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Evaluation of new formulation of seed treatment chemicals for the management of sucking insect pests of okra

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Abstract
Studies were conducted to evaluate the effect of new formulations of seed dressing chemicals *viz.*, Thiamethoxam 35 FS and Imidacloprid 60 FS at different concentrations against the sucking insect pests of okra *viz.*, thrips and leafhopper using the most popular Arka Anamika variety during 2015, 2016 and 2017 at different regions of north eastern zones of Karnataka like Main Agricultural Research Station, Raichur (Zone-2) and Agricultural Research Station, Bidar (zone-1). Earlier these two chemicals formulation were available as 70 WS, but now these chemicals formulation has changed to FS (Formulation of seed). Hence studies were conducted to evaluate the effective dosage of these two chemicals. Among them imidacloprid at 10 ml per kg seed recorded minimum number of 3.39 and 2.50 thrips per leaf and 1.18 and 1.49 leafhopper population per leaf from MARS, Raichur and ARS, Bidar respectively. However, this treatment found to be on par with thiamethoxam 35 FS @ 15 ml/kg seed. Further, the fruit yields obtained from these two treatments were 122.53 and 125.30 q/ha with a B: C ratio of 3.40 and 3.48 respectively.

Keywords: Okra, sucking insect, B: C ratio, seed dressing chemicals

1. Introduction
Okra (*Abelmoschus esculentus*), also known as lady's fingers in English, gombo in French and bhendi in Hindi [3], is a popular and common vegetable. Okra has a good potential as a foreign exchange crop and accounts for 65 per cent of the export of fresh vegetables. It is cultivated in 0.35 m ha area with the production of 3.5 mt and productivity of 9.6 mt/ha. The major okra producing states in India are Uttar Pradesh, Bihar, Orissa, West Bengal, Andra Pradesh and Karnataka. As high as 72 species of insects have been recorded on okra [16], of which, the sucking pests comprising of aphids, leafhopper, whiteflies and mite causes significant damage to the crop. Leafhoppers causes about 40 to 56 per cent losses in okra [7]. Aphids and leafhoppers are important pests in the early stage of the crop which desap the plants, make them weak and reduce the yield. Failure to control them in the initial stages was reported to cause a yield loss to the tune of 54.04 per cent [2].
Management of sucking pests by chemical application is a routine and never ending process because if some pests are controlled by the use of selective new molecules but repeated application of the same might lead to resistance development coupled with accumulation of residue in the fruits. Hence, to avoid these consequences an eco-friendly, cost effective and easy to adopt method was evolved *i.e.*, seed treatment with definite formulation of chemicals. In bhendi for the management of sucking insect pest seed treatment with imidacloprid 70 WS @ 5 gm per kg seed and thiamethoxam 70 WS @ 3gm per kg seed is in vogue [15], but the formulation of these chemicals have been changed to FS (formulation of seed). Once their formulation is changed automatically their dosage to be used also varies. Hence, studies were conducted to evaluate new formulation of these two chemicals for their effective dosage against sucking insect pest management in okra.

2. Materials and Methods
The field experiment was conducted to evaluate new formulation of seed treatment chemicals against sucking insect pests of okra in two different regions of north eastern dry zones of Karnataka *viz.*, Main Agricultural Research Station, Raichur (Zone II) and Agricultural Research station, Bidar (Zone I) consecutively for three years during 2015-16, 2016-17 and

2017-18. The experiment was conducted to evaluate imidacloprid 60 FS (Gaucho) at 5 and 10 ml per kg seed and thiamethoxam 7.5 and 15 ml per kg of seed in comparison with imidacloprid 17.8 SL @ 0.30 ml per lit spray against sucking insect pests. Okra crop variety Arka anamika seeds were treated with different seed dressing chemicals and later shade dried and dibbled manually in the field during 2nd week of July in 2015, 2016 and 2017 with a spacing of 75 X 30 cm in a plot size of 4.5× 2.40 m at the both Agricultural Research Stations.

