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Bio-efficacy of some newer insecticides and biopesticides against jassid (*Amrasca biguttula biguttula* Ishida) infesting brinjal

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Abstract
An investigation was carried out to study the relative Efficacy of some newer insecticides and biopesticides against jassid (*Amrasca biguttula biguttula* Ishida) infesting brinjal in randomized block design with these replications at Crop Research Center of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut during *kharif* 2017. Efficacy of different treatments viz imidacloprid 17.8 SL, buprofezin 25 SC, fipronil 5 SC, spinosad 45 SC, emamectin benzoate 5 SG, *Bacillus thuringiensis*, and neem oil 1500 ppm reveled that all the treatment were found significantly effective in reducing the population of jassid. The most effective treatment in reducing the population of jassid was imidacloprid 17.8 SL @ 100ml/ha followed by fipronil 5 SC @ 750 ml/ha. The *Bacillus thuringiensis* @ 1.0kg/ha was found less effective but it was significantly superior over control.

Keywords: Bio-efficacy, insecticides, biopesticides, jassid, brinjal

Introduction
The brinjal (*Solanum melongena* L) is one of the most important solanaceous vegetable in South East Asian countries including India, Bangladesh, Sri Lanka, China and Japan etc. India is the second largest producer of brinjal cultivated in about 0.669 million hectares with a production of 12.40 million tonnes after China (Anonymous, 2017) [2]. In India, brinjal is growing in following states *viz.*, Andhra Pradesh, Karnataka, west Bengal, Tamil Nadu, Maharashtra, Orissa, Uttar Pradesh, Bihar and Rajasthan (Anonymous, 2008) [1]. It posses ayurvedic medicinal properties, and hence used for diabetic patients as well as for those suffering from liver complaints (Shukla and Naik 1993) [18]. It is also known as eggplant belongs to Solanaceae family and bitterness is due to the presence of an alkaloid i.e. glycoalkaloids **(**0.37 mg/100 g fresh weight to 4.83 mg) (Bajaj *et al.*, 1981) [3].
Though brinjal is known as summer crop and it is being cultivated throughout the year under irrigated condition. This important crop is attacked by various insect pests right from nursery stage till harvesting *viz.*, shoot and fruit borer, *Leucinodes orbonalis* Guenee, jassid, *Amrasca biguttula biguttula* Ishida, aphid, *Aphis gossypii* (Glov.), white fly, *Bemisia tabaci* (Genn.), hadda beetle, *Epilachna spp.* (Fab.) and egg plant mealy bug, *Centrococcus insolitus* (Ferris.) (Regupathy *et al.*, 1997) [16].
The magnitude and severe population out breaks are greatly influenced by both abiotic and biotic factors that cause seasonal variations. Jassid are come under the hemiptera and carries piercing-sucking type mouth parts. Both nymphs and adults suck the sap from lower surface of leaf. When several insects suck the sap from the same leaf, yellow spot appear on the leaf, followed by crinkling, curling and drying or "hopper burn".
Farmers spray synthetic insecticides four to six times for managing these sucking pests, resulting in the reduction of natural enemies and beneficial organisms. Even though, neonicotinoids are widely used for managing the sucking insect pest, very little side effects on natural enemy has been carried out (Cloyd and Bethke, 2011) [6]. Infestation due to leafhoppers, whitefly and shoot and fruit borer results in about 70-92 per cent loss in yield of brinjal (Rosaiah, 2001) [17]. In order to cope these insect pests, in recent years, different types of systemic and contact insecticides either in spray or seed treatment or granular formulation are being applied in trend (Dhankar *et al.*, 1997) [8]. Mote and Bhavikatti (2003) [15] suggested the use of novel insecticides to control sucking pests, borers, and other pest, in order to provide safer, eco-friendly and economical management of its major insect pests.

