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Comparative efficacy of different bio and synthetic insecticides against sucking pests of okra (*Abelmoschus esculentus* L. Moench)

Deepak Jain, Hasmukh Kumar, Bhagwat Singh Chouhan and Bahadur Singh and Harish Sumeriya

Abstract
The field experiment was carried out in the pre-kharif season of 2020 at instructional farm of Vidya Bhawan Krishi Vigyan Kendra, Udaipur, Rajasthan, India to assess the efficacy of different bio-pesticides against sucking pests of okra. The experiment was laid out in randomized complete block design with three replications for each treatment. .Seed treatment with Imidacloprid 600 FS (10 ml / kg seed) and two sprays of imdacloprid 17.8% SL (0.3 ml per litre) at 40 and 60 DAG recorded lowest mean population of whiteflies and jassids (3.90 whiteflies &14.96 jassids/15 leaves).It was followed by seed treatment with Imidacloprid 600 FS (5 ml / kg seed) and two sprays of imdacloprid 17.8% SL (0.15 ml per litre) at 40 and 60 DAG, (4.67 whitefly and 17.59 jassid /15 leaves). Among the different bio-pesticides used neem oil, NSKE and butter milk were also found effective against the targeted sucking pests. Therefore, neem oil can be used as an alternative eco– friendly management option for the sucking pests of okra. Among the microbials, *Beauveria bassiana* and *M. anisopliae* were less effective as compared to other method in reducing the whitefly population, yet found superior over control.

Keywords: Imidacloprid, botanicals, microbials, whiteflies, jassids, yellow mosaic disease

Introduction
Okra or Ladies finger or Bhendi [*Abelmoschus esculentus* (L.) Moench] is most popular vegetable of the family Malvaceae. In India, it is grown both in *summer* and *rainy* seasons [1]. It is cultivated throughout India over an area of 5.09 lakh hectares with a total annual production of 60.94 lakh metric tonnes and a productivity of 11.9 t/ha [2]. In Rajasthan okra as a cash crop providing a continuous and good source of income to the farmers. Okra growers frequently complain yield losses due to insect pests. Though, okra shoot and fruit borer appeared to be the most serious inflicting 45-57.1% damage to fruits [3] but recently the sucking pests like whitefly (*Bemisia tabaci* Genn,) and jassid (*Amrasca biguttula biguttula* Ishida) are becoming major pests under changing climatic condition coupled with application of injudicious and spurious pesticides which causes considerable yield loss. Both nymphs and adults of jassids suck the cell sap usually from the ventral surface of the leaves; while, feeding inject toxic saliva into plant tissues, turning affected leaves turn to yellow and curl. Whiteflies are the milky white minute flies; nymphs and adults suck the cell sap from the leaves. The affected leaves are curled and dried. The affected plants show a stunted growth. Whiteflies are also responsible for transmitting yellow vein mosaic virus Singh *et al.* [4]. Insect pests cause 35-40% crop yield losses and ultimately increase the level of damage up to 60-70% in optimal condition [5]. Presently broad range of systemic and contact insecticides and biopesticides have been recommended to control white flies and jassids Suryawanshi *et al.* [6]., Satpathy *et al.* [7]. Acharya *et al.* [8] reported that imadacloprid formulations were safer to use in the presence of coccinellid predators, Since imadacloprid gives protection to crop by seed treatment from sucking pests for initial 30- 40 days the sprays are not required which helps in augmentation of natural enemies. However, short picking interval of okra fruits cause residue hazards to the consumers when conventional pesticides are used repeatedly, besides killing natural enemies and eventual development of resistance. For the management of whiteflies, farmers use several insecticides indiscriminately, which has lead to development of resistance, resurgence of pest and problem of residual toxicity. To overcome these problems, identification of safe molecules with better insecticidal properties with lower mammalian toxicity, safety to natural enemies and which fit well in the IPM concept is need of the present scenario. In view of these the present investigation was initiated.

Materials and Methods

The field experiment was carried out in the pre-kharif season of 2020 at D Block of techno Farm of Vidya Bhawan Krishi Vigyan Kendra, Badgaon, Udaipur, Rajasthan, India to evaluate the efficacy of different bio-pesticides and insecticides against sucking pests of okra. The experiment was laid out in randomized complete block design with three replications for each treatment. Crop was sown in the plot size of 3m x 4m area with 30 cm x 15 cm spacing. The crop was raised with recommended management practices except plant protection measures. The treatment details for experiment shown below.

T_1- Spray of *Metarhizium anisopliae* (CFU Count 1 x 10^8 / g (5ml/l) at15 days interval on initiation of whitefly and jassid infestation.

T_2- Spray of *Verticillium lecanii* (CFU Count 1 x 10^8 / g (5 ml/l) at15 days interval on initiation of whitefly and jassid infestation.

T_3- Spray of *Beauveria bassiana* (CFU Count 1 x 10^8 / g (5 ml/l) at15 days interval on initiation of whitefly and jassid infestation.

T_4- Spray of Neem oil 1500 PPM (5 ml/l) at15 days interval on initiation of whitefly and jassid infestation.

T_5- Spray of Butter milk (20 ml/l) at15 days interval on initiation of whitefly and jassid infestation.

T_6- Spray of NSKE (5 ml/l) at15 days interval on initiation of whitefly and jassid infestation.

T_7- Seed treatment with Imidacloprid 600 FS (5 ml/ kg seed) followed by two sprays of imdacloprid 17.8% SL (0.15 ml per litre) at 40 and 60 DAG.

T_8 - Spray of Imidacloprid 17.8% SL (0.3 ml/l) at15 days interval on initiation of whitefly and jassid infestation.

T_9- Seed treatment with Imidacloprid 600 FS (10 ml / kg seed) followed by two sprays of imdacloprid 17.8% SL (0.3 ml per litre) at 40 and 60 DAG.

T_9- Untreated (control)

Spraying were done with pneumatic knapsack sprayer using spray fluid @500 l/ ha. Observations were taken on 1 day before the spray as pretreatment and successive observations were recorded on 1, 3, 7 and 14 days after each spray. Whitefly and jassid were counted from randomly selected 5 tagged plants/plot covering top, middle and lower leaves/plant. Critical difference (CD) at 5% level of significance was worked out from the data of mean population before the spraying and subsequent various days' intervals after spraying.

