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Comparative efficacy of selected insecticides with botanicals against jassid [*Amrasca biguttula biguttula* (Ishida)] on okra [*Abelmoschus esculentus* (L.) Moench]

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Abstract
The current study was carried out at Central Research Field, Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Prayagraj, U.P. during the *kharif* season of 2021-2022. Two applications of seven insecticides were used against *Amrasca biguttula biguttula* and the results revealed that treatments T_1-Spinosad 45 SC is most effective treatment with per cent reduction of jassid population of okra with (80.64%) followed by T_4- Cypermethrin 25 EC with (74.49%), T_7- Imidacloprid 17.8% SL(69.23%), T_5- Garlic bulb extract (65.77%), T_2- Neem oil 5%(61.95%), T_6- Pongamia oil 5% (59.31%), T_3- NSKE 5%(56.29%) as compared to T_0-control (water spray). The best and most economical treatment was Spinosad 45SC (1:5.78) followed by Cypermethrin (1:5.08), Imidacloprid (1:4.68) Garlic bulb extract 3% (1:4.44), Neem oil 5% (1:4.24), Pongamia oil 5% (1:3.74) and NSKE 5% (1:3.40) as compared to control (1:2.44).

Keywords: *Abelmoschus esculentus*, *Amrasca biguttula biguttula*, cost benefit ratio, efficacy, spinosad

Introduction
Okra (*Abelmoschus esculentus* L. Moench), also known as lady's finger, it belongs to *Malvaceae* family, is an important vegetable crop of tropics and subtropics. It is an important source of vitamin A, B, C and is also rich in protein, carbohydrates, fats, iron and iodine and plays a vital role in human diet. Beside these, it is also a rich source of dietary fiber, antioxidants, ascorbic acid and folate. The crop is attacked by a variety of pests throughout its growth stages (Rao *et al*., 2002) [13].

In Gujarat, it is mainly grown in Vadodara, Surat, Junagadh, Banaskantha, Bhavnagar, Valsad, Gandhinagar, Kheda and Anand districts. Pest species have been recorded in Gujarat (Patel *et al.*, 1970) among which shoot and fruit borer, aphid, jassid and whitefly are the destructive pests. Among sucking pest, aphid *Aphis gossypii* is a serious pest of okra throughout India which suck cell sap from the leaves of plant (Srinivasan and kumar 1983) [14]. The loss in fruit yield due to *E. vittella* in okra is estimated to be 45% in Karnataka, 22.5% in Uttar Pradesh and 50.58%. Various biophysical and biochemical characters of the plants play an important role by providing resistance against this pest. However, literature on role of these biophysical and biochemical parameters imparting resistance towards different okra genotypes against *E. vittella* is scanty (Gautam *et al.*, 2015) [9]. Amongst them, okra shoot and fruit borer (*Earias vittella* Fabricius; Noctuidae, Lepidoptera) is of much significance (Prasad 2004; Shanti and Mishra 2007) [13, 15] and causes extensive damage to fruits resulting in 69% yield loss. Its infestation started from the beginning of the crop growth and damage due to the borer varied from 21.33 to 43.99% in shoots and 21 to 51.3% in case of fruits. *Amrasca biguttula biguttula* is considered the most destructive sucking pest of this crop (Dhandapani *et al.*, 2003) [7]. Jassid caused up to 63.41% yield loss on okra (Sharma and Sharma, 2001) [15], About 40-56 percent losses in okra due to leafhopper. There is a reduction of 49.8 and 45.1 per cent in height and number of leaves, respectively due to attack of leafhopper. Its infestation begins at very early stages of crop growth and continues up to harvest depending upon agro-climatic conditions. The nymphs and adults suck the sap from leaves and cause phytotoxic symptoms known as hopper burn which results in complete desiccation of plants. leafhopper population was low during early part of March to third week of June. Appearance of pest, *Amrasca biguttula biguttula* on okra in Pakistan and reported the activity of leafhopper until the end of crop season. Pest population was positively correlated with the minimum temperature and average relative humidity.