It is being a vegetable crop; use of broad-spectrum synthetic insecticides will leave considerable toxic residues on the brinjal fruits. Next to this, sole dependence on several broad-spectrum insecticides for the control of these pests has led to insecticidal resistance (Harish *et al*., 2011) [10]. Now a day's many new emerging chemicals including growth regulators and neonicotinoids are available in the market with good efficacy for pest control and safety to non target organisms. Evaluation of such chemicals for their bio-efficacy against crop pests is acceptable (Regupathy *et al.*, 1997) [16]. Hence, the present day need emphasizes on jassid in brinjal with ecologically and environmentally safe management strategies, so that we can suggest to the farmer with least disturbance of agro-climatic conditions of Western Uttar Pradesh. Keeping in view of the seriousness of the pest and economic importance of this crop, the present investigation was planned to evaluate the efficacy of various newer insecticides against jassid under field condition.

Materials and methods

Experimental site

A field experiment was carried out at Crop Research Center (CRC) of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut which is situated 10 km far from the Meerut city on Delhi – Dehradun National Highway (NH-58). It lies between 29^0 17' N latitude and 77^0 42' E longitudes at an altitude of 237 meter above mean sea level. Meerut comes under the Western Plain Zone of Uttar Pradesh, sub region of upper Gangetic plain.

Climatic and weather

The general climate of Meerut is semi-arid, sub-tropical, characterized by very hot summer and cold winters. In summer, the temperature goes up to 45^0 C in the month of June. The winters are severe with a minimum temperature of about 2-3^0 C with occasional ground frost. The monsoon commence generally by third week of June and cessation of it by the end of September. The annual rainfall is about 863 mm, of which about 75-80 per cent is received from July to September at the time of monsoon. The daily meteorological data pertaining to rainfall, relative humidity and temperature during the experimental period obtained from Meteorological Observatory of Department of Soil Science, SVPUA&T, Meerut - 250110 (U.P.)

Layout of experiment

The experiment was laid out in a randomized block design (R.B.D.) with three replications. There were total eight treatments including control. The plot size for each treatment was kept 5X3 m^2.

Treatment details

In experiment there were eight treatments including imidacloprid (Confidor 17.8 SL; Bayer crop science; Dose 100-ml/h), buprofezin (Applaud 25 SC; Rallis India Limited; Dose 800ml/h), fipronil (Regent 5 SC; Bayer crop science; Dose 750 ml/ha) spinosad (Conserve 45 SC; Nagarjun agrochem limited; Dose 160ml/h**),** emamectin benzoate (Proclaim 5 SG; Volex^{TM} ; Dose 125ml/h) *B. thuringiensis*, Dose 1.0 kg/h and neem oil 1500 ppm; YK Laboratory; Dose 3 lit/h were taken in the presents experiment. All the treatments were applied three sprays during the crop season. First spray was done at 30 days after transplanting. Second and third subsequent spraying was done at 20 days interval. In the untreated control plot only water was sprayed. The spray volume used for foliar application of insecticides was 600 liter/hectare. During spraying care was taken to prevent insecticide drift to other plots.

Preparation of spray solution

In case of liquid formulation, the required quantity of insecticide added in small quantity of water and stirred thoroughly. The remaining quantity of water was then added slowly with constant stirring to get the desired concentration of spray solution. The quantity of insecticide required per liter of water was calculated by the following formula-

$$\text{Amount of formulation (L)} = \frac{\text{Concentration Required (\%) X Volume Required}}{\text{Concentration of toxicants in insecticidal formulation}} \text{ x } 100$$

Observations

Three sprays were applied during the crop season at 30, 50 and 70 days after transplanting of the crop. Observations on the population of sucking pests were recorded on three leaves one each from top, middle and bottom canopy of the five plants selected randomly in each replication (Mathur *et al*., 2012) [15].

Statistical analysis

The data recorded were subjected to statistical analysis by using analysis of variance technique (ANOVA) for randomized block design. The data were transformed necessarily as and when required. Standard error of mean in each case and the critical differences only for significant cases were computed at 5% level of probability as under –

$$\text{SE (m)} \pm = \sqrt{\frac{\text{EMSS}}{\text{r}}}$$

Where,
SE (m) = Standard error of mean
EMSS = Error mean sum of square
R = Number of replications

The critical differences at 5 per cent level of probability was worked out to compare treatment means wherever, F was significant.

Critical differences = SE (m) × √2 × t (at error degree of freedom) ()

Result and Discussion

Each treatment was applied thrice during the crop season. First spray was given at 30 days after transplanting and second and third sprays were applied subsequently at 20 days interval. The data on the number of jassid/leaf is presented in the following text.