Results and Discussion

The findings of the present research study as well as relevant discussion have been conferred under following points:

Efficacy of insecticides against whiteflies: It is evident from (Table 1) that there was no significant difference in whitefly population among the treatments before spraying. The lowest mean population of whiteflies (2.77 whiteflies/15 leaves) was observed in T_9-Seed treatment with Imidacloprid 600 FS (10 ml per kg seed) treated plots followed by T_7-Seed treatment with Imidacloprid 600 FS (5 ml per kg seed)(3.23 whiteflies/15 leaves), T_8 -Imidacloprid *17.8% SL*(0.3 ml per litre) (4.20 whiteflies/15 leaves), T_5-buttermilk (4.74 whiteflies/15 leaves), T_4 - neem oil (4.56 whiteflies/15 leaves)and T_6-neem seed kernel extract (5.86 whiteflies/15 leaves). Among the microbial pesticides, T_2 -*V. lecanii*, T_3-*B.bassiana*, and T_1- *M. anisopliae* were moderately effective with mean population of 6.89,8.08 and 9.29 whiteflies/15 leaves, respectively. Whereas, in T_{10} - untreated (control) plots it was 13.98 whiteflies/15 leaves. Highest percentage reduction of whiteflies population over control was also recorded in T_9-Seed treatment with Imidacloprid 600 FS (10 ml per kg seed) treated plots (80.20%) followed T_7-Seed treatment with Imidacloprid 600 FS (5 ml per kg seed) (76.87%), T_8 -Imidacloprid *17.8% SL*(0.3 ml per litre) (69.97%). Among the microbials, T_3 -*Beauveriabassiana (*42.17%) and T_1-*M. anisopliae (*33.51%) were not effective in reducing the whitefly population but these were found to be superior over control.

Treatment T_9- imidacloprid17.8% SL (0.3 ml per litre) at 40 days after germination (DAG) recorded minimum population of whitefly (5.04 whitefly/15 leaves) followed byT_7-imidacloprid17.8% SL(0.15 ml per litre) at 40DAG(5.60 whitefly/15 leaves),T_8-imidacloprid 17.8 SL(0.3 ml per litre)(6.80 whiteflies/15 leaves). Treatment T_4 -Neem oil and T_2 -*V. lecanii* were at par with T_6 -NSKE treated plots with 8.14, 8.94 and 9.46 whiteflies/15 leaves, respectively.T_1-*M.anisopliae*, and T_2-*B. bassiana* were found to be less effective in reducing whiteflies population but were superior over control. Similar trend was observed in percent reduction of whitefly population over control as in first spray (Table-2).

After final spray lowest mean population of whitefly (3.89 whiteflies/15 leaves) was observed in T_9- imidacloprid17.8% SL (0.3 ml per litre) at 60 DAG, treated plots followed by neem oil (5.17 whiteflies/15 leaves), imidacloprid (0.15 ml per litre) (5.18 whiteflies/15 leaves) and NSKE (6.90 whiteflies/15 leaves). Highest percent reduction of whiteflies population over control was also recorded in T_9- imidacloprid (0.3 ml per litre) treated plots (82.55%) followed by neemoil (76.87%) and imidacloprid (0.15 ml per litre) (69.97%). (Table -3)

Pooled data of three consecutive sprays or seed treatment plus two spray, presented in (Table 7), re- vealed that T_9- Seed treatment with Imidacloprid 600 FS (10 ml per kg seed) followed by two sprays of imdacloprid 17.8% SL (0.3 ml per litre) at 40 and 60 DAG provided best control with lowest mean population of whiteflies (3.90 whitefly/15 leaves) followed by T_7- Seed treatment with Imidacloprid 600 FS (5 ml/ kg seed) followed by two sprays of imdacloprid 17.8% SL (0.15 ml per litre) at 40 and 60 DAG. *V. lecanii*a, *B. bassiana* and *M. anisopliae*, were less effective in reducing population of whiteflies with mean population of 8.10, 9.18 and 10.11 whiteflies /15 leaves, respectively. Highest percent reduction of whitefly population over control was also recorded in T_9-Seed treatment with Imidacloprid 600 FS (10 ml per kg seed) with two sprays of imdacloprid 17.8% SL (0.3 ml per litre) at 40 and 60 DAG (80.54%) followed by T_7- Seed treatment with Imidacloprid 600 FS (5 ml/ kg seed) with two sprays of imdacloprid 17.8% SL (0.15 ml per litre) at 40 and 60 DAG (76.95%).

Present findings are in close conformity with the results of Sarkar *et al.* [9, 10] who reported that imidacloprid 17.8% SL 0.3 ml/l and@80gm a.i./ha significantly suppressed whitefly and jassid populations, and consequently increased the yield in okra Chandio *et al.* [11], Borkar *et al.* [12] also reported that application of neem oil 1 % as the most effective treatment in recording the minimum population of whitefly in okra. Negasi *et al.* [13C] reported that *V. lecanii* provided moderate control against whitefly population. *M. anisopliae* and *B. bassiana* were less effective in reducing population of whitefly [9].

Efficacy of insecticides against jassids: There was no significant difference of jassid population among the treatments before spraying (Table 4). Treatment, T_9-Seed treatment with Imidacloprid 600 FS (10 ml per kg seed) treated plots recorded lowest mean population (5.13 jassids/15 leaves) followed byT_7-Seed treatment with Imidacloprid 600 FS (5 ml per kg seed) (6.60jassids /15 leaves), T_8 - Imidacloprid *17.8% SL*(0.3 ml per litre) (9.30jassids /15 leaves)treated plots. Next best results were V. lecanii and neem oil with mean population of 11.59 and 12.37 jassids/15 leaves, respectively. *M. anisopliae* and *B. bassiana* were not effective as other treatments in reducing jassids population but were found to be superior over untreated control plots. Highest percentage reduction over control was also found in T_9-Seed treatment with Imidacloprid 600 FS (10 ml per kg seed)(76.79%) treated plots followed by T_7-Seed treatment with Imidacloprid 600 FS (5 ml per kg seed) (70.14%) and T_8 -Imidacloprid *17.8% SL*(0.3 ml per litre) (57.93%) treated plots.

Table (5) showed that treatment, T_9- imidacloprid17.8% SL (0.3 ml per litre) at 40 days after germination (DAG) again provided best control with lowest mean population of 11.12 jassids/15 leaves followed by T_7- imidacloprid 17.8% SL (0.15 ml per litre) at 40DAG(12.53jassids /15 leaves) and T_8-imidacloprid 17.8 SL(0.3 ml per litre) (32.21jassids /15 leaves). Treatment T_4 -Neem oil and T_2 -*V. lecanii* were at par with T_6 -NSKE treated plots with 36.40, 37.72 and 38.89 jassids /15 leaves, respectively. Similar trend was also observed in percent reduction of jassid population over control. During third spray same trend in efficacy of insecticides against jassids was observed (Table 6).

After all three consecutive sprays or seed treatment (Table 7), it was found that T_9- Seed treatment with Imidacloprid 600 FS (10 ml per kg seed) with two sprays of imdacloprid 17.8% SL (0.3 ml per litre) at 40 and 60 DAG proved best control with lowest mean population of jassid (14.96 jassids/15 leaves) followed by T_7-Seed treatment with imidacloprid 600 FS (10 ml per kg seed) and two sprays of imdacloprid 17.8% SL (0.3 ml per litre) at 40 and 60 DAG proved (17.59 jassids/15 leaves) and imidacloprid *17.8% SL* (0.3 ml per litre) (39.27jassid/15 leaves) treated plots. Highest percent reduction of jassids occurred in T_9 (79.14%) followed by T_7 (75.47 %) and T_8-Imidacloprid *17.8% SL* (0.3 ml per litre) (45.26 %). *M*. anisopliae and *B*. bassiana were not effective in reducing population but were superior over untreated control plots. Imidacloprid at 0.3 ml/l and 40 g a.i. ha-1 respectively was the best treatment in reducing the jassid population in okra [9, 14] similarly imidacloprid 600 FS at 9 ml/kg seeds and 70 WP at 10 g/kg seeds were found to be promising against jassid (*A.biguttulabiguttula*) [15]. Neem leaf extract was the most effective in reducing jassid and produced highest yield (426 kg/ha) on cotton [16] also *V. lecanii* at 7 g/l gave significantly higher mortality of okra jassid which is in conformity with the present findings [16].

