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CONTROL OF INSECT PESTS AND YIELD IMPROVEMENT IN BRINJAL BY PLANT EXTRACTS

Sumaira Maqsood[1*], Muhammad Usman Shafi[2], Arshad Javaid[3], Iqra Haider Khan[3], Muhammad Ali[2] and Malik F. H. Ferdosi[4]

[1]*Department of Environmental Sciences, Kohsar University, Murree 47150, Pakistan*
[2]*Department of Entomology, Faculty of Agricultural Sciences, University of the Punjab, Quaid-i-Azam Campus, Lahore 54590, Pakistan*
[3]*Department of Plant Pathology, Faculty of Agricultural Sciences, University of the Punjab, Quaid-i-Azam Campus, Lahore 54590, Pakistan*
[4]*Department of Horticulture, Faculty of Agricultural Sciences, University of the Punjab, Quaid-i-Azam Campus, Lahore 54590, Pakistan*
[*]*Corresponding author's email: sumairamaqsood@kum.edu.pk*

ABSTRACT

Plant secondary metabolites can be used for controlling different crop insect pests. Many compounds from different plant species have been reported possessing killing properties against different insect pests of brinjal (*Solanum melongena* L.). However, plant extracts are generally not used for pest control under field conditions because farmers are mostly relying on synthetic pesticides. In the present study, extracts of four plants namely neem (*Azadirachta indica* A. Juss.), garlic (*Allium sativum* L.),Tasmanian bluegum (*Eucalyptus globulus* Labill.) and pennyroyal plant (*Mentha pulegium* L.) were checked and compared with the efficacy of an insecticide lambda cyhalothrin on population of insect pests and beneficial insects as well as yield of brinjal. The highest population of different pests such as aphids, jassids and leaf hoppers were recorded in the negative control treatment (no application). The maximum control of pests was recorded due to insecticide application where 96–99% reduction in population of pests was recorded over negative control. All the plants extracts significantly ($P \leq 0.05$) suppressed population of insect pests over control to different extents. Extract of *A. indica* showed the highest pesticidal activity followed by extracts of *E. globulus, M. pulegium* and *A. sativum* resulting in 93–97%, 87–92%, 25–73% and 8–21% reduction in population of different pests, respectively. Population of beneficial insects was drastically decreased by application of lambda-cyhalothrin pyrethroids while they are less affected by plant extracts. The lowest yield of brinjal in term of number of fruits (178) was recorded in negative control that was increased by 96% due to application of insecticide. Different extract treatment increased yield by 10–37% over negative control. This study concluded that extracts of *A. indica* and *E. globulus* can be as useful as lambda-cyhalothrin pyrethroids in controlling insect's population and increasing yield of brinjal.

Key words: *Azadirachta indica*, Brinjal, *Eucalyptus globulus*, Insect pests, Natural insecticides.

INTRODUCTION

Insects are major pests of crops and cause considerable damage to food crops. They can cause extensive damage to the quality and quantity of the harvest resulting in significant economic losses (Tonnang *et al.,* 2022). Insects feed on leaves, stems, fruits, flowers, and roots of plants, reducing their growth and yield. They also cause direct damage by drilling holes into these plant parts. Insects can be vectors of plant diseases and can cause indirect damage by facilitating the spread of plant pathogens (Trębicki *et al.,* 2017). Brinjal is a famous vegetable in Asia and Mediterranean areas (Chapman, 2020). It is the 5th most popular vegetale of the world with a production of 56.6 Mt. China is leading brinjal cultivated country with 36.6 Mt while India and Egypt are the second and third major producers of brinjal in the world (Chioti *et al.,* 2022). It is a low-calorie but high nutritional value vegetable, also have many health benefits containing phenolics, fibers, minerals, proteins and vitamins (Raigón *et al.,* 2008). Brinjal is susceptible to various diseases, insect pests as well as abiotic stresses. It is commonly attacked by shoot and fruit borer *Leucinodes orbonalis* Guenée (Prodhan *et al.,* 2019). In addition, green peach aphid (*Myzus persicae* Sulzer) is also a harmful insect pest of brinjal that feeds on sap causing chlorosis and necrotic spots (Raeyat *et al.,* 2021). One of the most common and effective control measures of insects in brinjal crop is the use of insecticides. However, the use of insecticides is not only detrimental to the environment (Hrynko *et al.,* 2020), but also has other problems such as development of insecticide resistance, secondary pests outbreak, adverse effects on useful insects, and pesticide residues in food (Bass *et al.,* 2014; Blair *et al.,* 2015).

