Nat. Volatiles & Essent. Oils, 2022; 9 (1): 1608-1616

NVEO
Natural Volatiles & Essential Oils

Eco Friendly Management of Brinjal Borers Through Indigenous Plant Extracts

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ABSTRACT

A study was started to compare the efficacy of various phytoconstituents to a synthetic chemical for managing borers in brinjal fields. For the study, a farmer field with consistent agronomic techniques was chosen. The study included six treatments (Lambda cyhalothrin, Chili garlic extract, Chili garlic + onion extract, Bakain (*Melia azedarach*) leaf extract + Neem (*Azadirachta indica*) oil, Bakain (*M. azedarach*) leaf extract + Bakain (*M. azedarach*) fruit extract, Bakain leaf extract (*M. azedarach*) and an untreated control that were replicated three times. For data analysis, the statistical model Randomized Complete Block Design was used. Means were separated by 5%level of significance using LSD test in the statistical package Statistix 8.1. According to the results of the currentstudy, it was observed that after the first, second, and third sprays, Lambda cyhalothrin (11.19, 5.05, 3.88) proved to be the most effective treatment against brinjal shoot infestation, followed by botanical, Chili garlic extract (11.75, 8.57, 7.96), and Chili garlic + Onion extract (12.91, 8.84, 8.65). Plots treated with Lambda cyhalothrin (2.86, 0.00) had the lowest percent fruit infestation after the first and second sprays, followed by botanicals Bakain leaf extract + Neem oil (8.16, 1.69) and Chili garlic extract (11.6, 2.76). Lambda Cyhalothrin plots produced the most commercial yield (10370 kg hec^{-1}) followed by Chili garlic extract (9019 kg hec^{-1}) and Bakain leaf extract + Neem Oil (9000 kg hec^{-1}). The yield obtained from untreated control plot, was the lowest of all treatments. Best results among all the botanical treatments were obtained by combining bakain leaves extract with bakain fruit extract. Bakain leaf extract + Bakain fruit extract had the highest Cost Benefit Ratio (28.07), followed by Bakain leaf extract (27.24). Chili garlic extract, as well as bakain leaves extract+ neem oil, may successfully control brinjal shoot and fruit borer with maximum yield. However, when compared to other plant extracts, Bakain leaves extract + Bakainfruit extract has the best cost-benefit ratio.

Keywords: Botanicals, Brinjal borers, Pesticide pollution, Ecofriendly management, Pakistan

INTRODUCTION

Brinjal (*Solanum melongena* L.) is another name for eggplant or aubergine. It is one of the few seasonal vegetables that has a semi-perennial flavor and is available almost all year with about 15-20 different varieties. It is grown and used all over the world, particularly in hot and humid climates. It generates 50 MT worldwide from an area of around 1.6 million acres (FAO, 2012).

In Pakistan, the total area under cultivation of brinjals is 8,427 hectares, with a yield of 84,255 tonnes (Anonymous, 2019). In Khyber Pakhtunkhwa, the total area under brinjal cultivation is 945 hectares, with a total output of 8980 tonnes, whereas the total area under brinjal cultivation in District Charsaddais 11 hectares, with a total output of 128 tonnes (CRS, 2017-18).

Brinjal is abundant in antioxidants, vitamins, and proteins, and it also has therapeutic properties (Obhoet al., 2005). Brinjal is a prominent vegetable in Pakistani cuisine since it is available all year (Javed et al., 2017). Many pests attack the brinjal plant at various stages of development, but the most damaging is the shoot and fruit borer (*Leucinodes orbonalis*) Guenee. The Pyralidae family of the insect order Lepidoptera is responsible for 70% of the damage to brinjal shoots and fruits (Latif et al., 2010). Oviposition in brinjal shoots and fruit borer occurs primarily at night, and caterpillars bore both into shoots and fruits, eating within, disrupting the transfer mechanism of nutrients in the shoot (Alam et al., 2006). Shoot infection becomes minimal after fruit set occurs (Kumar and Dharmendra, 2013). Becauseof the severity of the damage caused by *L. orbonalis*, most eggplant producers continue to use pesticides as their primary method of control (Dwivedi et al., 2014).