Yield

Yield of okra were varied significantly in different treatment (Table 7). Highest fruit yield(86.71 q/ha) of okra was recorded in T_9- Seed treatment with Imidacloprid 600 FS (10 ml / kg seed) and two sprays of imdacloprid 17.8% SL (0.3 ml per litre) at 40 and 60 DAG followed by T_7- Seed treatment with Imidacloprid 600 FS (5ml / kg seed) and two sprays of imdacloprid 17.8% SL (0.15ml per litre) at 40 and 60 DAG.(82.32 q/ha) andT_8-Imidacloprid *17.8% SL* (0.3 ml per litre) (76.88 q/ha), whereas, the lowest yield obtained from untreated control plot was 37.42q/ha.

Experiment Field view

Taking Observation of Experiment plots

Counting of Population of white flies and jassids before and after treatment

Table 1: Efficacy of Bio and synthetic insecticides against whitefly during first spray on okra during pre kharif 2020.

Treatment	No. of whitefly/15 leaves before spraying	No. of whitefly /15 leaves at days interval				Mean of 2 nd spray	% reduction over control
		1 DAS	3 DAS	7 DAS	14 DAS		
T_1	11.28(3.43)	8.35(2.97)	9.23(3.12)	8.38(2.98)	11.21(3.42)	9.29	33.51
T_2	10.92(3.29)	5.27(2.40)	7.26(2.79)	6.29(2.61)	8.74(3.04)	6.89	50.70
T_3	10.11(3.26)	9.81(3.21)	7.14(2.76)	8.12(2.94)	7.26(2.79)	8.08	42.17
T_4	11.13(3.41)	3.72(2.05)	4.27(2.18)	4.29(2.19)	5.97(2.54)	4.56	67.35
T_5	11.10(3.41)	3.05(1.88)	4.78(2.30)	4.99(2.34)	6.12(2.57)	4.74	66.12
T_6	10.88(3.37)	4.35(2.20)	5.13(2.37)	6.18(2.58)	7.77(2.88)	5.86	58.09
T_7	10.14(3.26)	1.97(1.57)	1.90(1.55)	4.44(2.22)	4.62(2.26)	3.23	76.87
T_8	9.88(3.22)	2.98(1.86)	2.70(1.79)	5.13(2.37)	5.98(2.55)	4.20	69.97
T_9	11.13(3.44)	1.83(1.53)	1.80(1.52)	3.60(2.02)	3.84(2.08)	2.77	80.20
T_{10}	11.07(3.40)	12.13(3.55)	13.31(3.71)	14.27(3.84)	16.20(4.09)	13.98	--
SE.m	0.2148	0.041	0.050	0.062	0.052	0.019	---
CD at 5%	0.662	0.128	0.155	0.192	0.161	0.060	--

Figures in the parenthesis are square root transformed values; T1- Spray of Metarhizium anisopliae (CFU Count 1 x 108 / g (5ml/l) at 15 days interval on initiation of whitefly and jassid infestation; T_2- Spray of *Verticillium lecanii* (CFU Count 1 x 10^8 / g (5 ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_3- Spray of *Beauveria bassiana* (CFU Count 1 x 10^8 / g (5 ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_4- Spray of Neem oil 1500 PPM (5 ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_5- Spray of Butter milk (20 ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_6- Spray of NSKE (5 ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_7- Seed treatment with Imidacloprid 600 FS (5 ml/ kg seed) followed by two sprays of imdacloprid 17.8% SL (0.15 ml per litre) at 40 and 60 DAG; T_8 - Spray of Imidacloprid 17.8% SL (0.3 ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_9- Seed treatment with Imidacloprid 600 FS (10 ml per kg seed) followed by two sprays of imdacloprid 17.8% SL (0.3 ml per litre) at 40 and 60 DAG; T_9- Untreated (control).

Table 2: Efficacy of Bio and synthetic insecticides against whitefly during second spray on okra during pre kharif 2020.

Treatment	No. of whitefly/15 leaves before spraying	No. of whitefly /15 leaves at days interval				Mean of 2 nd spray	% reduction over control
		1 DAS	3 DAS	7 DAS	14 DAS		
T_1	9.27(3.13)	10.23(3.27)	8.80(3.05)	9.73(3.20)	13.13(3.69)	10.47	57.31
T_2	8.88(3.06)	9.13(3.10)	8.74(3.04)	7.13(2.76)	10.74(3.35)	8.94	63.55
T_3	9.13(3.10)	9.78(3.21)	9.01(3.08)	9.13(3.10)	11.73(3.50)	9.91	59.60
T_4	9.18(3.11)	7.71(2.87)	7.13(2.76)	7.98(2.91)	9.73(3.20)	8.14	66.81
T_5	10.13(3.26)	10.71(3.35)	9..13(3.10)	9.17(3.11)	10.28(3.28)	9.82	59.96
T_6	8.28(2.96)	9.10(3.10)	8.10(2.93)	9.88(3.22)	10.75(3.35)	9.46	61.43
T_7	5.93(2.54)	3.77(2.07)	2.69(1.79)	5.80(2.51)	1013(3.26)	5.60	77.17
T_8	9.23(3.12)	8.13(2.94)	5.83(2.52)	6.12(2.57)	7.10(2.76)	6.80	72.27
T_9	4.27(2.18)	2.81(1.82)	1.70(1.48)	5.77(2.50)	9.88(3.22)	5.04	79.45
T_{10}	16.80(4.12)	20.01(4.53)	22.13(4.75)	25.63(5.11)	30.35(5.55)	24.53	--
SE.m	0.165	0.064	0.058	0.059	0.076	0.043	--
CD at 5%	0.509	0.198	0.181	0.182	0.235	0.134	---

Table 3: Efficacy of Bio and synthetic insecticides against whitefly during third spray on okra during pre kharif 2020.