First application

Efficacy of different treatments against jassid, *Amrasca biguttula biguttula* was recorded by counting the number of jassids/leaf and presented in Table 1; Figure 1. The results revealed that all the treatments were significantly effective in reducing the population of jassid and thus increasing the yield significantly as compared to control. The initial jassid population ranged from 21.20 to 22.80 jassids per leaf before the spray and did not differ significantly.

Data recorded on 7th day after first spray, the minimum jassid population (6.67 jassids/ leaf) were recorded in the plot treated with imidacloprid 17.8 SL @ 100 ml/ha and it was significantly superior to rest of treatments. The next in order of effectiveness of treatment was fipronil 5 SC @ 750 ml/ha (8.00 jassids/leaf), buprofezin 25 SC @ 800 ml/ha (8.67 jassids/leaf), spinosad 45 SC @ 160 ml/ha (10.20 jassids/leaf), emamectin benzoate 5 SG @ 125 g/ha (10.46 jassids/leaf), neem oil 1500 ppm @ 3 lit/ha (12.60 jassids/leaf) and *Bacillus thuringiensis* @ 1.0 kg/ha (15.20 jassids/leaf). Maximum jassid population (21.80 jassids/leaf) was recorded in control plot.

Observation recorded on 14th day after first application, showed increase pattern of jassid in all the treatments but still all the treatments maintained their efficacy and significance over control. Most effective treatment was imidacloprid 17.8 SL @ 100 ml/ha with minimum jassid population (7.67 jassids/leaf) followed by fipronil 5 SC @ 750 ml/ha (9.60 jassids/leaf). The next effective treatment was buprofezin 25 SC @ 800 ml/ha (10.67 jassids/leaf) followed by spinosad 45 SC @ 160 ml/ha (12.80 jassids/leaf), emamectin benzoate 5 SG @ 125 g/ha (13.46 jassids/leaf) and neem oil 1500 ppm @ 3.0 lit/ha (16.00 jassids/leaf). *Bacillus thuringiensis* @ 1.0 kg/ha (19.00 jassids/leaf) was the least effective. However, maximum jassid population (22.20 jassids/ leaf) was recorded in control plot.

Second application

The second insecticidal spray was applied 20 days after first application and data recorded on the population of jassids (Table 1; Figure 1). A similar trend of efficacy of treatments as in first application on reduction of jassid population was recorded after the second spray and all the treatments proved better than control.

Observation recorded on 7th day of second application revealed that imidacloprid 17.8 SL @ 100 ml/ha again proved most effective treatment with minimum population (5.80 jassids/leaf). The next effective treatment was fipronil 5 SC @ 750 ml/ha (7.40 jassids/leaf) followed by buprofezin 25 SC @ 800 ml/ha (7.60 jassids/leaf), spinosad 45 SC @ 160 ml/ha (3.86 jassids/leaf), emamectin benzoate 5 SG @ 125g/ha (10.00 jassids/leaf) and neem oil 1500 ppm @ 3.0 lit/ha (12.00 jassids/leaf). *Bacillus thuringiensis* @ 1.0 kg/ha (13.80 jassids/leaf) was the least effective but it was significantly superior over control. However, maximum jassid population (21.00 jassids/ leaf) was recorded in control plot.

Data recorded on 14th day after second application showed that all the treatments were found effective over control (Table 1; Figure 1). Imidacloprid 17.8 SL @ 100 ml/ha maintained its efficacy and recorded lowest jassid population (6.20 jassids/leaf). The next effective treatment was fipronil 5 SC @ 750 ml/ha (7.80 jassids/leaf) followed by buprofezin 25 SC @ 750 ml/ha (8.40 jassids/leaf), spinosad 45 SC @ 160 ml/ha (10.60 jassids/leaf), emamectin benzoate 5 SG ()@ 125 g/ha (11.40 jassids/leaf) was closely related to each other. The rest treatment neem oil 1500 ppm @ 3.0 lit/ha (13.33 jassids/leaf) and *Bacillus thuringiensis* 1.0 kg/ha (15.80 jassids/leaf) were least effective. Maximum jassid population (21. 20 jassids/ leaf) was recorded in control plot.