Materials and Methods

The experimental trial was conducted at central research farm, SHUATS, Prayagraj, U.P. during *kharif* season of 2021-22. The experiment was laid down in randomized block design (RBD) with 3 replications and 8 treatments are T_1- Spinosad 45% SC, T_2- Neem Oil, T_3- NSKE 10%, T4-Cypermethrin 25 EC, T_5- Garlic bulb Extract, T_6-Pongamia Oil 5%, T7-Imidacloprid 17.8%, T_0- Control using variety Radhika (Improved) in a plot size of (2m x 2m) at a spacing of (45x30 cm).

The observations on population of sucking pest was recorded visually using a magnifying lens early on three leaves at top, middle and bottom canopy from five randomly selected and tagged plants in each plot.

The population was recorded a day before spray, 3, 7 and 14 days after the spray and the percent reduction was worked out using the formula.

The analysis of variance (ANOVA) technique was applied for drawing conclusion from data. The calculated values were compared the tabulated values at 5% level of probability for the appropriate degree of freedom.

$$\text{Percent reduction} = \frac{\text{Population in control} - \text{Population in treatment}}{\text{Population in control}} \times 100$$

(Chatterjee *et al.*, 2018) [3]

Cost benefit ratio of treatments

Gross returns were calculated by multiplying total yield with market price of the produce. Cost of cultivation and cost of treatments was deducted from the gross returns, to find out returns and cost benefit of ratio by following formula,

Gross return = Marketable Yield x Market price

Net return = Gross return – Total cost

$$\text{BCR} = \frac{\text{Gross return}}{\text{Total cost}}$$

(Tulankar *et al.*, 2012) [18]

Results and Discussion

The present study entitled, "Comparative efficacy of selected insecticides with botanicals on incidence of jassid [*Amrasca biguttula biguttula*] on okra (*Abelmoschus esculentus* L. Moench)." was undertaken at the central research farm, SHUATS, Prayagraj. The data so obtained through observation on various aspects were subjected to statistical analysis wherever necessary and the compiled mean data are tabulated in the following pages. Results, thus obtained are presented aspect wise hereunder.

The data on per cent reduction of jassids population of *Amrasca biguttula biguttula* over control at 3rd, 7th and 14th days after first spraying revealed that all the treatments were significantly superior over control. Among all the treatments used, the maximum population reduction of *Amrasca biguttula bigittula* was recorded in T_1-Spinosad 45 SC (60.69%) similar findings were found by Iqbal *et al.*, (2017) [10] 63.26%, Dake and Bhamare (2019) [5] 58.7% resulting as compared to the untreated control (T_0 –Water spray (0.00%). Next effective treatment was T_4- Cypermethrin 25 EC with (54.79%) Dahal *et al.*, (2020) [4] 49.8% reduction. T_7-Imidacloprid 17.8% SL Akbar *et al.*, (2012) [1] 46.6%, and Ghosh *et al.*, (2020) [8] 53.8% was recorded with (48.84%) per cent reduction was par with T_5-Garlic bulb extract (45.02%) Deepika *et al.*, (2018) [6] 43.8% which was also at par with T_2-Neem oil 5% (41.90%) Alam *et al.*, (2010) [2], 44.4%, Sultana *et al.*, (2012) [18] 43.8% and Madhuri and Thakur (2019) [12] 45.22% and T_6- Pongamia oil 5% (40.05%) Alam *et al.*, (2010) [2] 43.26% which was also at par with T_3- NSKE 5% (39.01%) Kalyan *et al*., (2017) [11] 43.26% per cent reduction in population over control.

The data on per cent reduction of jassids population of *Amrasca biguttula biguttula* over control at 3rd, 7th and 14th days after second spraying revealed that all the treatments were significantly superior over control. Among all the treatments used, the maximum population reduction of *Amrasca biguttula biguttula* was recorded in T_1-Spinosad 45 SC (80.64%) Iqbal *et al.*, (2017) [10], Dake and Bhamare (2019) [5] as compared to the untreated control (T_0-Water spray (0.00%). Next effective treatment was T_4- Cypermethrin 25 EC with (74.49%) Dahal *et al.*, (2020) 78.82% reduction. T_7- Imidacloprid 17.8% SL Akbar *et al.*, (2012) [1], 72.48% and Ghosh *et al.*, (2020) [8] 73.28% was recorded with (69.23%) per cent reduction was par with T_5-Garlic bulb extract (65.77%) Deepika *et al.*, (2018) [6] 66.2% which was also at par with T_2- Neem oil 5% (61.95%) Alam *et al.*, (2010) [2], Sultana *et al.*, (2012) [17] 66.85% and Madhuri and Thakur (2019) [12] and T_6- Pongamia oil 5% (59.31%) Alam *et al.*, (2010) [2] which was also at par with T_3- NSKE 5% (56.29%) Kalyan *et al*., (2017) [11] 59.56% per cent reduction in population over control.