Treatment	No. of whitefly/15 leaves before spraying	No. of whitefly /15 leaves at days interval				Mean of 2 nd spray	% reduction over control
		1 DAS	3 DAS	7 DAS	14 DAS		
T_1	13.44(3.65)	14.24(3.84)	10.20(3.27)	10.14(3.26)	7.66(2.86)	10.56	52.64
T_2	10.80(3.36)	11.10(3.41)	8.13(2.94)	7.67(2.86)	7.02(2.74)	8.48	61.97
T_3	11.75(3.50)	12.13(3.55)	10.17(3.27)	8.19(2.95)	7.69(2.86)	9.55	57.17
T_4	9.28(3.13)	5.50(2.45)	5.33(2.41)	5.13(2.37)	4.70(2.28)	5.17	76.81
T_5	10.13(3.26)	11.12(3.41)	8.24(2.96)	7.10(2.76)	7.13(2.76)	8.40	62.33
T_6	10.14(3.26)	1.25(1.32)	9.23(3.12)	8.18(2.95)	8.95(3.07)	6.90	69.05
T_7	9.23(3.12)	6.28(2.60)	5.23(2.39)	4.98(2.34)	4.24(2.18)	5.18	76.77
T_8	10.10(3.26)	8.33(2.97)	7.10(2.76)	6.13(2.57)	6.98(2.73)	7.14	67.98
T_9	8.88(3.06)	4.42(2.22)	4.02(2.13)	3.99(2.12)	3.12(1.90)	3.89	82.55
T_{10}	26.13(5.16)	27.52(5.29)	25.13(5.06)	20.29(4.56)	16.25(4.09)	22.30	------
SE.m	0.219	0.070	0.041	0.032	0.055	0.028	
CD at 5%	0.675	0.217	0.126	0.099	0.172	0.086	

Figures in the parenthesis are square root transformed values; T_1- Spray of *Metarhizium anisopliae* (CFU Count 1 x 10^8 / g (5ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_2- Spray of *Verticillium lecanii* (CFU Count 1 x 10^8 / g (5 ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_3- Spray of *Beauveria bassiana* (CFU Count 1 x 10^8 / g (5 ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_4- Spray of Neem oil 1500 PPM (5 ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_5- Spray of Butter milk (20 ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_6- Spray of NSKE (5 ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_7- Seed treatment with Imidacloprid 600 FS (5 ml/ kg seed) followed by two sprays

of imdacloprid 17.8% SL (0.15 ml per litre) at 40 and 60 DAG; T_8 - Spray of Imidacloprid 17.8% SL (0.3 ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_9- Seed treatment with Imidacloprid 600 FS (10 ml per kg seed) followed by two sprays of imdacloprid 17.8% SL (0.3 ml per litre) at 40 and 60 DAG;T_9- Untreated (control).

Table 4: Efficacy of Bio and synthetic insecticides against jassidduring first spray on okra during pre kharif 2020.

Treatment	No. of whitefly/15 leaves before spraying	No. of whitefly /15 leaves at days interval				Mean of 2 nd spray	% reduction over control
		1 DAS	3 DAS	7 DAS	14 DAS		
T_1	12.88(3.66)	13.13(3.67)	10.01(3.24)	17.13(4.18)	22.32(4.77)	15.65	29.21
T_2	13.11(3.69)	10.12(3.26)	9.22(3.12)	11.35(3.44)	15.66(4.02)	11.59	47.58
T_3	14.15(3.80)	12.13(3.55)	11.02(3.39)	18.13(4.32)	22.33(4.78)	15.90	28.08
T_4	11.88(3.52)	8.66(3.03)	7.35(2.80)	16.12(4.08)	17.33(4.22)	12.37	44.05
T_5	12.22(3.57)	9.17(3.11)	8.88(3.06)	17.12(4.20)	18.22(4.33)	13.35	39.62
T_6	13.13(3.69)	11.11(3.41)	10.13(3.26)	14.12(3.82)	17.34(4.22)	13.18	40.38
T_7	12.85(3.65)	7.13(2.76)	5.10(2.37)	6.01(2.55)	8.17(2.94)	6.60	70.14
T_8	12.88(3.66)	9.01(3.08)	8.77(3.04)	9.15(3.11)	10.28(3.28)	9.30	57.93
T_9	12.10(3.55)	6.10(2.57)	3.13(1.91)	4.15(2.16)	7.13(2.76)	5.13	76.79
T_{10}	13.10(3.69)	14.97(3.93)	17.98(4.29)	25.35(5.08)	30.12(5.53)	22.11	----
SE.m	0.118	0.101	0.052	0.107	0.089	0.330	----
CD at 5%	0.364	0.312	0.160	0.330	0.274	0.101	----
CD at 5%	0.064	Figures in the parenthesis are square root transformed values					

Table 5: Efficacy of Bio and synthetic insecticides against jassid during second spray on okra during pre kharif 2020.

Treatment	No. of whitefly/15 leaves before spraying	No. of whitefly /15 leaves at days interval				Mean of 2 nd spray	% reduction over control
		1 DAS	3 DAS	7 DAS	14 DAS		
T_1	25.31(5,08)	20.19(4.55)	22.22(4.77)	35.17(5.96)	112.11(10.60)	47.42	33.82
T_2	16.42(4.11)	19.20(4.44)	15.17(3.96)	30.17(5.54)	86.33(9.32)	37.72	47.36
T_3	23.93(4.94)	23.15(4.86)	29.12(5.44)	62.15(7.92)	88.17(9.42)	50.65	29.31
T_4	18.28(4.33)	13.07(3.68)	18.72(4.48)	35.15(5.97)	78.66(8.90)	36.40	49.20
T_5	19.23(4.44)	16.15(4.08)	22.13(4.76)	37.15(6.14)	80.12(8.98)	38.89	45.73
T_6	19.20(4.44)	16.20(4.09)	25.13(5.06)	40.12(6.37)	90.10(9.52)	42.89	40.14
T_7	9.17(3.11)	5.45(2.44)	6.20(2.59)	8.13(2.94)	30.35(5.55)	12.53	82.51
T_8	12.18(3.56)	10.17(3.27)	8.18(2.95)	40.15(6.38)	70.35(8.42)	32.21	55.05
T_9	8.22(2.95)	3.45(1.99)	3.80(2.07)	7.77(2.88)	29.45(5.47)	11.12	84.48
T_{10}	30.12(5.48)	34.88(5.95)	42.42(6.55)	68.12(8.28)	141.23(11.90)	71.66	-----
SE.m	0.208	0.094	0.105	0.097	0.154	0.060	------
CD at 5%	0.641	0.292	0.324	0.300	0.475		-----

Figures in the parenthesis are square root transformed values; T_1- Spray of *Metarhizium anisopliae* (CFU Count 1 x 10^8 / g (5ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_2- Spray of *Verticillium lecanii* (CFU Count 1 x 10^8 / g (5 ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_3- Spray of *Beauveria bassiana* (CFU Count 1 x 10^8 / g (5 ml/l) at15 days interval on initiation of whitefly and jassid infestation;T_4- Spray of Neem oil 1500 PPM (5 ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_5- Spray of Butter milk (20 ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_6- Spray of NSKE (5 ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_7- Seed treatment with Imidacloprid 600 FS (5 ml/ kg seed) followed by two sprays of imdacloprid 17.8% SL (0.15 ml per litre) at 40 and 60 DAG; T_8 - Spray of Imidacloprid 17.8% SL (0.3 ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_9- Seed treatment with Imidacloprid 600 FS (10 ml per kg seed) followed by two sprays of imdacloprid 17.8% SL (0.3 ml per litre) at 40 and 60 DAG; T_9- Untreated (control).

Table 6: Efficacy of Bio and synthetic insecticides against jassid during third spray on okra during pre kharif 2020.

