Pest complex of Brinjal crop (*Solanum mel~~a~~ongena* L.): Pest management with botanical~~s~~ insecticides comparing ~~Insecticide (~~Imidacloprid- 17.8 SL~~)~~

Abstract:

The field experiments of ~~The~~ the present investigation ~~entitled Pest complex of Brinjal and their management with Botanicals~~ was conducted ~~The field experiments~~ in the Instructional Farm, Faculty of Agriculture~~,~~. ~~while t~~The laboratory ~~works~~ experiments were done in the Department of Agricultural Entomology and Department of Biochemistry of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal in two successive ~~Rabi~~ spring seasons. The experiment was conducted in randomized block design with 7 treatments and 3 replications, to evaluate the ~~performance~~ efficacy of some botanical products against ~~the~~ certain sucking pest of brinjal. The treatments included Neem leaf extract, pongamia leaf extract, Accorus calamus, Tobacco, Imidacloprid, Multineem, Un treated control. Two spraying of each treatment were conducted starting 30 days after transplanting, at an interval of 15 days. Observation on population of sucking pests (aphids,whitefly and jassids) was recorded before treatment and 3, 7 and 10 days after each spraying. The results revealed that imidacloprid was significantly superior over all % reduction of sucking pest population over control followed by multineem, neem leaf extract, tobacco leaf extract and sweet flag leaf extract (35. Treatment with pongamia leaf extract was the least effective one as it caused the lowest reduction of population over control.

Key words: Brinjal, imidacloprid, aphids, whitefly, jassids, Plant extracts

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Introduction

Brinjal (*Solanum mel~~a~~ongena* L.) or egg plant is an important solanaceous vegetable among the listed popular vegetables grown in the tropics and sub tropics Vysali et al., (2021); Pandey et al., (2023). It is predominantly cultivated in the Asian countries *viz.* India, Pakistan, China, Philippines, Egypt; Europe *viz*; France, Italy; middle East, Far East and U.S.A. (Anon., 2010; Harish *et al.*, 2011). India occupies 2nd Position in brinjal production in the world after China ranking 1st position (Mathur *et.,al* 2012; Kasi et al., 2021a; Kasi et al., 2021b; Waiba et al., 2021b). During 2017-2018, brinjal production in the country was 128.01 million tonnes from an area of 7.3 million ha; whereas it is estimated that the corresponding

figure would be 126.60 million tonnes and 7.3 million ha in 2019 respectively (Kasi and Tayde (2018a); Kasi and Tayde (2018b); National Horticultural Board, 2019; Kasi et al., 2020). Brinjal is rich in a wide range of nutrients necessary for human body. It is abounded in dietary fibre, Vitamin B1 (Thaimin) and copper; whereas considerable amount of other important nutrients *viz.* manganese, vitamin B6, niacin, potassium, follate (B9) and Vitamin K are also present in brinjal fruit Waiba et al. (2021a). Besides, it provides phenolic compounds (anthocyanin) that act as anti-oxidant. It contains low level of cholesterol and saturated fat. India, being the centre of origin / place of domestication of brinjal has rich source of many wild and locally available germplasms /cultivars/varieties in different parts of the country and West Bengal is no exception. Terai Zone of west Bengal is a vast area where a variety of vegetables including brinjal are grown extensively Waiba et al. (2021); Kasi and Waiba (2022). The crop is grown two or three times in a year depending upon suitable climatic conditions and irrigation facilities. Many workers have evaluated different brinjal varieties/cultivars in different regions against major insect pests (Kumar *et al* , 2002 at Udaipur; Elanchezhyan *et al.,* 2008 at Madurai; Ahmad et al., 2008; Shaikh *et al.,* 2013 in Gujrat; Devi *et al.,* 2015 in Raipur; Singh *et al.,* 2016).

Management of various sucking pests, brinjal shoot and fruit borer and other pests by different means especially by chemical pesticides and plant –based chemicals has been tried by many workers with various degree of success. Thiomethoxam and confidor showed highest efficacy against whitefly and jassid (Naik *et al.,* 2016; Nath and Sinha, 2010; Shahzad Ali *et al.,* 2016; Monika et al., 2022). Imidacloprid provided very high degree of control of aphids, thrips and leaf hoppers up to 15 days after spraying (Dey *et et al.*, 2005; Dhandrokshin and Mallapur, 2008) and other pests. Neem oil @ 10 ml per little of water or NSKE (3%) and Achook provided satisfactory control of sucking pests namely white flies, aphids and leaf hoppers (Sarangdevot *et al.,* 2006; Singh and Kumar, 2003; Waseem et al., (2024)). Neem extract and Eucalyptus extract exhibited formidable reduction of whitefly, jassid and mite population in brinjal in order (Shahzad *et al.,* 2016).

