews pertaining to tuber crop like potato are compared and discussed. Basavaraju *et al*. (2015) [3] reported that imidacloprid was very effective for the management of aphids and thrips in potato. Similarly, the effectiveness of imidacloprid and thiamethoxam against aphids infesting potato was reported by More *et al*. (2015) [10]. Further, Nag *et al*. (2018) [11] also reported foliar spray of imidacloprid followed by thiamethoxam at 15 days interval found most effective against aphids in potato. The application of cyantraniliprole to be most effective against aphids and was at par with flonicamid, imidacloprid and thiamethoxam. The present results are partially supported by Swarupa *et al*. (2019) [19] who reported that seed treated with thiamethoxam 30 FS and imidacloprid 60 FS were found effective against aphids (*Aphis craccivora*) and protected the crop from 1st week to 5th week after germination. Similarly, Shobharani *et al*. (2019) [18] reported the efficacy of seed treated with imidacloprid 60 FS at 7 and 10 ml/kg and thiamethoxam 30 FS at 5.7 ml/kg of seeds proved superior in protecting crop from early season sucking pests like aphids in blackgram.

Table 2: Efficacy of insecticides against aphids in carrot during *rabi*/summer 2021-22

Treatment details	Mean number of aphids/3 leaves					Mean	ROC (%)
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS		
ST with thiamethoxam 30% FS @ 10 ml/kg	0.00 (1.36)^{a}	0.36 (1.24)^{a}	1.30 (1.14)^{a}	1.85 (1.36)^{b}	2.13 (1.46)^{b}	1.13	83.31
ST with cyantraniliprole 19.8% + thiamethoxam 19.8% @ 10 ml/kg	0.00 (1.17)^{a}	0.15 (0.95)^{a}	1.25 (1.12)^{a}	1.45 (1.32)^{b}	1.85 (1.36)^{b}	0.94	86.09
ST with imidacloprid 600 FS @ 10 ml/kg	0.00 (1.31)^{a}	0.42 (1.27)^{a}	1.34 (1.16)^{a}	1.95 (1.39)^{b}	2.19 (1.48)^{b}	1.18	82.54
Soil drenching with chlorpyrifos 20% EC @ 3 ml/l at 35 DAS	3.05 (1.42)^{c}	4.23 (1.54)^{c}	3.12 (1.76)^{b}	2.95 (1.72)^{c}	2.58 (1.60)^{c}	3.19	52.87
Soil application with chlorantraniliprole 0.4% GR @ 10 kg/ha at 35 DAS	3.01 (1.43)^{c}	4.26 (1.51)^{c}	1.3 (1.14)^{a}	1.25 (1.12)^{a}	1.18 (1.09)^{a}	2.20	67.46
Soil application with fipronil 0.3% GR @ 10 kg/ha at 35 DAS	3.10 (1.44)^{c}	4.34 (1.54)^{c}	1.32 (1.15)^{a}	1.28 (1.13)^{a}	1.25 (1.12)^{a}	2.26	66.60
Foliar spray with chlorantraniliprole 18.5% @ 0.3 ml/l at 25 DAS	3.03 (1.45)^{c}	4.10 (1.52)^{c}	1.34 (1.16)^{a}	1.32 (1.15)^{a}	1.29 (1.13)^{a}	2.22	67.22
Soil application with *Metarhizium anisopliae* (cfu 2 × 10^{8}/g) @ 7.50 kg/ha at sowing	3.36 (3.25)^{d}	4.98 (2.92)^{d}	6.23 (2.49)^{d}	8.56 (2.92)^{e}	10.65 (3.26)^{e}	6.76	0.00
Soil application with pongamia cake @ 250 kg/ha at sowing	1.93 (2.40)^{b}	2.12 (2.36)^{b}	3.89 (1.97)^{c}	5.57 (2.36)^{d}	5.76 (2.40)^{d}	3.85	42.99
Soil application with neem cake @ 250 kg/ha at sowing	1.85 (2.37)^{b}	1.98 (2.28)^{b}	3.79 (1.94)^{c}	5.34 (2.31)^{d}	5.65 (2.37)^{d}	3.72	44.94
Untreated control	3.36 (3.25)^{d}	4.98 (2.92)^{d}	6.23 (2.49)^{d}	8.56 (2.92)^{e}	10.65 (3.26)^{e}	6.76	0.00
S. Em. ±	0.13	0.17	0.16	0.21	0.24		
C.D. at 5%	0.38	0.51	0.47	0.62	0.70		
C.V. (%)	11.42	11.09	10.35	10.49	10.81		

Figures in parenthesis are square root (√x + 0.5) transformed values, Means showing similar alphabets do not differ significantly by DMRT, DAS – Days after sowing, ST – Seed treatment, ROC - Reduction over control.