Each treatment was replicated thrice and crop was raised with recommended package of practice prescribed by the University [1] excluding plant protection measures. Observations on sucking insect pests *viz.*, leafhopper, aphids, thrips and whiteflies were started documenting from 10 days after sowing and continued at 20, 30 and 40 days. But in imidacloprid 17.8 SL spray treatment the chemical was imposed when the crop was 15-20 and 25-30 days after sowing anticipating that population of sucking pests would cross threshold levels. Five plants were selected randomly in each plot per replication were tagged to document the sucking insects *viz.*, leafhopper, aphids, thrips and whiteflies per top three leaves. The data on insect counts were subjected to square root ($\sqrt{x+1}$) transformation prior to statistical analysis. While, the fruit yield per plot harvested from each picking was summed up and converted to per hectare. Later, cost-economics was worked out separately for each centre.

3. Results and Discussion

3.1 Effect of seed treatments on leafhopper and thrips population at MARS, Raichur

Management of sucking insect pest of okra through different seed dressing chemical *viz.*, imidacloprid 60 FS (5 & 10 ml/kg seed) and thiamethoxam 35 FS (7.5 & 15 ml/kg seed) was carried out at Main Agricultural Research Station, Raichur as well as Agricultural Research Station, Bidar for three seasons during 2015-16, 2016-17 and 2017-18. The data obtained from this experiment is presented location wise.

Population of thrips and leafhopper across different seed dressing chemical varied from 1.62 to 4.24 and 0.69 to 2.09 per leaf at 10 days after sowing respectively. The minimum population of thrips (1.62/leaf) and leafhopper (0.69/leaf) was recorded in higher dosage of thiamethoxam 35 FS @ 15 ml per kg seed which found to be on par with imidacloprid 60 FS @ 10 ml per kg of seed with 1.77 thrips and 0.77 leafhopper per leaf. Further, when the observations recorded at 20, 30 and 40 days after spray followed similar trend as above but as observation days progressed there found gradual increase in the pest population in all the seed dressing chemical treatments but not exceeded the economic threshold level. However, in standard check *i.e.*, imidacloprid 17.8 SL @ 0.30 ml per lit spray was given at 15-20 and 25-30 day after sowing so as to curb the menace of thrips and leafhopper population.

3.2 Effect of seed treatments on leafhopper and thrips at ARS, Bidar

The observations recorded during all the three seasons depicted that the thrips and leafhopper population were varied from 0.48 to 5.74 and 0.29 to 4.70 per leaf at 10 days after sowing respectively. The least thrips and leafhoppers population was noticed in seed dressing chemicals *viz.*, thiamethoxam 35 FS @ 7.5 ml per kg seed with 0.88 and 0.48 per leaf and the highest dosage (15 ml/kg seed) of the same chemical recorded 0.48 and 0.29 per leaf respectively. The seed dressing chemical like imidacloprid 60 FS @ 10 ml per kg seed recorded minimum thrips and leafhopper population of 1.06 and 0.49 per leaf respectively and it was on par with the above two treatments. The observations recorded at 20, 30 and 40 days after sowing followed the similar trend but when observation days progressed there was a gradual increase in the thrips and leafhopper population but not exceed the economic threshold level.

In all the three cropping seasons higher dosage of the imidacloprid 60 FS (10ml/kg seed) and thiamethoxam 35 FS (15ml/kg seed) proved effective and were on par with each other in reducing thrips and leafhopper population up to 40 DAS. The reviews pertaining to efficacy of new formulation, imidacloprid 60 FS and thiamethoxam 35 FS in okra are lacking as it is new molecule. However, their superiority in managing the sucking pests in other crops has been documented. Thiamethoxam and imidacloprid 70 WS seed dressing chemical protect the crop up to 55 days after sowing in okra [15]. Further, imidacloprid 60 FS @ 10 ml/kg seed was most effective in controlling sucking pest up to 40-45 days after sowing with highest grain yield and cost effective in green gram crop [12]. Imidacloprid 600FS when applied as seed treatment was most effective in controlling the sucking pests up to four week of seed germination in soybean [5].

