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Pest management in brinjal through bio-rational products under organic farming system

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ABSTRACT

In organic farming, secondary metabolites of plants can be used to manage insect-pests in crops. Various plant-derived compounds have been reported to exhibit insecticidal properties. However, due to farmers' dependence on synthetic pesticides, plant extracts are not widely popular. On the other hand, excessive use of synthetic pesticides has led to negative impacts on human health and the environment, which can be mitigated through eco-friendly techniques. Brinjal is an important vegetable crop in India. Considering these factors, the present study evaluated organic extracts such as modified *Agniastra* (MAA), modified *Brahmastra* (MBA), and *Dharek* extract (DE), applied at 7.5, 10.0 and 12.5 L/ha for the control of various insect-pests under organic conditions. A standard check of homemade *neem* extract (HMNE) at 4.0 L/ha and an untreated control were also included. Among the organic extracts, MBA and MAA at 12.5 L/ha performed best, showing a significant reduction in the whitefly population, lower fruit damage due to shoot and fruit borer, higher fruit yield, and better economic returns. DE at 12.5 L/ha was the next best treatment based on these parameters.

Key words: *Solanum melongena* L., *dharek* extract, *neem* extract, whitefly, shoot and fruit borer.

INTRODUCTION

Organic farming provides a sustainable and environmentally friendly alternative to conventional agricultural practices. It emphasizes soil, animal, and plant health by incorporating natural inputs and eco-friendly techniques such as farmyard manure, compost, green manuring, cover crops, and crop rotation. This approach not only enhances soil fertility but also supports sustainable agriculture, environmental conservation, and human health. Research indicates that organically grown crops are more nutritious, and in brinjal (*Solanum melongena* L.), these practices have been shown to increase antioxidant content. Brinjal, a member of the Solanaceae family, is widely cultivated across various countries (Harish *et al*., 14). Though grown as an annual crop, it is naturally perennial and is a rich source of essential vitamins and minerals (Nonnecke, 15). In India, brinjal ranks as the fourth most important vegetable crop after potato, onion, and tomato. In Punjab area under production is 5.82 thousand hectares and average yield is 255.76 quintal per hectare with a production of 148.75 thousand tonnes (Anon., 3). It is generally raised by small and marginal farmers for their source of income. But its production practices deal with various challenges which affect the yield directly (Choudhary, 10). To control different insect-pests locally prepared bio-rational products are widely in use in present days (Golob and Webly, 13). Various insect-pests, *viz.,* whitefly, shoot and fruit borer, hopper, aphid and *Epilachna* beetle have been considered as major threat to the production of brinjal crop (Bhadauria *et al*., 5). However, among these pests, *Bemisia tabaci* is a global pest that attacks over 600 plant species (Alemandri *et al*., 2) and distributed in 162 countries (CABI, 6). The organic extracts can be easily prepared by the farmers, are eco-friendly and do not cause any health issues over the chemical pesticides (Saxena *et al*., 18). Ashadul *et al.* (4) found that fruit and shoot borer infestation was reduced with the application of *neem* leaf extract, which in return increased the total yield of the crop. Singh *et al.* (19) have reported that *B. tabaci* population was managed with two sprays of *azadirachtin* 1% @ 1000 mL/ ha (need based) and with installation of yellow sticky traps (100 traps/ha). These extracts contain defensive chemicals that make pests difficult or impossible to consume the sprayed plants. Indiscriminate use of synthetic insecticides by brinjal growers has resulted in soil, water and environmental pollution and also affects human health. Given the challenges posed by insect-pests in brinjal cultivation and the adverse effects of synthetic insecticides on the environment and human health, this study was undertaken to explore the efficacy of eco-friendly bio-rational strategies such as modified *Brahmastra* (MBA), modified *Agniastra* (MAA), and modified *Dharek* extract (DE) for sustainable pest management under organic and natural farming systems.