Comment [H3]: Rewrite with more details.

Materials and Methods:

The experiment was laid out in a RBD with seven treatments as per following. There were three replications in the experiment.

Table 1: List of botanical treatments

Sl.No.	Botanicals
1.	Neem leaf extract

2.	Pongamia leaf extract
3.	Acorus colomus
4.	Tobacco
5.	Imidacloprid
6.	Multi neem
7.	Untreated control

Transplanting was done on 1st week of December. The variety Soltha,a local variety was used. Twenty four days old seedlings were transplanted in plots, measuring 3 mx 2m where plant to plant and row to row distance was 60cm x75cm respectively. Two sprays were applied at 15 days interval. Pre-treatment count of aphid, white fly and shoot and fruit borer infestations was made and after application of treatments reused of the above three insect pests/ infestations was taken after 1st,3rd,5th and 10th days after treatment. Similar procedure was followed for second spray. Percent reduction over control (ROC%) of insect pests was estimated.

Comment [H4]: Winter or spring???

Botanical Extract Method:

The leaves of neem, pongamia,sweet flag, tobacco were collected from the university campus at Pundibari. One gram sample hexane was taken. The solvent hexane was used and the leaf sample was put in thumbal. After 1 hour hexane chemical evaporated. The sample weight estimated the beaker weight before and after extracting the chemical along with the beaker. Take the 1ml of sample mixed with 99 ml of water. After that sprayed in field.

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Results and Discussion:

The results of different treatments on the sucking insect pests are presented below.

Comment [H6]: Have all species of aphids, whiteflies and jassids been identified or only specific species?

4.2.1 Effect on jassid population

Table 2 :Effect of different botanicals against jassid on brinjal during 2020

Treatments	Dosage	Jassid population/leaf	Overall %ROC

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		First Spray						Second spray						
		PTC	3DAS	7DAS	10DAS	Mean	%ROC	PTC	3DAS	7DAS	10 DAS	Mean	%ROC	
Neem leaf extract		2.18	1.35 (1.36)	1.42 (1.38)	1.49 (1.41)	1.42	48.74	1.52	1.05 (1.24)	1.25 (1.32)	1.38 (1.37)	1.23	57.26	53.00
Pongamia leaf extract		2.68	2.10 (1.61)	1.88 (1.54)	1.70 (1.48)	1.89	31.71	1.73	0.90 (1.17)	1.20 (1.30)	1.89 (1.54)	1.33	53.66	42.68
Tobacco leaf extract		2.25	1.10 (1.25)	1.25 (1.32)	1.98 (1.57)	1.44	47.89	2.01	1.24 (1.31)	1.05 (1.24)	1.59 (1.44)	1.29	54.94	51.42
Sweet flag leaf extract		2.38	1.20 (1.30)	1.70 (1.48)	1.80 (1.51)	1.57	43.44	1.86	1.50 (1.41)	1.55 (1.43)	1.50 (1.41)	1.52	47.15	45.30
Multineem (Azadiractin 0.03%)		2.35	0.90 (1.18)	1.30 (1.34)	1.48 (1.40)	1.23	55.72	1.52	0.65 (1.07)	1.08 (1.25)	1.17 (1.29)	0.97	66.32	61.02
Imidacloprid17.8 SL	0.3ml/L	2.89	0.57 (1.03)	0.49 (0.99)	0.69 (1.09)	0.58	78.94	0.75	0.46 (0.97)	0.25 (0.86)	0.29 (0.89)	0.33	88.39	83.66
Untreated control	-	2.50	2.70 (1.78)	2.70 (1.78)	2.90 (1.84)	2.77	-	2.97	2.90 (1.84)	2.78 (1.81)	2.93 (1.85)	2.87	-	-
S. Em (±)		-	0.03	0.01	0.03	-	-	-	0.06	0.02	0.02	-	-	-
CD (5%)		NS	0.09	0.03	0.10	-	-	NS	0.19	0.07	0.07	-	-	-

Effect of different botanicals against jassid on brinjal during 2020

N.B.: DAS: Days after spraying; **NS:** Non-Significant; **PTC:** Pre-treatment count;
ROC: Reduction over control.
Figures in parenthesis are square root transformed values.