Further, Seed treatment with imidacloprid 70 WS @ 2.0, 3.0, 5.0, 4.0 and 0.5 g a. i./kg recorded least number of hoppers *i.e.*, 0.5, 0.5, 0.5, 0.6 and 0.8 per 5 sweeps, respectively at 30 days after emergence in groundnut [10]. Imidacloprid as seed treating chemical reduced sucking pest population below the economic threshold level up to 40 days after sowing in cotton and 61 days after germination [4, 8, 9, 11] in cotton. The seed treatment by Imidacloprid recorded the lowest incidence of the sucking pests in blackgram [14] Imidacloprid (Gaucho 70 WS) effectively reduced population of aphids, whiteflies and thrips in cotton [6]. Seed treatment with imidacloprid 70 WS @ 5 g a. i./kg in mustard for the management of painted bug recorded higher benefit cost ratio [13].

3.3 Yield

Among the seed dressing chemical applied, highest fruit yield of 133.11 q/ha (Raichur) and 128.53q/ha (Bidar) was noticed in thiamethoxam 35 FS @ 15ml per kg seed treatment which was on par with the other seed dressing chemical like imidacloprid @ 10 ml per kg seed treatment recorded 122.53 (Raichur) and 125.30 (Bidar) q/ha. All the above treatments are far superior over standard check *viz.*, imidacloprid 17.8 SL @ 0.30 spray treatment recorded fruit yield of 109.99 and 108.66 q/ha in Raichur and Bidar respectively.

3.4 Benefit: Cost Ratio

Cost economics of different seed dressing chemicals tested at MARS, Raichur, revealed that thiamethoxam 35 FS @ 15 ml per kg of seed recorded significantly highest net returns of Rs.1, 35,983 with a B: C ratio of 3.70 which found statistically on par with imidacloprid 60 FS @ 10 ml per kg of seed which recorded net returns of Rs.121162 and B: C ratio of 2.40. These two treatments are differed significantly with rest other treatments and found to be far superior over their lower dosages as well as imidacloprid 17.8 SL which registered net returns of Rs. 1, 02, 426 and B: C ratio of 2.99.

Cost economics made from the seed dressing trial carriedout at ARS, Bidar revealed that net returns realized from thiamethoxam 35 FS @ 15 ml per kg seed was Rs. 129571

which was much more than 7.5ml per kg seed. Imidacloprid 60 FS @ 10 ml per kg seed recorded highest net returns of Rs. 175420 which was more than 5 ml per kg seed. That means just by increasing the dosage of the chemical from 7.5 to 15 ml per kg seed in thiamethoxam and 5 to 10 ml per kg seed in case of imidacloprid seed treatment we can get additional net returns of Rs.13,916 and 15316 respectively. Hence, the benefit: cost ratio obtained was 3.57 and 3.48 as against 3.30 and 3.18 in thiamethoxam and imidacloprid seed treatment respectively.

Table 1: Effect of new formulation of seed dressing chemicals against sucking insect pest of okra at MARS, Raichur