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MATERIALS AND METHODS

The present investigations were conducted at the Research Farm, School of Organic Farming, Punjab Agricultural University (PAU), Ludhiana, during 2020, 2021, and 2022. The brinjal variety Punjab Bharpur was sown in July and transplanted in August each year. All cultural practices were followed as per the recommended production technology for brinjal under organic farming conditions, as outlined in the Package of Practices for Cultivation of Vegetables (Anon., 3). A Randomized Complete Block Design (RCBD) was adopted, with a total of eleven treatments applied against insect-pests of brinjal. For the preparation of MBA, plant materials, including 2.0 kg leaves each of guava (*Psidium guajava*), *karanj* (*Pongamia pinnata*), papaya (*Carica papaya*), castor (*Ricinus communis* L.), and *aak* (*Calotropis procera*), along with 5.0 kg *neem* leaves (*Azadirachta indica*), were crushed and added to 10 L of bovine urine. The mixture was boiled 3-4 times and then cooled in the shade. After 48 h, the extract was diluted in 250 L of water per hectare for application. For the preparation of MAA, 5.0 kg *neem* leaves, 200 g dry ginger (*Zingiber officinale*), 500 g chili (*Capsicum annuum* L.), and 500 g garlic (*Allium sativum*) were ground into a paste and mixed with 10 L of bovine urine. The mixture was boiled 3-4 times, cooled in the shade, and used in 250 L of water per hectare after 48 h. For the preparation of DE, 4.0 kg terminal shoot parts, including leaves, green branches, and fruits of *dharek* (*Melia azedarach*), were crushed and boiled in 10 L of water for 30 min. The mixture was then filtered through muslin cloth, and the filtrate was used for spraying at the recommended dose. HMNE was prepared similarly, using 4.0 kg terminal shoot parts, including leaves, green branches, and fruits of the *neem* plant. These were crushed, boiled in 10 L of water for 30 min, filtered through muslin cloth, and applied at the recommended dose.

Two sprays of the above-mentioned organic extracts were applied: the first spray at pest appearance and the second spray seven days later. The incidence of whitefly was recorded on three leaves per plant from the upper canopy before 10:00 AM on five randomly tagged plants in each replicated plot before spraying and at 1, 3, and 7 days after spraying. The incidence of shoot and fruit borer was recorded at each fruit picking. Phytotoxic effects were also observed. Fruit yield was recorded in kilograms per plot and converted to a per-hectare basis. Economic returns for insect-pest management in brinjal were also calculated. The data analyzed by ANOVA using RCBD design through CPCS 1 program (Cheema and Singh, 9).

RESULTS AND DISCUSSION

The incidence of insect-pests had shown non-significant differences in the treated as well as untreated control plots during 2020, 2021 and 2022 (Tables 1 and 2). The incidence of whitefly was lowest and expressed in terms of percent reduction over control (PROC) for all the tested bio-rational products, *viz.,* MBA, MAA and DE as compared to the standard check, PAU HMNE and the untreated control (Table 1). Pooled PROC for three years (2020, 2021 and 2022) was significantly higher in MBA @ 12.5 Lha^{-1} at 1 DAT (37.92 and 57.42%), 3 DAT (62.69 and 54.41%) and 7 DAT (50.29 and 59.20%) after 1st and 2nd spray, respectively. MAA @ @ 12.5 L ha^{-1} also recorded higher pooled PROC at 1 DAT

Table 1. Efficacy of various bio-rational products against whitefly on brinjal under organic farming conditions.

Treatment	Per cent reduction over control (PROC) of whitefly (Pooled data 2020, 2021 & 2022)					
	1 DAS		3 DAS		7 DAS	
	1st Spray	2nd Spray	1st Spray	2nd Spray	1st Spray	2nd Spray
MBA @ 7.5 Lha^{-1}	25.13±0.47^{ef}	42.11±0.85^{c}	48.48±0.79^{c}	36.34±0.35^{f}	32.55±0.14^{de}	44.08±0.63^{c}
MBA @ 10.0 Lha^{-1}	30.71±1.15^{cde}	51.10±0.68^{b}	55.87±0.46^{b}	45.76±0.15^{cd}	42.60±0.06^{b}	50.93±0.25^{b}
MBA @ 12.5 Lha^{-1}	37.92±0.40^{ab}	57.42±0.38^{a}	62.69±0.14^{a}	54.41±0.16^{b}	50.29±0.41^{a}	59.20±0.19^{a}
MAA @ 7.5 Lha^{-1}	29.60±0.44^{de}	42.31±0.68^{c}	49.27±0.66^{c}	42.56±0.14^{de}	33.83±0.16^{cd}	44.04±0.60^{c}
MAA @ 10.0 Lha^{-1}	37.17±1.23^{abc}	48.59±0.27^{b}	55.57±0.47^{b}	47.61±0.55^{c}	38.25±0.564^{bcd}	49.04±0.38^{b}
MAA @ 12.5 Lha^{-1}	41.98±1.70^{a}	57.00±0.62^{a}	63.75±0.04^{a}	58.34±0.25^{a}	43.18±1.84^{b}	59.68±0.11^{a}
DE @ 7.5 Lha^{-1}	20.64±1.08^{f}	34.73±0.29^{d}	38.93±0.04^{d}	30.87±0.64^{g}	26.30±0.53^{f}	35.49±0.30^{d}
DE @10.0 Lha^{-1}	26.47±0.54^{ef}	43.82±0.71^{c}	48.55±0.59^{c}	39.30±0.39^{ef}	35.47±0.27^{cd}	47.66±0.60^{c}
DE @ 12.5 Lha^{-1}	34.55±0.48^{bcd}	48.76±0.76^{b}	53.47±0.09^{b}	45.38±0.55^{cd}	39.37±0.66^{bc}	52.73±0.48^{b}
PAU HMNE @ 4.0 L ha^{-1}	25.95±0.55^{ef}	35.96±0.26^{d}	40.06±0.15^{d}	32.52±0.30^{g}	27.63±0.08^{ef}	37.51±0.25^{d}