Treatment	No. of whitefly/15 leaves before spraying	No. of whitefly /15 leaves at days interval				Mean of 2 nd spray	% reduction over control
		1 DAS	3 DAS	7 DAS	14 DAS		
T_1	110.11(10.52)	95.23(9.78)	98.21(9.94)	116.10(10.78)	122.33(11.08)	107.97	11.09
T_2	113.12(10.65)	96.23(9.84)	82.18(9.09)	90.12(9.52)	110.13(10.51)	94.67	22.05
T_3	89.13(9.47)	72.12(8.52)	66.77(8.20)	98.92(9.97)	116.10(10.78)	88.48	27.14
T_4	83.13(9.14)	70.10(8.40)	65.17(8.10)	70.12(8.40)	88.09(9.41)	73.37	39.58
T_5	90.13(9.52)	78.13(8.87)	69.23(8.35)	75.13(8.70)	109.10(10.47)	82.90	31.74
T_6	110.12(10.45)	93.13(9.68)	98.19(9.93)	99.10(9.98)	121.15(11.03)	102.89	15.28
T_7	36.12(6.05)	20.12(4.54)	18.16(4.32)	37.17(6.14)	59.12(7.72)	33.64	72.30
T_8	78.12(8.87)	50.53(7.14)	47.20(6.91)	98.35(9.94)	109.10(10.47)	76.30	37.13
T_9	35.17(5.97)	17.18(4.20)	14.16(3.83)	32.66(5.76)	50.56(7.15)	28.64	76.41
T_{10}	145.25(12.00)	120.12(10.97)	109.16(10.47)	123.16(11.12)	133.35(11.57)	121.45	-----
SE.m	0.531	0.154	0.098	0.168	0.208	0.095	---
CD at 5%	1.638	0.475	0.302	0.518	0.643	0.292	--

Table 7: Overall performance of insecticides against whitefly and jassid (Pooled of three spray)

Treatment	Maen No. of insects /15 leaves at days interval		% reduction over control		Yield (q/ha)	% increase yield over control
	White fly	Jassid	White fly	Jassid		
T_1	10.11(3.24)	57.01(6.94)	49.25	20.52	50.11	33.91
T_2	8.10(2.92)	47.99(6.34)	60.33	33.10	54.17	44.76
T_3	9.18(3.10)	51.68(6.76)	53.18	27.96	53.76	43.66
T_4	5.96(2.52)	40.71(5.95)	71.33	43.25	67.13	79.39
T_5	7.65(2.82)	45.04(6.25)	64.24	37.21	62.17	66.14
T_6	7.41(2.76)	52.99(6.70)	64.25	26.14	60.97	62.93
T_7	4.67(2.23)	17.59(3.91)	76.95	75.47	82.32	119.98
T_8	6.04(2.53)	39.27(5.67)	71.37	45.26	76.88	105.45
T_9	3.90(2.05)	14.96(3.56)	80.54	79.14	86.71	131.72
T_{10}	20.27(4.91)	71.74(7.97)	--	--	37.42	--
SE.m	0.020	0.035	--	--	--	---
CD at 5%	0.064	0.110	--	--	--	---

Figures in the parenthesis are square root transformed values; T_1- Spray of *Metarhizium anisopliae* (CFU Count 1 x 10^8 / g (5ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_2- Spray of *Verticillium lecanii* (CFU Count 1 x 10^8 / g (5 ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_3- Spray of *Beauveria bassiana* (CFU Count 1 x 10^8 / g (5 ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_4- Spray of Neem oil 1500 PPM (5 ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_5- Spray of Butter milk (20 ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_6- Spray of NSKE (5 ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_7- Seed treatment with Imidacloprid 600 FS (5 ml/ kg seed) followed by two sprays of imdacloprid 17.8% SL (0.15 ml per litre) at 40 and 60 DAG; T_8 - Spray of Imidacloprid 17.8% SL (0.3 ml/l) at15 days interval on initiation of whitefly and jassid infestation; T_9- Seed treatment with Imidacloprid 600 FS (10 ml per kg seed) followed by two sprays of imdacloprid 17.8% SL (0.3 ml per litre) at 40 and 60 DAG;T_9- Untreated (control).