Third application

At 7th day after third spray all the insecticidal treatments significantly reduced the jassid population as compared to control (19.20 jassids/ leaf). Among the treatments, imidacloprid 17.8 SL @ 100 ml/ha was found significantly superior among all the treatments with lowest jassid population (5.33 jassids/leaf). It was followed by fipronil 5 SC @ 750 ml/ha (6.80 jassids/leaf) and buprofezin 25 SC @ 800 ml/ha (7.00 jassids/leaf) was closely related to each other. The next effective treatment was spinosad 45 SC @ 160 ml/ha (9.20 jassids/leaf) followed by emamectin benzoate 5 SG @ 125 g/ha (9.60 jassids/leaf) and neem oil 1500 ppm @ 3 lit/ha (11.60 jassids/leaf). *Bacillus thuringiensis* @ 1.0 kg/ha (13.40 jassids/leaf) was found to be least effective, but better than the control (19.20 jassids/leaf).

The data recorded on 14th day after third application. The minimum jassid population (5.33 jassids/leaf) again was recorded with imidacloprid 17.8 SL @ 100 ml/ha and it was significantly superior over rest of the treatments. The next effective treatment was fipronil 5 SC @ 750 ml/ha (6.80 jassids/leaf) followed by buprofezin 25 SC @ 800 ml/ha (7.20 jassids/leaf), spinosad 45 SC @ 160 ml/ha (9.40 jassids/leaf) and emamectin benzoate 5 SG @ 125 g/ha (9.60 jassids/leaf). Rest treatment neem oil 1500 ppm @ 3.0 lit/ha had 11.80 jassids/leaf and it was followed by *Bacillus thuringiensis* @ 1.0 kg/ha (13.80 jassids/leaf). Maximum jassid population (18.00 jassids/leaf) was recorded in control plot. It appeared from the data there all the chemical/biopesticide treatments were effective in controlling jassid population at different intervals after each spray in comparison to untreated control. Imidacloprid 17.8 SL @100ml/ha proved the most effective treatment for the control of jassid population in present study. The effectivity of imidacloprid against jassid on brinjal has also been reported by Bhargawa *et al*., (2003); Das and Islam (2014); Ghosal and Chatterjee (2013); Yadav and Raghuraman (2014) [5, 7, 9, 20]. The application of fipronil 5 SC @ 750 ml/ha and buprofezin 25 SC @ 800 ml/ha were next effective treatment in present study which is in conformity with the finding of Das and Islam (2014); Yadav and Raghuraman (2014) [7, 20]. The effectiveness of spinosad 45 SC and emamectin benzoate against jassid are in agreement with the results obtained by Kalawate and Dethe (2012); Bharti *et al*., (2015) [11, 4]. Efficacy of biopesticide *Bacillus thuringiensis* @ 1.0 kg/ha and neem oil @ 3.0 lit/ha were found effective for the control of insect pest in present investigation. The similar findings have also been reported by Konar (2011) [12], Mhaske and Mote (2005) [14], Kalawate and Dethe (2012) [11] and Sunda *et al*., (2015) [12, 14, 11, 19].

Table 1: Efficacy of different insecticides against jassid, *Amrasca biguttula biguttula*