The research has been focused on innovative botanical products but results are always not encouraging and profitable (Isman and Grieneisan, 2013). These plant products in crude and purified forms have been found very effective as herbicides (Javaid and Khan, 2020; Javaid *et al.,* 2020), fungicides (Naqvi *et al.,* 2020; Jabeen *et al.,* 2021), bactericides (Ferdosi *et al.,* 2021; Saeed *et al.,* 2023), and also as bioactive compounds against various ailments (Javaid *et al.*, 2021, 2022). Moreover, certain plant species have pest killing qualities and show their effectiveness under controlled conditions and can be helpful in novel products making (Stevenson *et al.,* 2017). Recent studies have shown that extracts of *Melia azedarach*, *Conocarpus lancifolius*, and *Parthenium hysterophorus* found very effective against *Trogoderma granarium* (Ahmad *et al.*, 2022a,b; Zafar *et al.*, 2022). Isman (2017) suggested that research is needed in the field of natural pesticides regarding their field application under variable environmental conditions. In addition, their socio-economic and agro-ecological usefulness and their effectiveness against general and specific insect species need attention. Only their analysis under field conditions can guide to utilize more natural products for pest control, as natural products are not always as efficient as synthetic pesticides (Casida,1980). The problem of insecticides resistance can be solved by the application of crude plant extracts in addition to other benefits associated with their use such as low cost of use especially for poor farmers and less persistency in environment (Caboni *et al.*, 2006). The present study was, therefore, undertaken to assess the efficacy of various botanicals in their crude forms against beneficial and harmful insects of brinjal and subsequent effect on the yield of the crop.

MATERIALS AND METHODS

Study site

The experiment was performed in Lahore in 2019 during brinjal growing season. The longitude and latitude of the study area are 31.4790° N and 74.2662° E, respectively. Here the annual rainfall was recorded as 628.8 mm. The average temperature during the growing months March, April, May, June, July and August were 30, 35, 40, 42, 40 and 39 °C, respectively.

Experimental design

Before plantation, cultural practices were made in the experimental plots. Brinjal variety Pusa Purple Round was used for the purpose of experiment. Row to row distance was maintained as 80 cm and plant to plant distance was 70 cm. Eighteen rows of plants were made, each having 10 plants of brinjal. Diammonium phosphate and urea were applied during sowing. Experimental units were inspected weekly, and weeds were removed according to need of the hour. Randomized complete block design layout was followed for the experiment, which consisted of 6 blocks. Treatments were repeated three times.

Plant materials collection & processing

Four plant species including *A. indica, A. sativum, E. globulus* and *M. pulegium* were selected for this study. These plants were selected due to their easy availability and their effectiveness in previous biological studies. Leaves of these plants were collected. Then these leaves were placed in shade to dry for 3-4 days. Thereafter, the leaves were completely dried in an oven at 40 ^{o}C. Later on, dry leaves were crushed into powdered form. This powdery material was stored in a completely dry place to save them from deterioration.