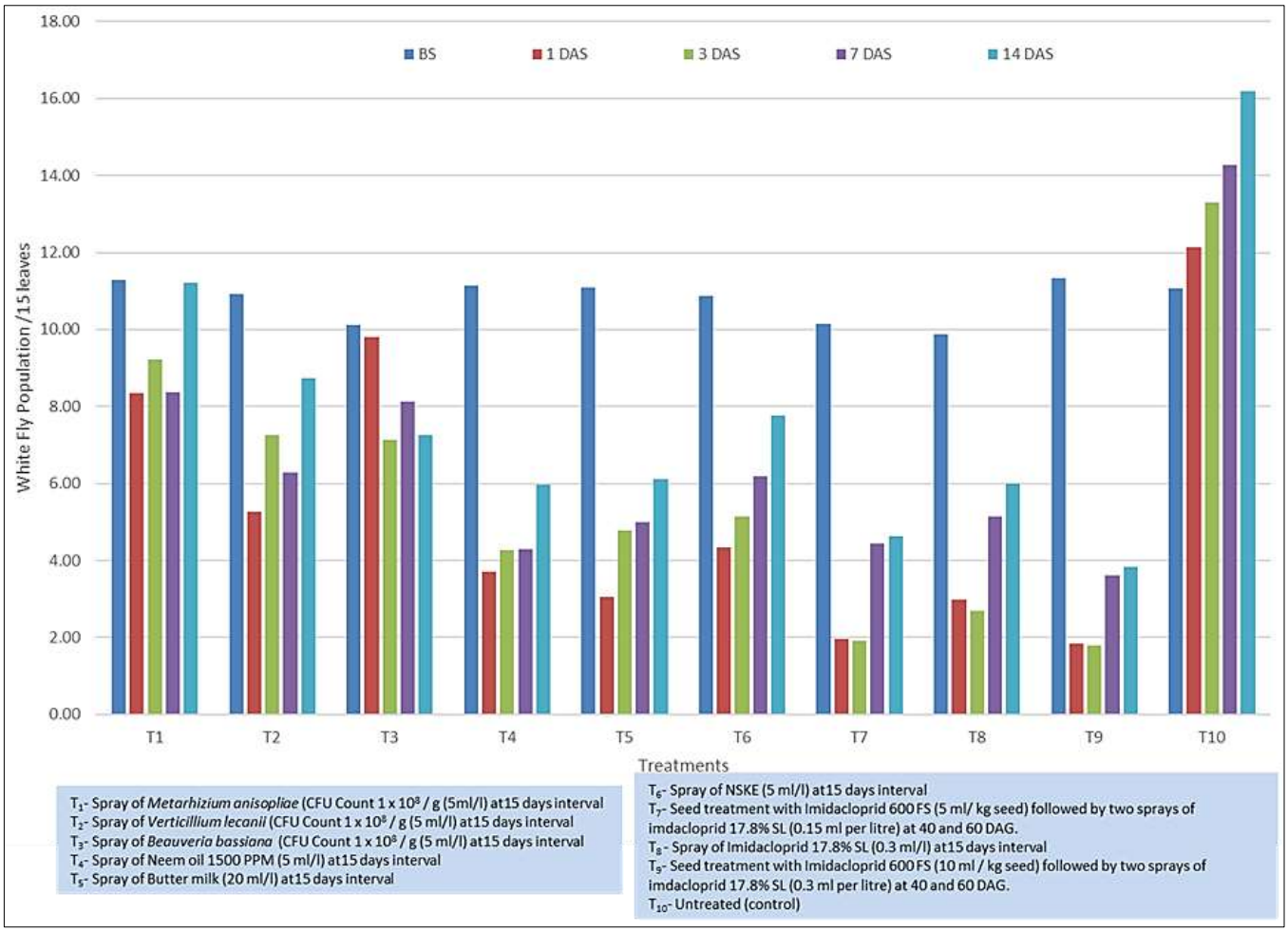

Fig 1: Bio-efficacy of insecticides against whiteflies *on* okra, pre kharif 2020 (I Spray)

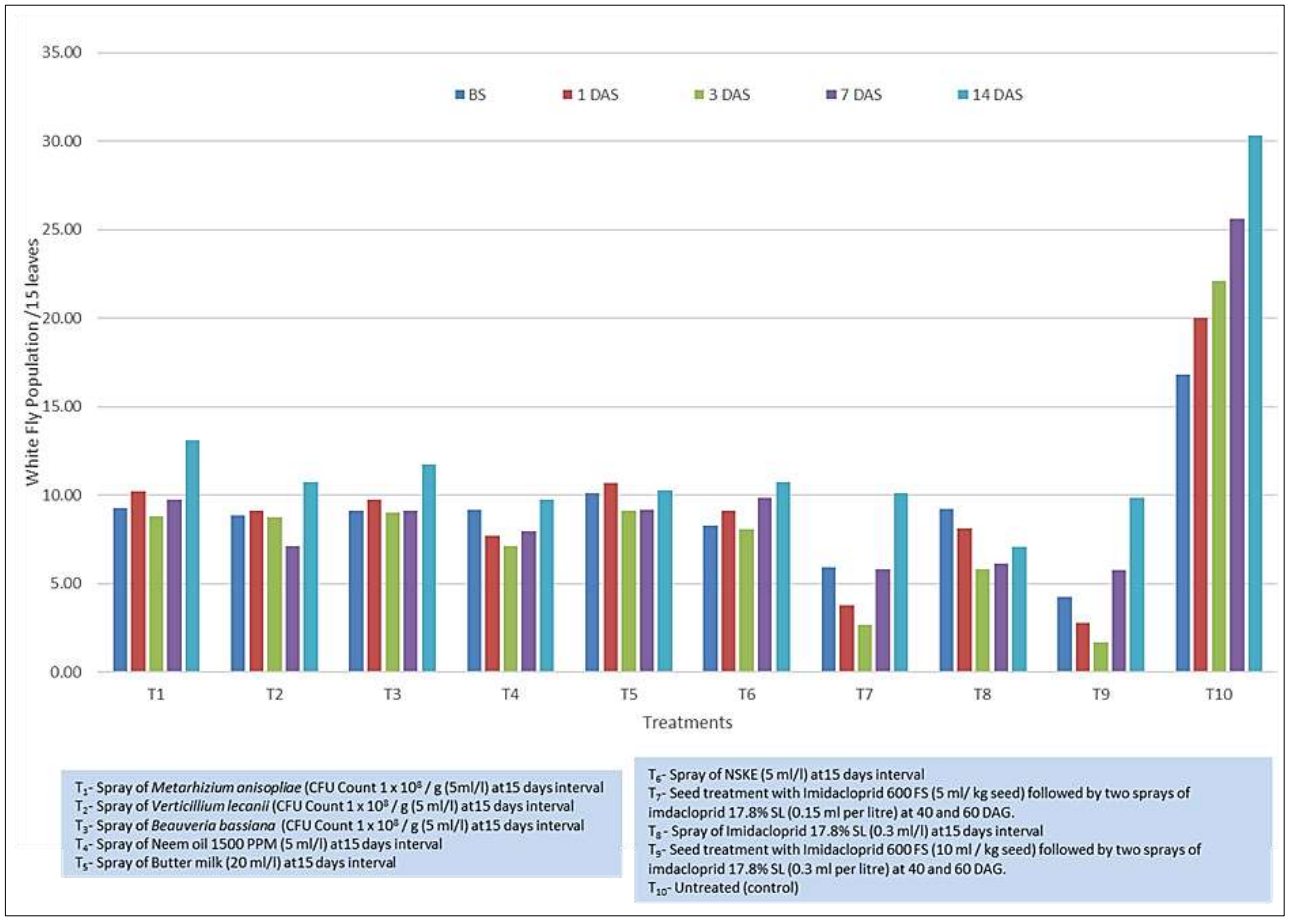

Fig 2: Bio-efficacy of insecticides against whiteflies *on* okra, pre kharif 2020 (II Spray)