Treatment details	Population of thrips/leaf					Population of leafhopper / leaf					Fruit Yield (q/ha)
	10 DAS	20 DAS	30 DAS	40 DAS	Mean	10 DAS	20 DAS	30 DAS	40 DAS	Mean	
T1: Imidacloprid 60 FS @ 5 ml/kg seed (Gaucho 48 FS)	2.15 (1.62)^{a}	3.88 (2.09)^{b}	6.04 (2.55)^{b}	7.29 (2.79)^{d}	4.84	1.18 (1.29)^{b}	1.38 (1.37)^{b}	1.75 (1.50)^{b}	2.28 (1.66)^{bc}	1.64	109.33
T2: Imidacloprid 60 FS @ 10 ml/kg seed (Gaucho 48 FS)	1.77 (1.50)^{a}	2.42 (1.97)^{b}	4.28 (2.18)^{a}	5.09 (2.36)^{ab}	3.39	0.77 (1.12)^{a}	0.95 (1.20)^{a}	1.24 (1.31)^{a}	1.79 (1.59)^{ab}	1.18	122.53
T3: Thiamethoxam 35 FS @ 7.5 ml/kg seed (Cruiser 35 FS)	2.05 (1.59)^{a}	3.58 (2.01)^{b}	5.46 (2.44)^{b}	5.75 (2.50)^{bc}	4.21	0.99 (1.22)^{ab}	1.35 (1.36)^{b}	1.66 (1.46)^{b}	2.02 (1.58)^{abc}	1.50	114.15
T4: Thiamethoxam 35 FS @ 15 ml/kg seed (Cruiser 35 FS)	1.62 (1.45)^{a}	2.23 (1.65)^{a}	3.75 (2.06)^{a}	4.69 (2.27)^{a}	3.07	0.69 (1.09)^{a}	0.87 (1.17)^{a}	1.19 (1.20)^{a}	1.68 (1.47)^{a}	1.10	133.11
T5: Imidacloprid 17.8 SL spray @ 0.30 ml/lit	3.12 (1.90)^{b}	4.48 (2.23)^{c}	7.05 (2.74)^{c}	6.22 (2.59)^{c}	5.21	1.65 (1.46)^{c}	1.62 (1.45)^{b}	2.29 (1.67)^{c}	2.37 (1.63)^{c}	1.98	109.99
T6: Untreated Control	4.24 (2.17)^{c}	7.41 (2.81)^{d}	8.94 (3.07)^{d}	11.11 (3.40)^{e}	7.92	2.09 (1.60)^{c}	2.53 (1.74)^{c}	3.35 (1.96)^{d}	4.46 (2.22)^{d}	3.10	56.10
S. Em ±	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.05	0.04	1.09
CD @ 5 %	0.17	0.16	0.16	0.17	0.16	0.14	0.14	0.14	0.17	0.14	3.50
CV (%)	8.63	10.67	6.55	6.35	8.05	6.25	8.69	5.80	7.30	7.01	4.27

DAS-Days after sowing, Figures in the parentheses are square root ($\sqrt{x+1}$) transformed values.

Table 2: Effect of new formulation of seed dressing chemicals against sucking insect pest of okra at ARS, Bidar