3.2 Leaf hoppers, *Blaclutha* sp.

The cumulative mean population of leaf hoppers was recorded in seed treated with cyantraniliprole 19.8% + thiamethoxam 19.8% @ 10 ml/kg seed (1.35 leaf hoppers/3 leaves) followed by seed treated with thiamethoxam 30 FS @ 10 ml/kg seed (1.41 leaf hoppers/3 leaves), seed treated with imidacloprid 600 FS @ 10 ml/kg seed (1.46 leaf hoppers/3 leaves). However, the highest mean population of leaf hoppers was recorded in soil application of *M. anisopliae* (cfu 2 × 10^{8}/g) @ 7.50 kg/ha at sowing and untreated control with 7.00 leaf hoppers per three leaves (Table 3).

The highest reduction in the population of leaf hoppers was registered in seed treated with cyantraniliprole 19.8% + thiamethoxam 19.8% @ 10 ml/kg seed with 80.69 percent reduction over untreated control. The seed treated with thiamethoxam 30 FS @ 10 ml/kg seed (79.89%), seed treated with imidacloprid 600 FS @ 10 ml/kg seed (79.11%) and soil application of chlorantraniliprole 0.4% GR @ 10 kg/ha at 35 DAS (63.66%) have recorded maximum reduction of leaf hoppers population over control and were effective treatments to manage leaf hoppers in carrot (Table 3).

Reviews related to seed treated with cyantraniprole 19.8% + thiamethoxam 19.8%, thiamethoxam 30 FS and imidacloprid 600 FS to manage leaf hopers in carrot are lacking. However, these chemicals are belonging to similar chemical group and hence literature on leaf hopper management in other crops with these molecules are compared and discussed here. Swarupa *et al*. (2019) [19] opined that seed treated with thiamethoxam 35 FS was found to be the best in reducing the leaf hopper, *Emposca kerri* population by 47.38 and 55.23 percent in both the experiments I and II, respectively. Neonicotinoids are unique because there are few insecticidal seed treatments and they have both contact and systemic activity. Thus, these neonicotinoids control both soil pests and above ground insects that attack early stages of the crop during emergence. Puramchatwad (2017) [14] who reported seed treated with imidacloprid 60 FS @ 10 ml/kg seed and seed treated with thiamethoxam 70 WS @ 5 g/kg seed were found effective in controlling leaf hoppers in green gram is supporting to the present finding in carrot with variations in formulation and dosage.

3.3 Plant hoppers, *Sogatella* sp.

The lowest overall mean population of plant hoppers was recorded in seed treated with cyantraniliprole 19.8% + thiamethoxam 19.8% @ 10 ml/kg seed (1.14 plant hoppers/3 leaves) followed by seed treated with thiamethoxam 30 FS @ 10 ml/kg seed (1.21 plant hoppers/3 leaves), seed treated with imidacloprid 600 FS @ 10 ml/kg seed (1.26 plant hoppers/3 leaves). However, the highest mean population of plant hoppers was recorded in soil application of *M. anisopliae* (cfu 2 × 10^{8}/g) at sowing and untreated control with 5.77 plant hoppers per three leaves (Table 4).

Table 3: Efficacy of insecticides against leaf hoppers in carrot during *rabi*/summer 2021-22