First spray:

The effects of different treatments on jassids are presented. The pre treatment count of jassid (both adult and nymph) population was made one day before first spray and the results

revealed that it varied from 2.18 to 2.89 per leaf. It was found that all the treatments were significantly superior over control. Observations recorded after first spray showed that population of jassid declined from the pre-spray count but the reduction in population varied from treatment to treatment. It was observed that among the botanicals, the

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lowest mean jassid population occurred in multineem treated plots (1.23 per leaf) followed by neem leaf extract treated plots (1.42 per leaf). Maximum mean population of jassid was observed in pongamia leaf extract treated plots (1.89 per leaf). In control plots the mean population was 2.77 per leaf. Maximum reduction in population over control was recorded in imidacloprid treated plots (78.94%) followed by multineem treated plots (55.72%). Pongamia leaf extract treated plots caused only 31.71% reduction in population over control.

Second spray:

After the second round of spraying the lowest mean population of jassid was observed in imidacloprid treated plots (0.33 per leaf) causing the maximum reduction in population over control (88.39 %). The effect of multineem was next to imidacloprid in terms of reducing the jassid population over control (66.32%). Sweet flag leaf extract treated plots had the maximum mean population of jassid (1.52 per leaf) reflecting the minimum reduction in population over control (47.15%). It was observed that in untreated control the mean population increased and reached at 2.87 per leaf.

After two rounds of spraying, it was observed that imidacloprid was the best treatment in terms of overall % reduction of jassid population over control. It recorded 83.66 % overall reductionin population over control followed by multineem (61.02%), neem leaf extract (53%), tobacco leaf extract (51.42%) and sweet flag leaf extract (45.30%). The least population reduction over control after two sprays was recorded in pongamia leaf extract treated pots (42.68%).

4.2.2 Effect on whitefly population

Table 3 : Effect of different treatments on whitefly population

Treatments	Dosage	Whitefly population/leaf												Overall
		First Spray						Second spray						
		PTC	3DAS	7DAS	10DAS	Mean	%ROC	PTC	3DAS	7DAS	10 DAS	Mean	%ROC	%ROC

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Neem leaf extract		**7.68**	4.72 (2.27)	3.85 (2.07)	4.53 (2.24)	4.37	52.79	4.98	2.9 (1.83)	3.58 (2.01)	4.75 (2.29)	3.74	59.92	56.36
Pongamia leaf extract		**7.74**	6.72 (2.68)	5.08 (2.36)	6.01 (2.55)	5.94	35.82	6.16	5.08 (2.36)	5.43 (2.43)	6.01 (2.54)	5.51	41.04	38.43
Tobacco leaf extract		**7.39**	5.38 (2.42)	4.52 (2.24)	5.2 (2.38)	5.03	45.59	5.38	4.13 (2.15)	4.81 (2.30)	5.04 (2.35)	4.66	50.11	47.85
Sweet flag leaf extract		**6.69**	6.05 (2.55)	5.18 (2.37)	5.87 (2.52)	5.70	38.38	5.91	4.12 (2.14)	4.96 (2.33)	5.98 (2.54)	5.02	46.25	42.32
Multineem (Azadiractin 0.03%)		**7.92**	4.05 (2.13)	3.18 (1.91)	3.53 (1.99)	3.59	61.23	3.76	2.5 (1.73)	2.87 (1.83)	3.56 (2.01)	2.98	68.13	64.68
Imidacloprid 17.8 SL	0.3ml/L	**8.51**	3.25 (1.93)	2.45 (1.71)	2.48 (1.72)	1.54	83.35	2.51	1.85 (1.52)	1.28 (132)	0.65 (1.07)	1.26	86.51	84.93
Untreated control	-	**8.38**	9.09 (3.09)	9.24 (3.12)	9.43 (3.15)	9.25	-	9.18	9.08 (3.09)	9.35 (3.13)	9.58 (3.17)	9.34	-	-
S. Em (±)			-	0.07	0.08	0.06	-	-	-	0.08	0.09	0.05	-	-	-
CD (5%)			NS	0.22	0.24	0.20	-	-	NS	0.25	0.29	0.15	-	-	-

N.B.: DAS: Days after spraying; **NS:** Non-Significant; **PTC:** Pre-treatment count;
ROC: Reduction over control.
Figures in parenthesis are square root transformed values.

First spray:

The effects of different treatments on whitefly population are furnished in table no. The results reveal that the pre-treatment count of whitefly population before the first spray varied from 6.69 to 8.51 per leaf. It is evident from the results that all the treatments were significantly superior over control. It was observed that whitefly population started to decline after first spray but the resultant population varied from treatment to treatment. The results clearly indicated that among the biopesticidal treatments, the lowest mean whitefly population was in multineem treated plots (3.59 per leaf) followed by neem leaf extract treated plots (4.37 per leaf). Maximum mean population of jassid was observed in pongamia

leaf extract treated plots (5.94 per leaf). In control plots the mean population however, increased to 9.25 per leaf. Maximum reduction of population over control was effected in imidacloprid treated plots (83.35%) followed by multineem treated plots (61.23%). Pongamia leaf extract treated plots caused only 35.82% reduction of population over control and it was the lowest reduction over control.