Insecticides used carelessly have resulted in higher production costs, pesticide resistance, secondarypest outbreaks, health issues, and mortality of beneficial insects (Gaur and Chaudhary, 2009). Non- chemical methods such as botanicals, mechanical control such as hand picking and removal of affected plant portions, particularly shoots and fruits, are commonly employed to manage the pest (Hassan,1994). Application of bio-pesticides might be a safe approach of pest management (Adalbert, 2013). Chemicals that are environmentally friendly are among the effective pest control tools that are employed as a safe alternative (Prasad and Devappa, 2006). Azadirachtin is a compound found in neem plants that acts as an antifeedant and repellant (Singh and Kumar, 2015).

Farmers spray massive amounts of pesticides for insect pest management to maximize production, which are not only harmful to human health, the environment, and other beneficial insects, but also build resistance in target insect pests. Furthermore, importing many pesticides places a significant economic strain on our country. To address the concerns, current study aims to assess plant resources in the form of extracts that can be utilized to combat insect pests.

MATERIALS AND METHODS

The research began on a farmer's field in District Charsadda, Khyber Pakhtunkhwa, Pakistan, during the summer of 2020. During the second week of July, Brinjal seedlings of the Purple long type were obtained from a local store and placed into a farmer's field that had already been prepared. The tests used an RCBD design with seven treatments, including a control, which was duplicated three times. Each plot was 3m x 3m ($9m^2$) in size, with a 60cm row-to-row spacing and a 30cm plant-to-plant distance. A Knapsack sprayer was used to apply all treatments, including botanicals and pesticide. The control plot

was not treated in any way. Data on shoot infection was collected before and after treatment at 7- and 14-day intervals, as well as fruit infestation after each picking.

Preparation of Plant Extracts

20 g paste of both chili and garlic was measured and combined with liter water to make a volume of 1liter stock solution of chili garlic extract. Leaf extract of Bakain was obtained by following Mochiah et al., (2011). For fruit extract from bakain, Ali et al. (2016), whereas Jazzar and Hammad, (2003) were followed to prepare chili garlic and onion extracts. A local market provided the neem oil and lambda- cyhalothrin.

Treatments

T_1: Lambda cyhalothrin 2.5 % EC @ 0.5 %

T_2 : Chili garlic extract @ 4%

T_3 : Chili garlic @ 4% + onion extract @ 4%

T_4: Bakain (M. azedarach) leaf extract @5% + Neem (Azadirachta indica) oil @ 1%

T_5: Bakain (M. azedarach) leaf extract @ 5 % + Bakain (M. azedarach) fruit extract@7%

T_6: Bakain (M. azedarach) leaf extract @ 5%

T_7: Control

Statistical analysis

The data collected was subjected to analysis of variance (ANOVA) to ascertain the significance of treatments. Means were compared using the LSD test at 5% level of significance.

RESULTS

Shoot and Fruit infestation

Table 1 shows data about shoot infestation by brinjal borer. Before spray data shows a significantly higher number of shoot fly infestation in brinjal field. When compared with the control, where shoot infestation was notably high, the mean column after two weeks of data demonstrates that percent shoot infestation was much reduced and statistically non-significant in all tested treatments after first application of treatments in these plots. After second dose of treatment application, mean column shows better results in case of plots treated with Lambda cyhalothrin which was used as a standard.

Among botanicals, chili garlic extract as well as chili garlic + Onion extract, Bakain leaves extract + Neem oil and Bakain leaves extract performed well against brinjal shoot fly but were statistically non significantly different from each other.

Mean of treatment doses applied after 3rd application shows better lowest percent of shoot fly infestation in plots treated with Lambda cyhalothrin. Among tested botanicals, Chili garlic extract persistently managed the shoot fly population and was non-significant with the extract Bakain leaves extract + Neem oil, Chili garlic + Onion extract and Bakain leaves extract. All the tested botanicals however, performed way better than the control plot.