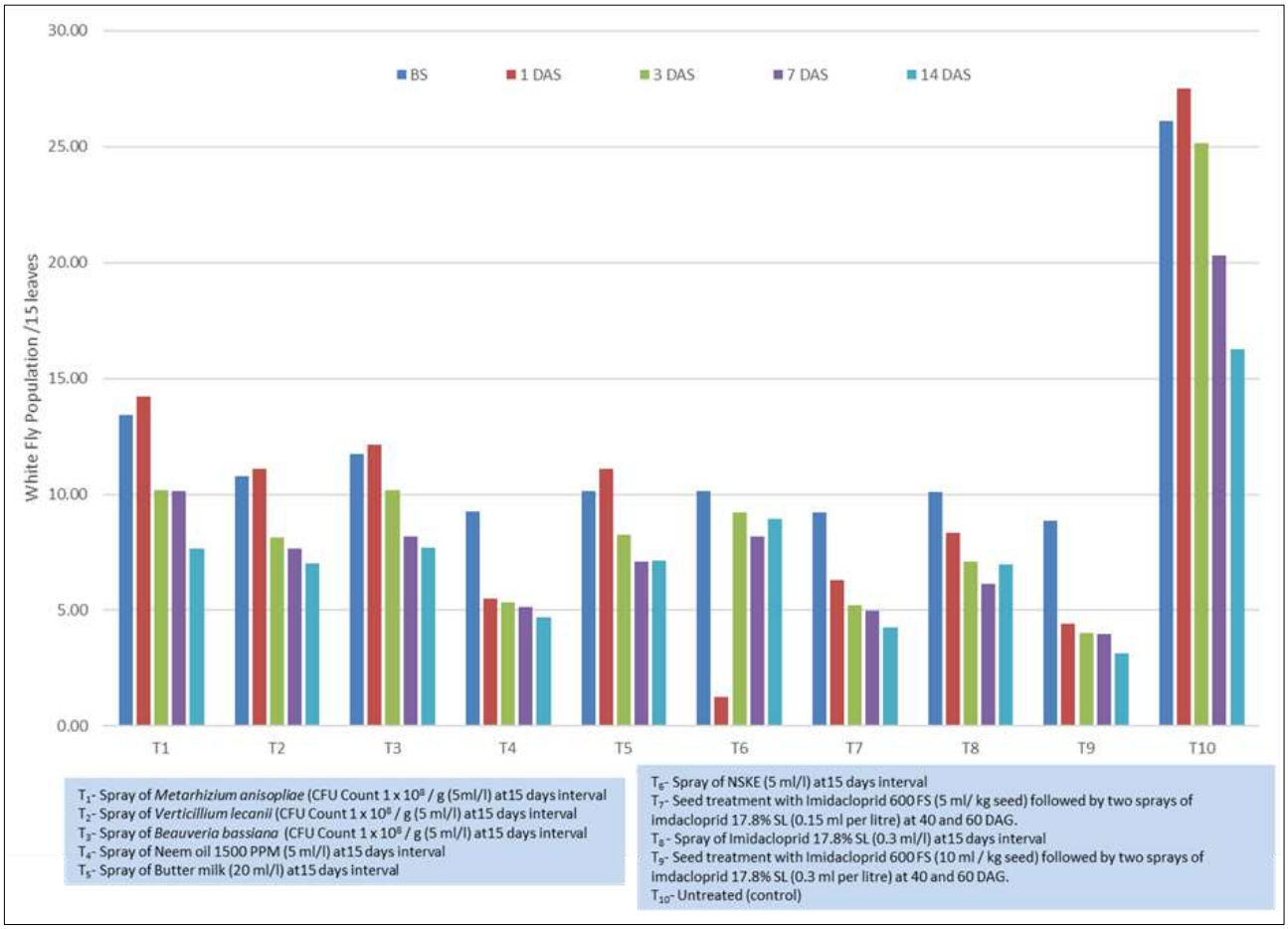

Fig 3: Bio-efficacy of insecticides against whiteflies *on* okra, pre kharif 2020 (III Spray)

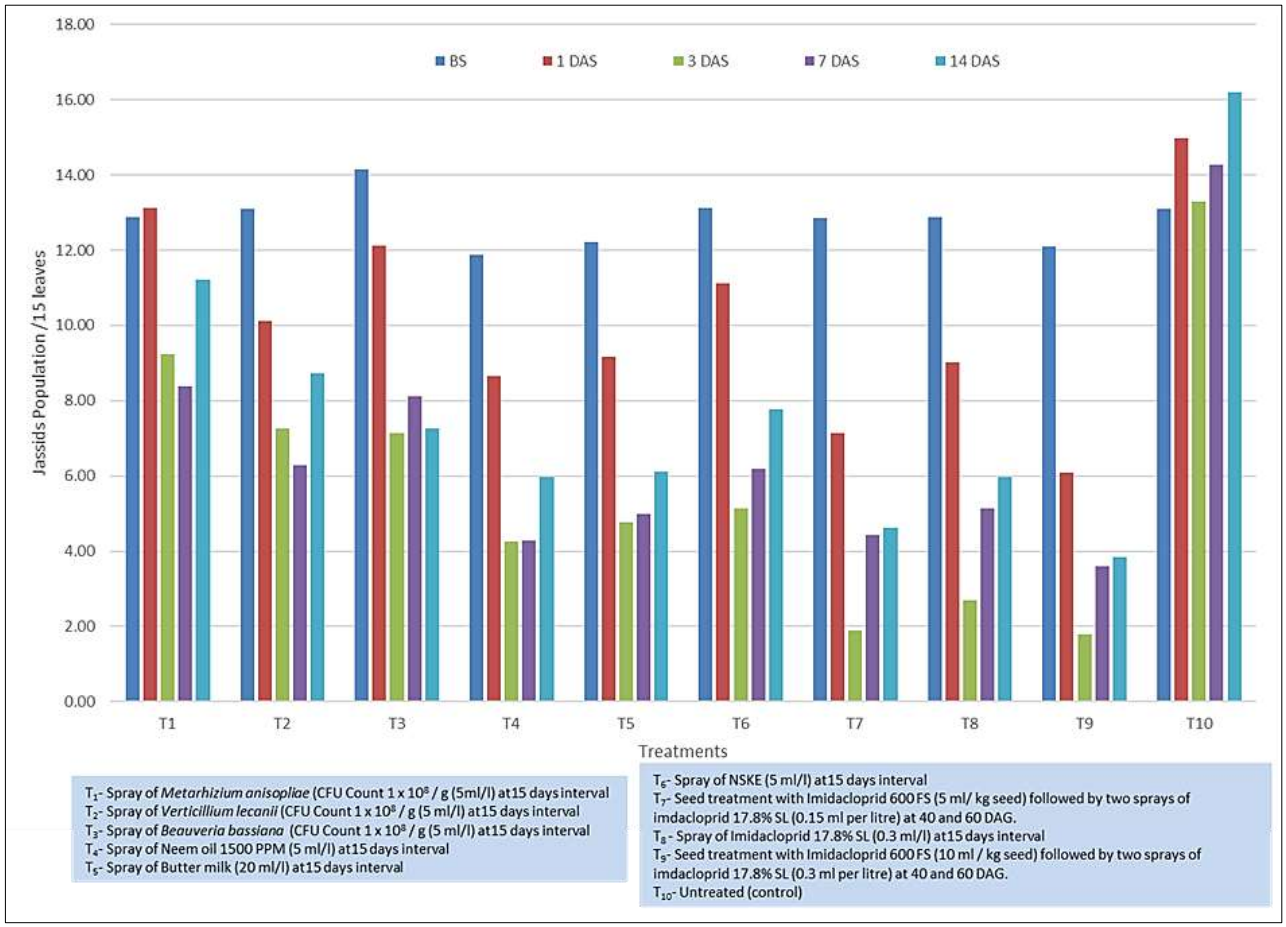

Fig 4: Bio-efficacy of insecticides against jassids *on* okra, pre kharif 2020 (I Spray)