Second spray:

Observation recorded after second sprayings revealed that imidacloprid was the best among the treatments as it brought about the maximum reduction of population over control (86.51 %). Multineem was found to be the next to imidacloprid in terms of reduction of jassid population over control (68.13%). Pongamia leaf extract treated plots recorded the maximum mean population of jassid (5.51 per leaf) exhibiting the minimum reduction of population over control (41.04%). On the other hand, in untreated control plots, the mean population increased to 9.34 per leaf.

After two rounds of spraying it was found that imidacloprid was the best treatment in terms of overall per cent reduction of jassid population over control. It caused 84.93 % overall reduction over control followed by multineem (64.68%), neem leaf extract (56.36%), tobacco leaf extract (47.85%) and sweet flag leaf extract (42.32%). The minimum population reduction over control after two sprays was recorded in pongamia leaf extract treated pots (38.43%).

4.2.3 Effect on aphid population

Table 4: **Effect of different treatments on aphid population**

Treatments	Dosage	Aphid population/leaf												Overall %ROC
		First Spray						Second spray						
		PTC	3DAS	7DAS	10DAS	Mean	%ROC	PTC	3DAS	7DAS	10 DAS	Mean	%ROC	
Neem leaf extract		**1.75**	0.98 (1.22)	1.21 (1.31)	1.58 (1.44)	1.26	36.48	1.68	0.89 (1.18)	0.99 (1.22)	1.58 (1.44)	1.15	49.02	42.75
Pongamia leaf extract		**1.83**	1.23 (1.32)	1.43 (1.39)	1.55 (1.43)	1.40	29.18	1.65	0.98 (1.22)	1.42 (1.38)	1.84 (1.53)	1.41	37.46	33.32
Tobacco leaf extract		**1.91**	1.05	1.31	1.51	1.	34.	1.62	1.04 (1.2	1.24	1.45 (1.4	1.2	44.94	39.89

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			(1.24)	(1.34)	(1.42)	29	85		4)	(1.32)	0)	4		
Sweet flag leaf extract		**1.98**	1.42 (1.39)	0.98 (1.22)	1.66 (1.47)	1.35	31.82	1.72	1.24 (1.32)	1.39 (1.37)	1.52 (1.42)	1.38	38.79	35.30
Multineem (Azadiractin 0.03%)		**1.81**	0.85 (1.16)	1.05 (1.24)	1.45 (1.40)	1.11	43.77	1.53	0.79 (1.13)	0.75 (1.12)	1.51 (1.42)	1.02	55.01	49.39
Imidacloprid 17.8 SL	0.3 ml /L	**1.88**	0.78 (1.13)	0.16 (0.81)	0.12 (0.79)	0.35	82.15	0.65	0.52 (1.01)	0.15 (0.81)	0.11 (0.78)	0.26	88.50	85.33
Untreated control	-	**2.05**	1.91 (1.55)	1.91 (1.55)	2.11 (1.61)	1.98	-	2.16	2.17 (1.63)	2.28 (1.67)	2.32 (1.68)	2.26	-	-
S. Em (±)		-	0.02	0.05	0.03	-	-	-	0.02	0.03	0.04	-	-	-
CD (5%)		NS	0.06	0.14	0.09	-	-	NS	0.07	0.09	0.12	-	-	-

N.B.: DAS: Days after spraying; **NS:** Non-Significant; **PTC:** Pre-treatment count; **ROC**: Reduction over control.
Figures in parenthesis are square root transformed values.

First spray

Before the first spray, the pre treatment count of the aphid population was recorded. The results furnished in reveal that it varied from 1.75 to 2.05 per leaf. It was found that all the treatments were significantly superior over control. Aphid population was found to decline after first spray but the population varied from treatment to treatment. The results clearly exhibit that multineem emerged as the best treatment among the biopesticidal treatments as it exhibited the lowest mean aphid population (1.11 per leaf) followed by neem leaf extract treated plots (1.26 per leaf). Maximum mean population of aphid was observed in pongamia leaf extract treated plots (1.40 per leaf). In control plots the mean population of aphid increased to 1.98 per leaf. Maximum reduction of aphid population over control was recorded in imidacloprid treated plots (82.15%) followed by multineem (43.77%) and neem leaf extract (36.48%). Pongamia leaf- extract treated plots showed only 29.18% reduction of population over control and it was observed to be the lowest reduction over control.