Table1. Percent Shoot infestation in farmer field, treated with botanicals and a chemical insecticide against shoot fly in brinjal crop at District Charsadda, Khyber Pakhtunkhwa, Pakistan

Treatments	Percent Shoot Infestation			
	Before spray Data	Mean after 1st spray	Mean after 2nd spray	Mean after 3rd spray
Lambda cyhalothrin	20.47	11.19 b	5.05 d	3.88 d
Chili garlic extract	16.69	11.75 b	8.57 c	7.96 c
Chili garlic + Onion extract	19.91	12.91 b	8.84 c	8.65 bc
Bakain leaves extract + Neem oil	15.93	13.06 b	10.03 bc	7.89 c
Bakain leaves extract + Bakain fruit extract	18.80	14.60 b	11.77 b	10.53 b
Bakain leaves extract	20.47	14.56 b	10.03 bc	9.70 bc
Control	18.44	21.75 a	32.54 a	31.93 a
LSD (0.05)	Ns	3.61	2.67	2.33

Figures followed by same the same letters are non-significant from each other at P (0.05%)

Table 2 illustrates the percent of fruit infestation before and after two sprays, each conducted at a gap of 14 days. Mean column after first application of treatments dose shows that brinjal fruit infestation was highest in untreated control plot whereas minimum pest attack was observed in plots treated with Lambda cyhalothrin treated plots. Among botanicals, Bakain leaves extract + Neem oil gave best resultin case of percent fruit infestation but was statistically non-significant with Chili garlic extract and Bakain leaves extract + Bakain fruit extract. Chili garlic + onion extract and Bakain leaves extract were far better than control after first application.

Percent infestation by brinjal fruit borer after second spray in table 2 shows effective management in the plots treated with Lambda cyhalothrin whereas in case of plant extracts, bakain leaves extract + Neem oil showed better control of the brinjal fruit borer; however, it was statistically non-significantwith chili garlic extract. Other botanicals also proved effective against the pest as compared to control but statistically they were significantly different from bakain leaves extract + Neem oil and chili garlic extract.

Table 2. Percent infestation of Brinjal fruit borers in farmer field, treated with botanicals and a chemical insecticide at District Charsadda, Khyber Pakhtunkhwa, Pakistan

Treatments	% Fruit infestation after 1st spray	% Fruit infestation after 2nd spray
Lambda cyhalothrin	2.86 d	0.00 d
Chili garlic extract	11.61 bc	2.76 bc
Chili garlic + onion extract	15.44 b	3.28 b
Bakain leaves extract + Neem oil	8.16 c	1.69 c
Bakain leaves extract + Bakain fruit extract	12.92 bc	3.15 b
Bakain leaves extract	14.56 b	3.11 b
Control	66.90 a	21.24 a
LSD	5.11	1.35

Figures in columns followed by same the same letters are non-significant from each other at P (0.05%)

Marketable Yield (kg ha^{-1})

Table 3 shows the yield of brinjal in kg per hectare. The plot treated with Lambda cyhalothrin produced the highest yield, followed by chili garlic and bakain leaves extract + neem oil. Treatment's chili garlic + onion, bakain leaves extract, and bakain leaves extract + bakain fruit extract were not substantiallydifferent from each other, although they yielded considerably more than the control plot.

Table 3. Marketable yield (Kg hec^{-1}) obtained from plots treated with botanicals and synthetic insecticides against brinjal borers at farmer's field, district Charsadda, Khyber Pakhtunkhwa, Pakistan

Treatments	Marketable Yield (Kg hec^{-1})
Lambda cyhalothrin	10370.0 a
Chili garlic extract	9019 ab
Chili garlic + onion extract	8000 b
Bakain leaves extract + Neem oil	9000.0 ab
Bakain leaves extract + Bakain fruit extract	7778 b
Bakain leaves extract	7790 b
Control	3567 c
LSD (0.05)	2141.1

Figures in columns followed by same letters are non-significant from each other at P (0.05%)

Economic analysis of managements applied against brinjal borers

Table 4 compares the cost of control and the with the income received after selling the produce. According to the table, all the tested therapies were lucrative, with a CBR value of more than one which means that the cost of management was low than the benefit received from the treated crop. Bakain leaves extract + bakain fruit extract, has the greatest CBR (1: 28.07) which shows that due to lower management cost, we may get a profit which is best among all the tested treatments. bakain leaves extract proved to the be second most beneficial treatment in case of profit received from the treated plots (1: 27.24), followed by Lambda cyhalothrin, chili garlic + onion extract, and chili garlic extract with CB ratio of 15.59, 9.55, and 8.64 respectively. The treatment of bakain leaves extract+ neem oil, on the other hand, was the least lucrative, with the lowest CBR value (1: 6.58).

Table 4. Cost Benefit Ratio of different treatments used against Brinjal borers treated with different plant extracts in comparison to chemical insecticide in farmer's field at District Charsadda, during Summer 2020.