Treatment details	Population of thrips/leaf					Population of leafhopper / leaf					Fruit Yield (q/ha)
	10 DAS	20 DAS	30 DAS	40 DAS	Mean	10 DAS	20 DAS	30 DAS	40 DAS	Mean	
T1: Imidacloprid 60 FS @ 5 ml/kg seed (Gaucho 48 FS)	1.55 (1.43)^{c}	3.76 (2.06)^{c}	5.18 (2.38)^{c}	4.43 (2.22)^{c}	3.73	0.98 (1.21)^{b}	1.40 (1.37)^{bc}	2.41 (1.70)^{b}	3.32 (1.95)^{c}	2.02	114.36
T2: Imidacloprid 60 FS @ 10 ml/kg seed (Gaucho 48 FS)	1.06 (1.24)^{bc}	2.73 (1.79)^{b}	3.11 (1.90)^{ab}	3.13 (1.90)^{b}	2.50	0.49 (0.99)^{a}	0.95 (1.20)^{ab}	2.04 (1.59)^{b}	2.50 (1.73)^{b}	1.49	125.30
T3: Thiamethoxam 35 FS @ 7.5 ml/kg seed (Cruiser 35 FS)	0.88 (1.17)^{ab}	2.77 (1.80)^{b}	3.98 (2.11)^{b}	3.10 (1.89)^{b}	2.68	0.48 (0.98)^{a}	1.10 (1.26)^{b}	2.01 (1.58)^{b}	2.66 (1.77)^{bc}	1.56	118.59
T4: Thiamethoxam 35 FS @ 15 ml/kg seed (Cruiser 35 FS)	0.48 (0.98)^{a}	1.67 (1.47)^{a}	2.38 (1.69)^{a}	1.91 (1.55)^{a}	1.61	0.29 (0.88)^{a}	0.67 (1.08)^{a}	1.29 (1.33)^{a}	1.75 (1.50)^{a}	1.00	128.53
T5: Imidacloprid 17.8 SL spray @ 0.30 ml/lit	5.74 (2.49)^{d}	3.31 (1.95)^{bc}	3.02 (1.87)^{ab}	4.97 (2.33)^{c}	4.26	4.65 (2.26)^{c}	1.68 (1.47)^{c}	2.45 (1.71)^{b}	4.24 (2.17)^{d}	3.25	108.66
T6: Untreated Control	5.59 (2.46)^{d}	7.54 (2.83)^{d}	11.12 (3.40)^{c}	9.61 (3.17)^{d}	8.46	4.70 (2.28)^{c}	7.25 (2.78)^{d}	8.45 (2.99)^{c}	6.58 (2.66)^{e}	6.74	53.20
S. Em ±	0.07	0.08	0.08	0.09	0.08	0.06	0.05	0.07	0.07	0.06	1.05
CD @ 5 %	0.21	0.24	0.24	0.25	0.23	0.18	0.17	0.21	0.21	0.19	3.15
CV (%)	7.67	7.60	6.87	7.45	7.39	7.71	6.63	7.05	6.75	7.03	5.62

DAS-Days after sowing, Figures in the parentheses are square root ($\sqrt{x+1}$) transformed values.

Table 3: Details of economics and Cost Benefit Ratio of different treatment used against sucking insect pest of Okra at MARS, Raichur

Sl. No	Treatment details	Okra fruit yield (q/ha)	Common cost of cultivation (Rs/ha)	Treatment cost (Rs/ha)	Total cost (Rs/ha)	Gross return (Rs/ha)	Net returns (Rs/ha)	B:C Ratio
1	T1: Imidacloprid 60 FS @ 5 ml/kg seed (Gaucho 48 FS)	109.73	50000	240	50240	153622	103382	3.06
2	T2: Imidacloprid 60 FS @ 10 ml/kg seed (Gaucho 48 FS)	122.53	50000	380	50380	171542	121162	3.40
3	T3: Thiamethoxam 35 FS @ 7.5 ml/kg seed (Cruiser 35 FS)	114.15	50000	235	50235	159600	109365	3.18
4	T4: Thiamethoxam 35 FS @ 15 ml/kg seed (Cruiser 35 FS)	133.11	50000	371	50371	186354	135983	3.70
5	T5: Imidacloprid 17.8 SL spray @ 0.30 ml/lit	109.99	50000	1560	51560	153986	102426	2.99
6	T6: Untreated Control	56.10	50000	-	50000	78540	28540	2.57

Imidacloprid 60 FS @ Rs. 372/100ml Seed rate: 7.5 kg/hectare
Thiamethoxam 35 FS @ 600/250ml Litre of water for spray: 500 lit/ha
Imidacloprid 17.8 SL @ Rs. 1200/lit Okra rate 14 Rs/kg, 1400/qt

Table 4: Details of economics and Cost Benefit Ratio of different treatment used against sucking insect pest of Okra at ARS, Bidar