Treatment details	Mean number of leaf hoppers/3 leaves					Mean	ROC (%)
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS		
ST with thiamethoxam 30% FS @ 10 ml/kg	0.35 (0.59)^{a}	0.52 (0.72)^{a}	1.72 (1.31)^{a}	2.15 (1.46)^{b}	2.30 (1.52)^{b}	1.41	79.89
ST with cyantraniliprole 19.8% + thiamethoxam 19.8% @ 10 ml/kg	0.30 (0.59)^{a}	0.49 (0.72)^{a}	1.62 (1.27)^{a}	2.12 (1.45)^{b}	2.23 (1.49)^{b}	1.35	80.69
ST with imidacloprid 600 FS @ 10 ml/kg	0.39 (0.62)^{a}	0.58 (0.76)^{a}	1.79 (1.34)^{a}	2.19 (1.48)^{b}	2.36 (1.53)^{b}	1.46	79.11
Soil drenching with chlorpyrifos 20% EC @ 3 ml/l at 35 DAS	3.12 (1.76)^{c}	4.21 (2.05)^{c}	3.02 (1.74)^{b}	2.78 (1.67)^{c}	2.58 (1.60)^{c}	3.14	55.11
Soil application with chlorantraniliprole 0.4% GR @ 10 kg/ha at 35 DAS	3.10 (1.76)^{c}	4.12 (2.03)^{c}	1.73 (1.31)^{a}	1.85 (1.36)^{a}	1.92 (1.38)^{a}	2.54	63.66
Soil application with fipronil 0.3% GR @ 10 kg/ha at 35 DAS	3.12 (1.76)^{c}	4.19 (2.04)^{c}	1.76 (1.32)^{a}	1.90 (1.38)^{a}	1.98 (1.41)^{a}	2.59	63.00
Foliar spray with chlorantraniliprole 18.5% @ 0.3 ml/l at 25 DAS	3.19 (1.78)^{c}	4.20 (2.05)^{c}	1.79 (1.34)^{a}	1.95 (1.39)^{a}	2.05 (1.43)^{a}	2.64	62.34
Soil application with *Metarhizium anisopliae* (cfu 2 × 10^{8}/g) @ 7.50 kg/ha at sowing	4.05 (2.01)^{d}	6.34 (2.51)^{d}	7.24 (2.69)^{d}	8.23 (2.87)^{e}	9.12 (3.02)^{e}	7.00	0.00
Soil application with pongamia cake @ 250 kg/ha at sowing	1.78 (1.33)^{b}	2.45 (1.56)^{b}	3.38 (1.84)^{c}	4.65 (2.15)^{d}	5.34 (2.31)^{d}	3.52	49.71
Soil application with neem cake @ 250 kg/ha at sowing	1.65 (1.28)^{b}	2.35 (1.53)^{b}	3.32 (1.82)^{c}	4.60 (2.14)^{d}	5.26 (2.29)^{d}	3.44	50.91
Untreated control	4.05 (2.01)^{d}	6.34 (2.51)^{d}	7.24 (2.69)^{d}	8.23 (2.87)^{e}	9.12 (3.02)^{e}	7.00	0.00
S. Em. ±	0.14	0.24	0.18	0.23	0.25	-	
C.D. at 5%	0.43	0.60	0.54	0.65	0.75	-	
C.V. (%)	11.91	11.54	11.04	11.45	11.64	-	

Figures in parenthesis are square root (√x + 0.5) transformed values, Means showing similar alphabets do not differ significantly by DMRT, DAS – Days after sowing, ST – Seed treatment, ROC - Reduction over control

The highest reduction in the population of plant hoppers was recorded in seed treated with cyantraniliprole 19.8% + thiamethoxam 19.8% @ 10 ml/kg seed with 80.31 percent reduction over untreated control. The seed treated with thiamethoxam 30 FS @ 10 ml/kg seed (78.96%), seed treated with imidacloprid 600 FS @ 10 ml/kg seed (78.16%), soil application of chlorantraniliprole 0.4% GR @ 10 kg/ha at 35 DAS (63.33%) and soil application of fipronil 0.3% GR @ 20 kg/ha at 35 DAS with 62.77 percent reduction of plant hoppers population over control (Table 4). The incidence and management strategies of insect pests of carrot are the first of its kind from India.

Table 4: Efficacy of insecticides against plant hoppers in carrot during *rabi*/summer 2021-22