Treatments	Marketable yield (Kg hec^{-1})	Gross Income	Cost of Control	Return Over Control	Net Increase over control	CBR
Lambda cyhalothrin	10370	414800	17444.4	272120	254675.6	15.59
Chili garlic extract	9019	360760	25222.2	218080	192857.8	8.64
Chili garlic + onion extract	8000	320000	18555.5	177320	158764.5	9.55
Bakain leaves extract + Neemoil	9000	360000	33000	217320	184320	6.58
Bakain leaves extract + Bakain fruit extract	7778	311120	6000	168440	162440	28.07
Bakain leaves extract	7790	311600	6200	168920	162720	27.24
Control	3567	142680				

Average price of brinjal = Rs. 40/- kg^{-1}

DISCUSSION

The purpose of this study was to evaluate the efficacy of several botanicals a chemical against the brinjal shoot and fruit borer at farmers field in District Charsadda, Khyber Pakhtunkhwa, Pakistan during 2020. Based on our findings on management of brinjal shoot and fruit borer, it was observed that among plant extracts, the pest was effectively managed by Chili garlic extract and Bakain leaves extract + Neem oil. Similar research was also conducted by Sahana and Tayde (2017), who evaluated botanicals with a chemical insecticide against brinjal shoot and fruit borer. They found synthetic insecticide more effective than plant extracts as in our case. Further they explained that neem oil and pongamia oil are effective management tools among plant products in managing these pests. Similar results were also obtained by Amonkor and Baneji (1971) who reported that Sulphoroxide components present in garlic and onion has repellent nature and can be effectively used in management of potato tuber moth, aphids, and other similar pests.

Zidan et al., (2012) used several insecticides to combat cotton chewing and sucking bugs and found Lambda cyhalothrin to be efficient against all pests. Our studies also show that all the tested botanicals in present studies were effective in controlling shoot and fruit borer, and our result lie in conformity with Sahu et al., (2017), who found neem oil effective against brinjal shoot and fruit borer. Similar results were also observed by Mochiah et al., (2011), who used different botanicals and found neem oil more effective than garlic extract against brinjal borers.

Bakain leaf extract + neem oil and Chili garlic gives us excellent yield in case of plot treated with botanicals whereas synthetic pesticide gives us best yield among all the treatments. Our results are in similarity with Murugesan and Murugesh (2009), who reported that high brinjal yield was obtained because of brinjal field treated with synthetic chemicals followed by botanicals.

Likewise, Gupta and Singh (2017) used many pesticides against brinjal borer and found that all treatments were effective against brinjal shoot and fruit borers, although lambda cyhalothrin had the best cost-benefit ratio. Farooq et al., 2016 found similar results utilizing different botanicals against wheat aphids, with bakain seeds extract outperforming bakain leaves extract in terms of cost-benefit ratio.

LITERATURE CITED

Alam S N., Hossain M I., Rouf F M A., Jhala R C., Patel M G., Rath L K., Sengupta A., Baral K., Shylesha AN., Satpathy S., Shivalinga swamy T M., Cork A., Talekar N S. (2006): Implementation and promotion of an IPM strategy for control of eggplant fruit and shoot borer in South Asia. Tech. Bull. 36. AVRDC publication number 06-672.The World Vegetable Center, Shanhua, Taiwan. pp. 74.

Ali S S., Ahmad S., Ahmed S S., Rizwana H., Siddiqui S., Ali S S., Rattar I A., Shah M A. (2016): Effect of biopesticides against sucking insect pests of brinjal crop under field condition. J. Basic. Appl. Sci., 12(1): 41-49.

Amonkar S V., Banerji A. (1971): Isolation and characterization of the larval principle of garlic. Hortic. Sci., 17(4): 1343-1344.

Anonymous. 2019. Fruit, Vegetables and Condiments Statistics of Pakistan 2017-2018. Economics Wing,

Ministry of National Food Security and Research, Government of Pakistan, Islamabad, pp. 11-20.

Crop Reporting Sevices (CRS). Government of Khyber Pakhtunkhwa, Pakistan.2017-2018.

Dwivedi R., A. Tripathi A., Pal R., Singh D. (2014): Effect and eco-friendly management of brinjal shoot and fruit borer (Leucinodes orbonalis Guenee) on brinjal. Int. J. Plant Prot., 7(2): 287-291.