Sl. No	Treatment details	Okra fruit yield (q/ha)	Common cost of cultivation(Rs/ha)	Treatment cost (Rs/ha)	Total cost (Rs/ha)	Gross return (Rs/ha)	Net returns (Rs/ha)	B:C Ratio
1	T1: Imidacloprid 60 FS @ 5 ml/kg seed (Gaucho 48 FS)	114.36	50000	240	50240	160104	109864	3.18
2	T2: Imidacloprid 60 FS @ 10 ml/kg seed (Gaucho 48 FS)	125.30	50000	380	50380	175420	125040	3.48
3	T3: Thiamethoxam 35 FS @ 7.5 ml/kg seed (Cruiser 35 FS)	118.59	50000	235	50235	166026	115791	3.30
4	T4: Thiamethoxam 35 FS @ 15 ml/kg seed (Cruiser 35 FS)	128.53	50000	371	50371	179942	129571	3.57
5	T5: Imidacloprid 17.8 SL spray @ 0.30 ml/lit	108.66	50000	1560	51560	152124	100564	2.95
6	T6: Untreated Control	53.20	50000	-	50000	74480	24480	1.48

Imidacloprid 60 FS @ Rs. 372/100ml Seed rate: 7.5 kg/hectare
Thiamethoxam 35 FS @ 600/250ml Litre of water for spray: 500 lit/ha
Imidacloprid 17.8 SL @ Rs. 1200/lit Okra rate 14 Rs/kg, 1400/qt

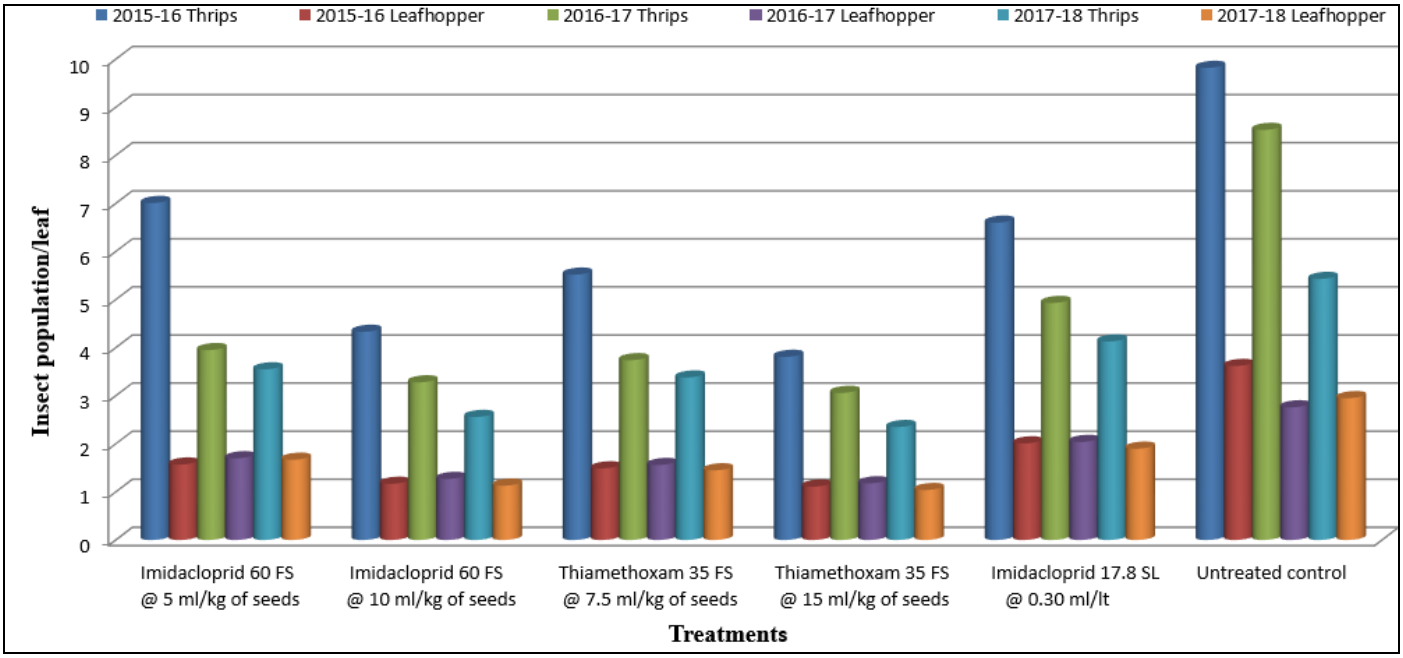

Fig 1: Effect of new formulation of seed dressing chemicals against sucking insect pest of okra (Pooled mean of three years) at MARS, Raichur