Treatment No.	Insecticides	Dose/ ha	1 DBS	No. of jassid/leaf					
				First spray		Second spray		Third spray	
				7 DAS	14 DAS	7 DAS	14 DAS	7 DAS	14 DAS
T_1	Imidacloprid 17.8 SL	100 ml	22.26 (4.82)	6.67 (2.76)	7.67 (2.94)	5.80 (2.60)	6.20 (2.68)	5.33 (2.50)	5.33 (2.50)
T_2	Buprofezin 25 SC	800 ml	21.20 (4.71)	8.67 (3.10)	10.67 (3.40)	7.60 (2.99)	8.40 (3.06)	7.00 (2.82)	7.20 (2.86)
T_3	Fipronil 5 SC	750 ml	21.40 (4.73)	8.00 (2.99)	9.60 (3.24)	7.40 (2.89)	7.80 (2.96)	6.80 (2.78)	6.80 (2.78)
T_4	Spinosad 45 SC	160 ml	22.67 (4.86)	10.20 (3.34)	12.80 (3.71)	9.80 (3.28)	10.60 (3.40)	9.20 (3.19)	9.40 (3.22)
T_5	Emamectin benzoate 5 SG	125 g	22.20 (4.81)	10.46 (3.40)	13.46 (3.80)	10.00 (3.31)	11.40 (3.51)	9.60 (3.25)	9.60 (3.25)
T_6	*Bacillus thuringiensis*	1.0 kg	22.80 (4.87)	15.20 (4.02)	19.00 (4.47)	13.80 (3.84)	15.80 (4.09)	13.40 (3.74)	13.80 (3.84)
T_7	Neem oil 1500 ppm	3.0 Litre	22.00 (4.79)	12.60 (3.68)	16.00 (4.12)	12.00 (3.60)	13.33 (3.78)	11.60 (3.54)	11.80 (3.57)
T_8	Control	-	21.67 (4.76)	21.80 (4.77)	22.20 (4.81)	21.00 (4.69)	21.20 (4.71)	19.20 (4.40)	18.00 (4.35)
	SEm (±)		0.05	0.07	0.09	0.07	0.08	0.09	0.08
	CD at 5 %		NS	0.23	0.30	0.23	0.25	0.27	0.27

Figure in parenthesis are square root transformed values **DAS**= Days after spray **DBS**= Days before spray

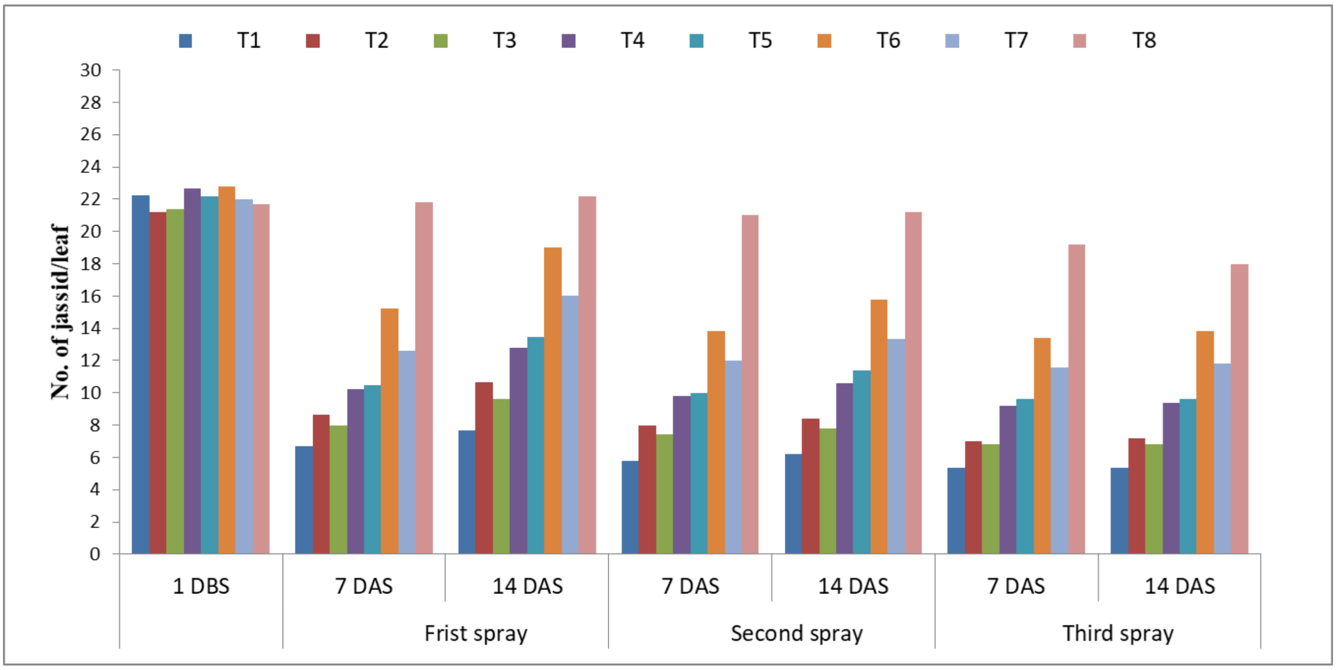

Fig 1: Efficacy of different treatments against jassid, *Amrasca biguttula biguttula*

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