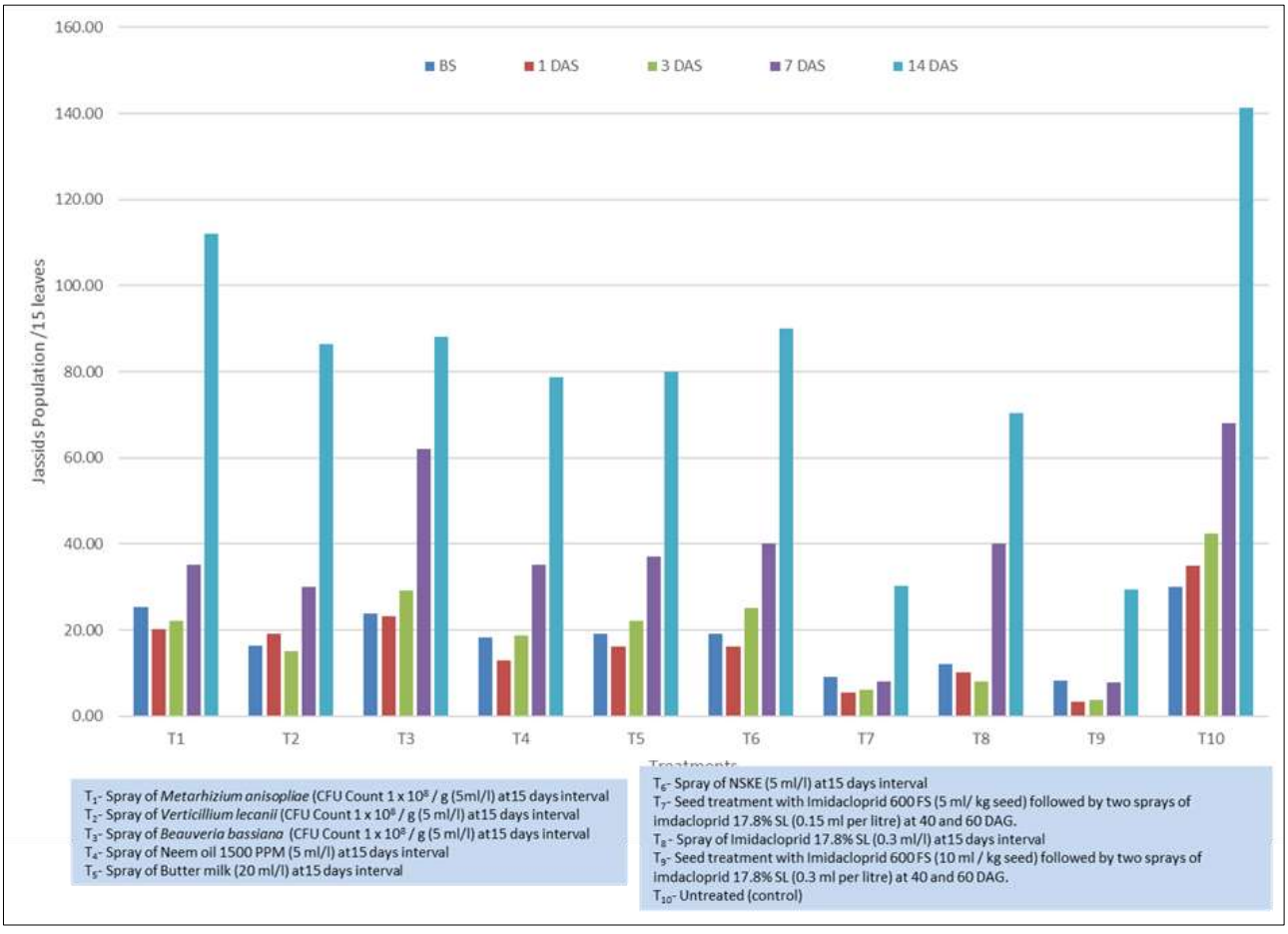

Fig 5: Bio-efficacy of insecticides against jassids *on* okra, pre kharif 2020 (II Spray)

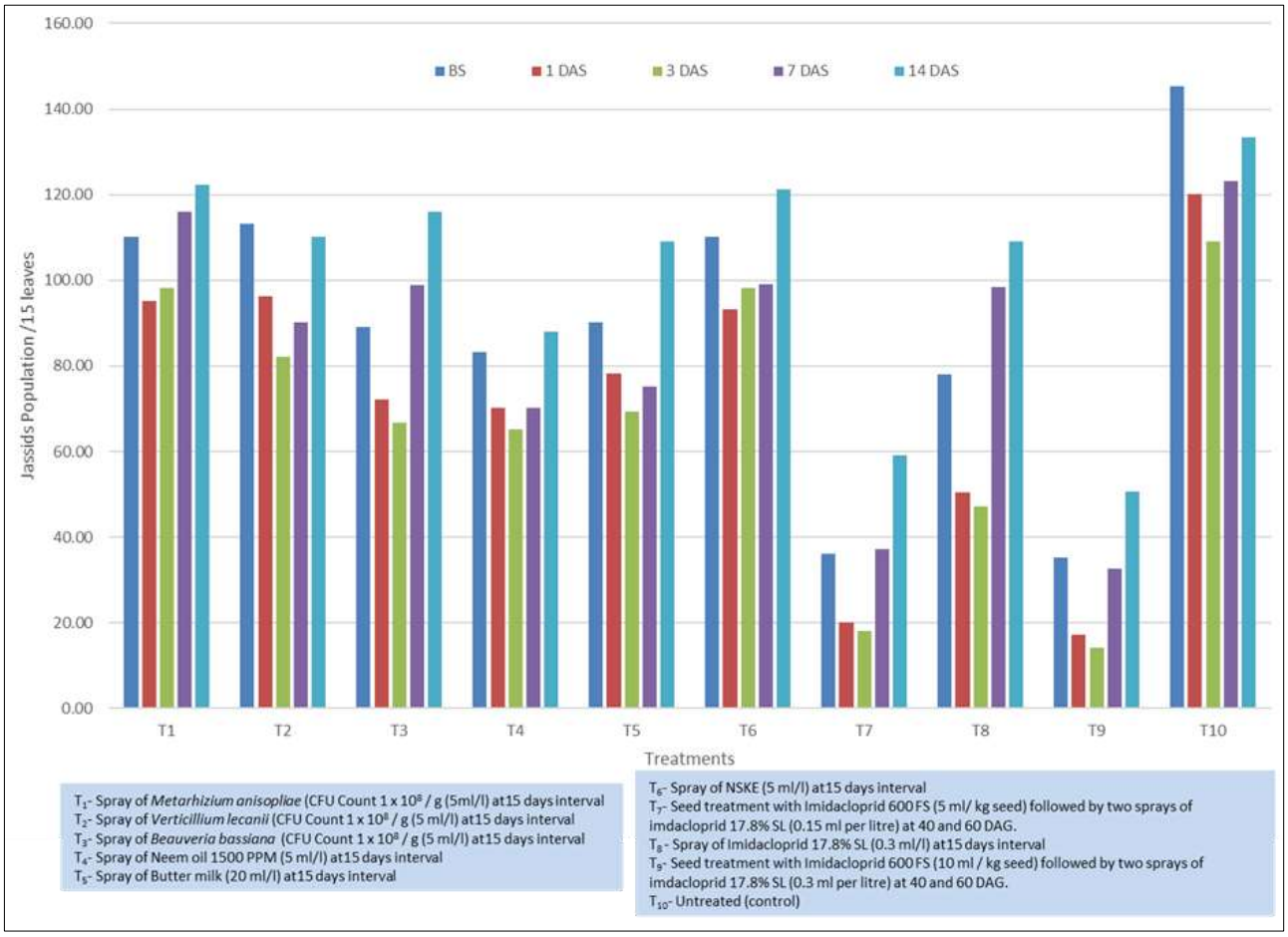

Fig 6: Bio-efficacy of insecticides against jassids *on* okra, pre *kharif* 2020 (III Spray)

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