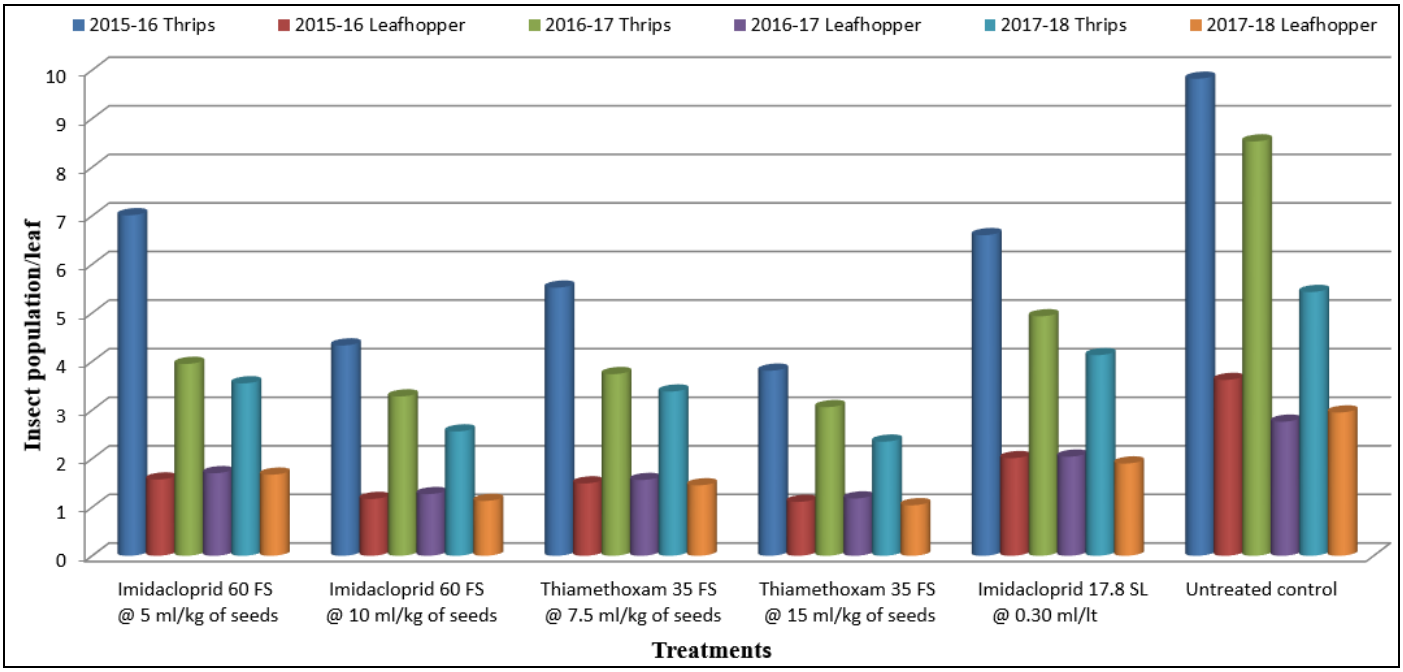

Fig 2: Effect of new formulation of seed dressing chemicals against sucking insect pest of okra (Pooled mean of three years) at ARS, Bidar

4. Conclusion

Imidacloprid 60 FS @ 10ml/kg seeds and thiamethoxam 35 FS @ 15ml/kg seeds were found effective in managing the thrips and leafhopper population in okra up to 40 days after germination and also getting higher fruit yield.

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