FAO., 2012. FAOSTAT. http://www.fao.org.

Farooq Z., Shoib A., Haider K., Mehek R., Syed F. H. S. (2016): Efficacy of botanicals extracts against wheat aphids Sitobion avenae (Homoptera: Aphididae) and their impact on predators population. J. Agric. Res., 54(4): 697-706

Choudhary, B., & Gaur, K. (2009). The development and regulation of Bt brinjal in India (Eggplant/Aubergine). International Service for the Acquisition of Agri-biotech Applications.

Gupta S P., Singh S P. (2017): Bio-Efficacy of some new insecticides against brinjal shoot and fruit borer, (Leucinodes orbonalis Guenee.). J. Pharmacogn. Phytochem., SP1:522-555.

Hanson P M., Yang R Y., Tsou S C S., Ledesma D., Engle L L., Lee T C. (2006): Diversity of eggplant (Solanum melongena) for superoxide scavenging activity, total phenolics and ascorbic acid. J. Food. Compost. Anal., 19: 594-600.

Hassan S A. (1994): Strategies to select Trichogramma species for use in biological control with egg parasitoids. Bulletin OILB., 17(10): 133-141.

Javed H., Mukhtar T., K. Javed K., Ata-ul-Mohsin. (2017): Management of egg plant Shoot and fruit borer (Leucinodes orbonalis Guenee) by integrating different non-chemical approaches. Pak. J. Agric.Sci., 54(1): 65-70.

Jazzar C., Hammad E A. (2003): The efficacy of enhanced aqueous extracts of Melia azedarach leaves and fruits integrated with the Camptotylus reuteri releases against sweetpotato whitefly nymphs. Bulletin. Insectol., 56(2): 269-275.

Kumar S., Dharmendra S. (2013): Seasonal incidence and economic losses of brinjal shoot and fruit borer, Leucinodesv orbonalis Guenee. Agri. Sci. Digest., 33(1): 98-103.

Latif M. A., Rahman M M., Alam M Z. (2010): Efficacy of nine insecticides against shoot and fruit borer, Leucinodes orbonalis Guenee (Lepidoptera: Pyralidae) in eggplant. J. Pest. Sci., 83(4): 391-397.

Mochiah, M B., Banful B., Fening K N., Amoabeng B W., Ekyem O K S., Braimah H., Owusu-Akyaw M. (2011): Botanicals for the management of insect pests in organic vegetable production. Int. J. Entomol. Nematol., 3(4): 207-219.

Murugesan, N., Murugesh T. (2009): Bioefficacy of some plant products against brinjal fruit borer, Leucinodes orbonalis Guenee (Lepidoptera: Pyrallidae). J. Biopestic., 2(1): 60-63

Obho G., Ekperigin M M., Kazeem M I. (2005): Nutritional and hemolytic properties of eggplant (Solanum macrocarpon) leaves. J. Food. Compost. Anal., 18: 153-160.

Pandey, N S., S. Thakur S. (2017): Bioefficacy of some plant products against Brinjal (Solanum melongena L.) Shoot and Fruit borer, Leucinodes orbonalis (Guenee). J. Pharmacogn. Phytochem., 6(4): 876-878.

Prasad. K., Devappa V. (2006). Bioefficacy of Emamectin 5 % SG against Diamond Back Moth in Cabbage. Pestol.,30(2): 23-25.

Sahana U., Tayde A R. (2017): Effect of Selected Botanicals and Spinosad on Shoot and Fruit Borer (Leucinodes orbonalis Gueene) and Natural Enemies in Brinjal Ecosystem. Int. J. Curr. Microb.Appl. Sci., 6(7): 189-193.

Sahu, P K., Kumar A., Kujur P K. (2017): Eco-friendly management of brinjal shoot and fruit borer in Allahabad, India. Int. J. Curr. Microbiol. App. Sci., 6(10): 2814-2818.

Singh A K., Kumar M. (2015): Efficacy and economics of neem-based products against cotton jassid, Amrasca biguttulla Ishida in okra. Crop Res (Hisar)., 26(2): 271-274.

Zidan N A., El-Naggar J B., Aref S A., El-Dewy M E. (2012). Field Evaluation of Different Pesticides against Cotton Bollworm and Sucking Insects and their side effects. J. Am. Sci., 8(2): 128-136.