Mean±SE; MBA: Modified *Brahamastra*; MAA: Modified *Agniastra*; DE: *Dharek* extract; DAS: Days after spray.

Table 2. Effect of organic extracts on fruit damage and yield on brinjal under organic conditions.

Treatment	Fruit damage (%)				Fruit yield (q ha^{-1})			
	2020	2021	2022	Pooled Mean	2020	2021	2022	Pooled Mean
MBA @ 7.5 Lha^{-1}	13.78 (21.77)	13.99 (21.95)	12.17 (20.40)	13.31 (21.38)	400.83	395.43	400.83	399.03
MBA @ 10.0 Lha^{-1}	11.05 (19.39)	11.25 (19.59)	11.46 (19.78)	11.25 (19.59)	411.68	405.18	406.25	407.70
MBA @ 12.5 Lha^{-1}	9.74 (18.16)	9.90 (18.30)	10.83 (19.21)	10.15 (18.57)	419.25	413.83	411.68	414.93
MAA @ 7.5 Lha^{-1}	15.07 (22.83)	14.93 (22.72)	11.87 (20.14)	13.96 (21.90)	395.43	398.68	391.08	395.05
MAA @ 10.0 Lha^{-1}	13.10 (21.21)	13.04 (21.15)	11.37(9.69)	12.50 (20.69)	405.18	407.33	384.58	399.03
MAA @ 12.5 Lha^{-1}	10.90 (19.26)	10.97 (19.33)	10.83 (19.21)	10.90 (19.27)	417.08	413.83	377.00	402.63
DE @ 7.5 Lha^{-1}	13.33 (21.40)	13.53 (21.57)	11.10 (19.45	12.65 (20.81)	398.68	393.25	384.58	392.18
DE @ 10.0 Lha^{-1}	11.50 (19.81)	11.67 (19.96)	10.63 (19.01)	11.26 (19.60)	406.25	399.75	395.43	400.48
DE @ 12.5 Lha^{-1}	11.03 (19.39)	11.27 (19.59)	10.27 (18.67)	10.86 (19.23)	411.68	404.08	400.83	405.53
PAU HMNE @ 4.0 L ha^{-1}	13.76 (21.77)	14.03 (21.99)	10.93 (19.29)	12.91 (21.02)	392.18	391.08	390.00	391.08
Untreated control	17.63 (24.80)	18.58 (25.52)	13.17 (21.26)	16.46 (23.87)	384.58	365.08	364.18	371.28
CD (p=0.05)	(0.89)	(1.03)	(0.82)	(1.41)	18.00	16.03	20.85	12.30

MBA: Modified *Brahamastra*; MAA: Modified *Agniastra*; DE: *Dharek* extract; Values in parentheses are Arc sine transformationed data.