Second spray:

Observations noted after second sprayings reveal that imidacloprid caused the maximum reduction of population over control (88.50 %) reflecting its superiority over other

treatments. Multineem was found to occupy the 2nd rank after imidacloprid in terms of reduction of aphid population over control (55.01%). Pongamia leaf extract treated plots had recorded the maximum mean population of aphid (1.41 per leaf) showing the minimum reduction of population over control (37.46 %). In untreated control plots the mean population increased to 2.26 per leaf from its initial population of 2.16 per leaf.

After second spraying it was noticed that in terms of overall per cent reduction of aphid population over control imidacloprid appeared to be the best treatment. It recorded 85.33 % overall reduction over control followed by multineem (49.39%), neem leaf extract (42.75 %), tobacco leaf extract (39.89%) and sweet flag leaf extract (35.30%). Treatment with pongamia leaf extract was the least effective one as it caused the lowest reduction of population over control (33.32%).

The present study indicated that among the botanicals evaluated, multineem was found to be the best treatment in brinjal followed by neem leaf extract. Khanzada and Khanzada (2018) also reported the good performance of neem seed kernel extract in reduction of sucking pest population over control in brinjal. It was observed during the present study that chemical treatment *i.e.*, imidacloprid showed highest per cent reduction of jassid, whitefly and aphid over control followed by multineem, neem leaf extract and tobacco leaf extract. Ali *et al*. (2016); Kasi and Tayde (2018a); Kasi and Tayde (2018b) obtained almost similar kind of results against whitefly and jassid in brinjal. The effectiveness of neem oil in suppressing the pest population in brinjal was reported by Karkar*et al.* (2014). The good efficacy of neem oil in management of aphid and jassid on brinjal was also reported by Dehariya*et al*. (2018); Kasi et al., (2022a); Thakur et al., (2023). The results of the present study lend support from Singh and Kumar (2003) who reported good efficacy of neem based pesticides against white fly and jassid. The efficacy of neem product was also reported by Haq (2006) and Hassan *et al*. (2006). The effectiveness of neem product and tobacco plant extract in management of pests of brinjal was earlier reported by Noonari (2008). Though the results of the present study are in consonance with the earlier reports of various workers as elaborated above, the finding of the present author may be confirmed by conducting the trial for another season.

Table 5 List of insect pests recorded in brinjal during 2020.

Order	Family	Common name	Scientific name	Stage of crop & site of damage

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Orthoptera	Acrididae	Short- horned grass- hopper	Hieroglyphus banian Fab.	Leaf
	Tettigonidae	Long- horned grass- hopper	Un- identified	Leaf
Diptera	Muscidae	Fruit fly	Un- identified	Fruit
Homoptera	Aphididae	Cotton aphid	Aphis giossypii	Leaf, shoot, flower bud, and leaf
Thysanoptera	Aleyrodidae	Cotton whitefly	Bemisia tabaci	Leaf
Coleoptera	Cooccinellidae	Epilachna beetle	Henosepilachna vigintioctopunctata	Leaf, shoot and fruit
	Chrysomelidae	Flea beetle	Phyllotreta sp.	leaf
	Chrysomelidae	Red pumkin beetle	Aulachophora foviecollis	leaf
Lepidoptera	Pyralidae	Brinjal Shoot and fruit borer	Leucinodes orbonalis	Shoot and fruit

Future scope:

Among the different botanicals used, all were found to be less efficacious than Imidacloprid which caused 83.66% reduction in case of jassid population. Multi neem was found to be the best biopesticide in reducing jassid population (61.02%) followed by neem leaf exract.Multi neem appeared to be the botanical in bringing down the white fly population(64.68%) followed by neem leaf extract 56.36% whereas imidacloprid recorded the highest reduction population 84.93%.

In case of shoot damage, the highest %reduction was achieved by imidacloprid 83.78%and it exhibited to be superior over the other botanicals. All the botanicals failed to provide more than 40%reduction in shoot damage. However, among the botanicals multi neem was found to be recording 36.58% reduction.The cotton aphid remained active in the field all throughout the period of study (2nd week of January to last week of May) for 21 weeks jassid, thrips and white flies also recorded their presence for 21 weeks.

Conclusion: The experiment on arthopod biodiversity was conducted with the variety Navakiran. Based on recording of data at weakly intervals 12 number of different insect pest under 6 orders and 12 families were found to occur in Terai zone.

Comment [H8]: Rewrite with mention the most important result of this study.

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Comment [H9]: Repeated

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