The yields among the treatment were significant .The highest yield was recording Spinosad 45SC (97.50 q/ha) followed by Cypermethrin (85.83q/ha), Imidacloprid (80.00q/ha) Garlic bulb extract 3% (75.83q/ha), Neem oil 5% (70.83 q/ha), Pongamia oil 5% (64.16 q/ha) and NSKE 5% (55.83 q/ha) as compared to control (39.16 q/ha). When cost benefit ratio was worked out, interesting result was achieved. Among the treatment studied, the best and most economical treatment was Spinosad 45% SC (1:5.78) followed by Cypermethrin (1:5.08), Imidacloprid (1:4.68) Garlic bulb extract 3% (1:4.50), Neem oil 5% (1:4.24), Pongamia oil 5% (1:3.74) and NSKE 5% (1:3.40) as compared to control (1:2.44).

Table 1: Comparative efficacy of selected insecticides with botanicals on incidence of jassid [*Amrasca biguttula biguttula*] on okra (*Abelmoschus esculentus* L. Moench). (First spray)

Treatments		Per cent reduction of jassid population (*Amrasca biguttula biguttula)*/3 leaves				
		One day before spray	After spray			
			3rdDAS	7thDAS	14thDAS	Mean
T_1	Spinosad 45% SC	2.66	53.66	65.09	60.69	59.81
T_2	Neem oil 5%	3.93	31.98	42.81	41.90	38.89
T_3	NSKE 5%	4.13	27.09	34.95	39.01	33.68
T_4	Cypermethrin 25 EC	3.13	46.86	58.11	54.79	53.25
T_5	Garlic bulb extract	3.66	32.03	45.00	45.02	40.68
T_6	Pongamia oil 5%	4.06	27.27	38.36	40.05	35.22
T_7	Imidacloprid 17.8 SL	3.46	38.25	52.16	48.84	45.56
T_0	Control	7.06	0.00	0.00	0.00	0.00
Overall mean		4.01	32.14	42.06	41.28	38.38
F- test		NS	S	S	S	S
C.D.(P=0.05)		-	6.16	5.07	4.25	4.87