(41.98 and 57.00%), 3 DAT (63.75 and 58.34%) and 7 DAT (43.18 and 59.68%) after 1st and 2nd spray, respectively. Similarly, DE @ 12.5 L ha^{-1} was the next best to record high PROC at 1 DAT (34.55 and 35.96%), 3 DAT (53.47 and 45.38%) and 7 DAT (39.37 and 52.73%) after 1st and 2nd spray, respectively. MAA @ 12.5 L ha^{-1} registered significantly lower fruit damage due to shoot and fruit borer (10.15%), which was at par with MBA @ 12.5 L ha^{-1} (10.90%) and DE @12.5 L ha^{-1} (10.86%) as against standard check, HMNE @ 4.0 L ha^{-1} (12.91%) and untreated control (16.46%) on pooled mean basis of three years (Table 2). MBA @ 12.5 L ha^{-1} recorded significantly the highest yield (414.93 q ha^{-1}), which was at par with and MAA @ 12.5 L ha^{-1} (402.63 q ha^{-1}) and DE @ 12.5 L ha^{-1} (405.53 q ha^{-1}) over HMNE @ 4.0 q ha^{-1} (391.08 q ha^{-1}) and untreated control (371.28 q ha^{-1}) on pooled mean basis of three years (Table 3). MAA @ 12.5 L ha^{-1} registered more economic returns (Rs. 53562.5 ha^{-1}) followed by DE @ 12.5 L ha^{-1} (Rs. 41812.5 ha^{-1}) and MBA @ 12.5 L ha^{-1} (Rs. 37687.5 ha^{-1}) over standard check, HMNE @ 4.0 L ha^{-1} (Rs. 24090.0 ha^{-1}) (Table 3). No relevant information was available in the literature on the present studies. However, some of the workers like Rosaib (16) while evaluating different botanicals against insect-pests of brinjal reported that NSKE 5% had recorded least shoot damage. Chatterjee (8) revealed application of azadex (*neem*-based bio-pesticide) as most effective treatment to reduce shoot damage (76.59%) in brinjal. Dutta *et al.* (11) reported that application of *neem* afford 79.24% reduction of shoot damage in brinjal. Chandra *et al.* (7) reported *brahamastra* and *agniastra* @ 10 litres/ acre, respectively based on three sprays on chickpea as moderately effective to record low population of gram caterpillar, *Helicoverpa armigera* Hubner. Santhosh *et al.* (17) observed that *agniastra* and *brahamastra* reduced larval mortality of *Spodoptera litura* (Fabricius) 63.33 and 50% respectively. The most important compound of *A. indica* is *aza*dirachtin that has been recognized as an essential insecticidal ingredient. It works as repellent, anti-feedant, and repugnant agent and causes sterility in insects by interfering production of sperms in males and preventing oviposition in femal (Chaudhary *et al.*, 10). A variety of other bioactive compounds have also been reported from leaves of *A. indica* by Eid *et al.* (12) and Ahmad *et al.* (1), which might be responsible for insecticidal properties.

The present study demonstrates the efficacy of bio-rational products in managing insect pests in brinjal under organic farming conditions. Among the tested treatments, MBA and MAA at 12.5 L ha^{-1} effectively reduced whitefly incidence and fruit damage due to shoot and fruit borer, leading to higher yields and economic returns. DE at 12.5 L ha^{-1} also showed promising results, ranking next to MBA and MAA. These organic extracts outperformed the standard check (PAU HMNE) and the untreated control, highlighting their potential as eco-friendly alternatives to synthetic pesticides. The findings align with previous studies on *neem*-based formulations but provide new insights into the effectiveness of MBA, MAA, and DE. Given their insecticidal properties and economic benefits, these bio-rational strategies can contribute to sustainable

Table 3. Yield and economic benefits for management of insect pests in brinjal.

Treatment	Fruit yield (q ha^{-1})	Additional yield over control (q ha^{-1})	Gross returns (Rs./acre)	Cost of treatment (Rs. ha^{-1})	Net returns over control (Rs. ha^{-1})
MBA @ 7.5 Lha^{-1}	399.03	27.75	34687.5	800.0	33887.5
MBA @ 10.0 Lha^{-1}	407.70	36.42	45525.0	900.0	44625.0
MBA @ 12.5 Lha^{-1}	414.93	43.65	54562.5	1000.0	53562.5
MAA @ 7.5 Lha^{-1}	395.05	23.77	29712.5	1100.0	28612.5
MAA @ 10.0 Lha^{-1}	399.03	27.75	34687.5	1300.0	33387.5
MAA @ 12.5 Lha^{-1}	402.63	31.35	39187.5	1500.0	37687.5
DE @ 7.5 Lha^{-1}	392.18	20.90	26125.0	800.0	25325.0
DE @ 10.0 Lha^{-1}	400.48	29.20	36500.0	900.0	35600.0
DE @ 12.5 Lha^{-1}	405.53	34.25	42812.5	1000.0	41812.5
PAU HMNE @ 4.0 L ha^{-1}	391.08	19.80	24750.0	660.0	24090.0
Control	371.28	-	-	-	-
CD (p=0.05)	12.30				

L: Litre; Av. price of organic brinjal = Rs. 1250/- per quintal; Labour cost for spraying one hectare = Rs. 250/-; Preparation cost of MBA @ Rs. 20/L; MAA@ @Rs.40/L; DE @ Rs. 20/L; PAU HMNE @ Rs.20/L.

pest management in organic brinjal cultivation. Further studies can explore their long-term impact on pest dynamics and soil health.

AUTHORS' CONTRIBUTION

Conceptualization of research (SS); Designing of the experiment (SS); Contribution of experimental materials (MKS); Crop management (KSB) Execution of field experiments and data collection (SS); Analysis of data (KSB and MT); Preparation of the manuscript and interpretation (SS).

DECLARATION

The authors declare that they have no conflict of interest.

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