Treatment details	Mean number of plant hoppers/3 leaves					Mean	ROC (%)
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS		
ST with thiamethoxam 30% FS @ 10 ml/kg	0.24 (0.49)^{a}	0.46 (0.68)^{a}	1.42 (1.19)^{a}	1.83 (1.35)^{b}	2.12 (1.45)^{b}	1.21	78.96
ST with cyantraniliprole 19.8% + thiamethoxam 19.8% @ 10 ml/kg	0.20 (0.45)^{a}	0.32 (0.57)^{a}	1.40 (1.18)^{a}	1.75 (1.32)^{b}	2.01 (1.42)^{b}	1.14	80.31
ST with imidacloprid 600 FS @ 10 ml/kg	0.26 (0.51)^{a}	0.53 (0.73)^{a}	1.42 (1.19)^{a}	1.94 (1.39)^{b}	2.15 (1.46)^{b}	1.26	78.16
Soil drenching with chlorpyrifos 20% EC @ 3 ml/l at 35 DAS	3.00 (1.73)^{c}	4.12 (2.03)^{c}	2.68 (1.98)^{b}	2.52 (1.48)^{c}	2.43 (1.33)^{c}	2.95	48.87
Soil application with chlorantraniliprole 0.4% GR @ 10 kg/ha at 35 DAS	2.85 (1.69)^{c}	4.10 (2.02)^{c}	1.42 (1.16)^{a}	1.20 (1.09)^{a}	1.01 (1.00)^{a}	2.12	63.33
Soil application with fipronil 0.3% GR @ 10 kg/ha at 35 DAS	2.95 (1.72)^{c}	4.15 (2.03)^{c}	1.45 (1.20)^{a}	1.20 (1.09)^{a}	0.99 (0.99)^{a}	2.15	62.77
Foliar spray with chlorantraniliprole 18.5% @ 0.3 ml/l at 25 DAS	2.98 (1.72)^{c}	4.10 (2.02)^{c}	1.47 (1.21)^{a}	1.23 (1.11)^{a}	1.09 (1.04)^{a}	2.17	62.32
Soil application with *Metarhizium anisopliae* (cfu 2 × 10^{8}/g) @ 7.50 kg/ha at sowing	3.84 (1.96)^{d}	4.92 (2.22)^{d}	5.78 (2.40)^{d}	6.47 (2.54)^{e}	7.84 (2.80)^{e}	5.77	0.00
Soil application with pongamia cake @ 250 kg/ha at sowing	2.02 (1.42)^{b}	2.30 (1.52)^{b}	3.12 (1.76)^{c}	3.83 (1.95)^{d}	4.45 (2.11)^{d}	3.14	45.51
Soil application with neem cake @ 250 kg/ha at sowing	1.98 (1.41)^{b}	2.25 (1.50)^{b}	3.08 (1.75)^{c}	3.7 (1.92)^{d}	4.34 (2.08)^{d}	3.07	46.79
Untreated control	3.84 (1.96)^{d}	4.92 (2.22)^{d}	5.78 (2.40)^{d}	6.47 (2.54)^{e}	7.84 (2.80)^{e}	5.77	0.00
S. Em. ±	0.13	0.17	0.14	0.17	0.20	-	
C.D. at 5%	0.38	0.50	0.41	0.49	0.60	-	
C.V. (%)	10.89	10.72	10.10	10.66	11.50	-	

Figures in parenthesis are square root (√x + 0.5) transformed values, Means showing similar alphabets do not differ significantly by DMRT, DAS – Days after sowing, ST – Seed treatment, ROC - Reduction over control

Conclusion

The highest percent reduction of aphid population was noticed in seed treated with cyantraniliprole 19.8% + thiamethoxam 19.8% @ 10 ml/kg seed with 86.09 percent over control. The seed treated with thiamethoxam 30 FS @ 10 ml/kg seed (83.31%), seed treated with imidacloprid 600 FS @ 10 ml/kg seed (82.54%), soil application of chlorantraniliprole 0.4% GR @ 10 kg/ha at 35 DAS (67.46%), foliar spray with chlorantraniliprole 18.5% @ 0.3 ml/l at 25 DAS (67.22%) and soil application of fipronil 0.3% GR @ 20 kg/ha at 35 DAS (66.60%) recorded a maximum reduction of aphids over control. Further, soil application of *M. anisopliae* (cfu 2×10^8/g) @ 7.50 kg/ha at sowing was ineffective against aphids and its efficacy was on par with control. With respect to leaf hoppers the highest reduction in the population was registered in seed treated with cyantraniliprole 19.8% + thiamethoxam 19.8% @ 10 ml/kg seed with 80.69 percent reduction over control. This was followed by seed treated with thiamethoxam 30 FS @ 10 ml/kg seed (79.89%), seed treated with imidacloprid 600 FS @ 10 ml/kg seed (79.11%). Soil application of *M. anisopliae* (cfu 2×10^8/g) @ 7.50 kg/ha at sowing continued to be ineffective treatment against leaf hoppers and on par with control. Further with respect to plant hoppers, the highest percent reduction was recorded in seed treated with cyantraniliprole 19.8% + thiamethoxam 19.8% @ 10 ml/kg seed with 80.31 percent reduction over untreated control which was followed by seed treated with thiamethoxam 30 FS @ 10 ml/kg seed (78.96%), seed treated with imidacloprid 600 FS @ 10 ml/kg seed (78.16%). As usual the soil application of *M. anisopliae* (cfu 2×10^8/g) @ 7.50 kg/ha at sowing once again proved to be ineffective against plant hoppers and was on par with control.

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