* DAS: Day After Spray

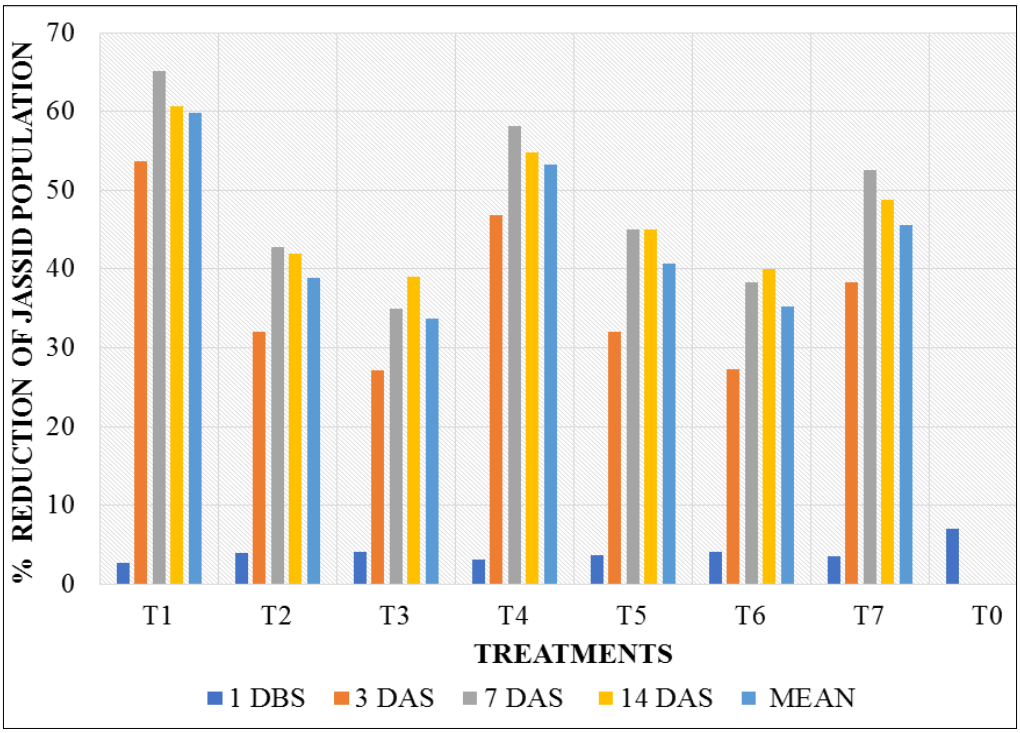

Fig 1: Comparative efficacy of selected insecticides with botanicals on incidence of jassid [*Amrasca biguttula biguttula*] on okra (*Abelmoschus esculentus* L. Moench). (% reduction of jassid population) (first spray).

Table 2: Comparative efficacy of selected insecticides with botanicals on incidence of jassid [*Amrasca biguttula biguttula*] on okra (*Abelmoschus esculentus* L. Moench). (second spray)

Treatments		Per cent reduction of jassid population (*Amrasca biguttula)*/ 3 leaves				
		One day before spray	After spray			
			3rdDAS	7thDAS	14thDAS	Mean
T_1	Spinosad 45% SC	1.66	72.75	86.52	82.67	80.64
T_2	Neem oil 5%	3.33	50.78	69.83	65.26	61.95
T_3	NSKE 5%	4.00	45.50	65.06	58.31	56.29
T_4	Cypermethrin 25 EC	2.06	64.84	80.20	78.44	74.49
T_5	Garlic bulb extract	2.86	54.25	72.97	70.10	65.77
T_6	Pongamia oil 5%	3.66	48.05	68.16	61.73	59.31
T_7	Imidacloprid 17.8 SL	2.53	58.74	75.35	73.60	69.23
T_0	Control	3.71	0.00	0.00	0.00	0.00
Overall mean		3.71	49.36	64.75	61.26	58.46
F- test		NS	S	S	S	S
C.D.(P=0.05)		-	3.97	2.58	2.76	6.20

* DAS: Day After Spray

Benefit Cost Ratio (BCR)

The data on Cost benefit ratio of the treatments are presented in tables.

Table 3: Economics of Cultivation

S. No:	Treatment	Yield(q/ha)	Total value of yield(₹)	Common cost (₹)	Treatment cost(₹)	Total cost(₹)	C:B ratio
01	Spinosad 45% SC	97.50	192772	31510	1800	33310	1:5.78
02	Neem oil 5%	70.83	139411	31510	1360	32870	1:4.24
03	NSKE 5%	55.83	113493	31510	2220	33370	1:3.40
04	Cypermethrin 25 EC	85.83	169230	31510	1760	32270	1:5.08
05	Garlic bulb extract	75.83	149212	31510	1600	33110	1:4.50
06	Pongamia oil 5%	64.16	125809	31510	2050	33560	1:3.74
07	Imidacloprid 17.8 SL	80.00	154459	31510	1472	32982	1:4.68
08	Control	39.16	76903	31510	-	31510	1:2.44

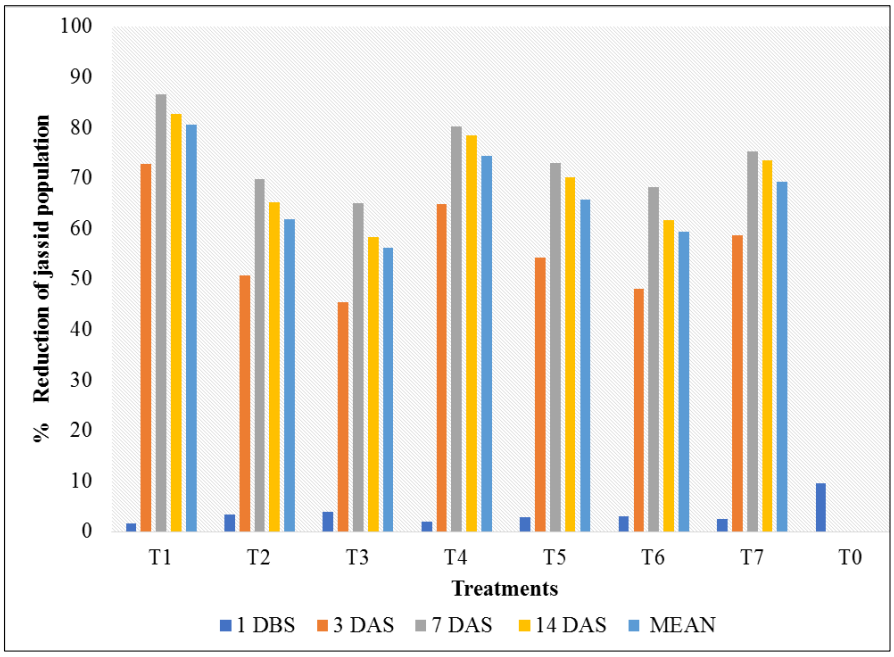

Fig 2: Comparative efficacy of selected insecticides with botanicals on incidence of jassid [*Amrasca biguttula biguttula*] on okra (*Abelmoschus esculentus* L. Moench). (% reduction of jassid population) (Second spray)

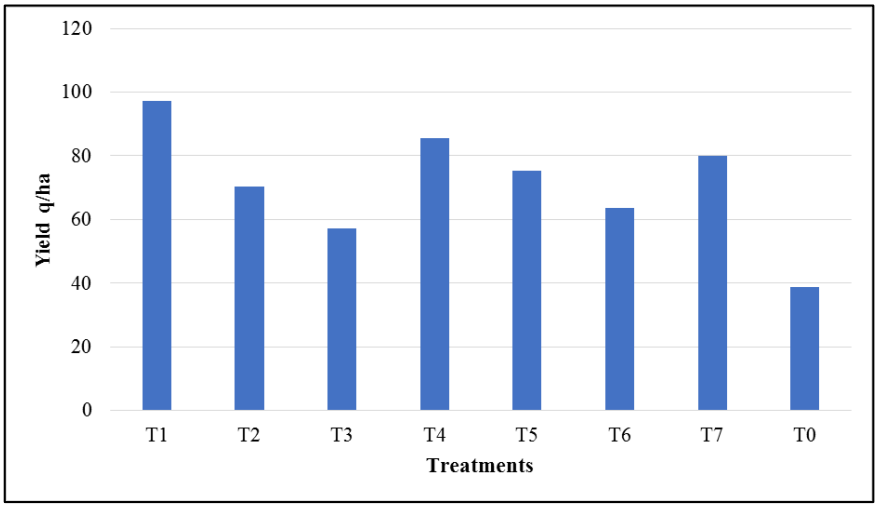

Fig 3: Comparative efficacy of selected insecticides with botanicals on the incidence of *Amrasca biguttula bigittula* of Yield (q/Ha)

Conclusion

It could be concluded that for the management of *Amrasca biguttula biguttula* on Okra crop, recommended biopesticides and botanicals in T_1-Spinosad 45 SC as compared to the untreated control (T_0-Water spray (0.00%). Next effective treatment was T_4- Cypermethrin 25 EC. T_7- Imidacloprid 17.8% SL was recorded percent reduction was with T_5-Garlic bulb extract which was T_2- Neem oil 5% and T_6- Pongamia oil 5% which was also at par with T_3- NSKE 5% can also be thought of for the management of okra jassid. However, the application of NSKE. could not exert encouraging role for Okra jassid *Amrasca biguttula biguttula* management. This plant product also helps in reducing pollution in the environments. Hence it can be suitably incorporated as treatments in IPM programme.

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