Field treatments

For preparation of a 10% leaf extract of each selected plant species, 1 kg of dried leaf material was soaked in 10 L water at room temperature (15–20 °C) for one day. As detergent enhances the efficacy of extraction of non-polar compounds from plant material, 0.1% soap was added to the soaked materials (Belmain *et al.,* 2012). The soaked materials were put in 10 L buckets with lids and kept in shade. These were filtered with coarse and fine cloths. Negative control composed of water plus 0.1 soap. Positive control included the application of 400 mL acre^{-1} Lambda cyhalothrin parathyroid, Syngenta (Karate). Each treatment was applied in 3 replicates in 6 blocks. After 7 days of emergence of plants, first spray was carried out and this practice was repeated during whole growing season after 7 days. A sprayer of 15 L knapsack was used for application of the treatments. Sprayer was washed thoroughly by soap and water before refilling of any other application.

Sampling of insect pests and beneficial species

From each plot, 3 rows were chosen for sampling. From these rows, 5 plants were selected for inspection for recording the data of each pest type. Immature hoverfly, lacewings and parasitoids were not monitored because they were small sized and were causing complexity in sampling. So, beneficial insects and indicator pests which were easy to locate and detect were selected for monitoring.

Collection of yield data

At the end of experimental period, fruits from each treatment were harvested and counted.

Statistical analysis

Data regarding the number of pests of different classes and number of fruits in different treatments were analyzed by one-way ANOVA. Thereafter, means were separated by applying LSD test at 5% level of significance.

RESULT AND DISCUSSION

Effect of plant extracts on insects population

The results regarding the effect of plant extracts and the insecticide on the population of insect pests and beneficial insects is shown in Table 1 and Fig. 1. The population of pests was the highest in negative control (no application) *i.e.* 25.7, 29.66 and 8 aphids, jassids and leafhoppers, respectively. The maximum control of pests was recorded due to insecticide lambda cyhalothrin application where 99, 98 and 96% reduction in the population of aphids, jassids and leaf hoppers, respectively, was recorded over negative control. Lambda cyhalothrin is a synthetic pyrethroid insecticide being used globally in agriculture for protection of foodstuff, and control of home pests and disease vectors (Fetoui *et al.*, 2010). It is a type II pyrethroid that is used to control insects in corn, wheat and potato, and also for malaria control (Nieradko-Iwanicka and Konopelko, 2020).

In general, all the plant extracts significantly ($P \leq 0.05$) reduced pest's population over control to variable extents. In some recent studies, similar effects of extracts of *Parthenium hysterophorus, Melia azedarach* and *Conocarpus lancifolius* were observed on larvae of khapra beetle (Ahmad *et al.,* 2022a, b; Zafar *et al.*, 2022). Extract of *A. indica* showed the highest pesticidal activity followed by extracts of *E. globulus* and *M. pulegium* resulting in 93–97%, 87–92% and 25–73% population of different pests, respectively. Extract of *A. sativum* showed the least pesticidal activity with 8–21% reduction in population of pests of different classes. *A. indica* leaves can enhance the shelf life of mungbean grain by protecting them against pulse beetle (*Callosobruchus chinensis).* A dose of 1.5 mg neem leaves per 100 g mungbean seed caused 62% mortality in adults beetles (Ahmad *et al.*, 2015). Likewise, application of neem leaf powder significantly increased plant resistance against infestation by aphids (Brotodjojo and Arbiwati, 2016). The most important compound of *A. indica* is azadirachtin that has been recognized as an essential insecticidal ingredient. It works as repellent, antifeedant, and repugnant agent and causes sterility in insects by interfering production of sperms in males and preventing oviposition in females (Chaudhary *et al.,* 2017). A variety of other bioactive compounds have also been reported from leaves of *A. indica* (Eid *et al.,* 2017; Ahmad *et al.,* 2019; Khan and Javaid, 2021), which might be responsible for insecticidal properties. In the present study, leaf extract of *E. globulus* also showed remarkable insecticidal properties. Earlier, Russo *et al.* (2015) reported remarkable activity of essential oil from leaves of *E. globulus* against flour beetle, *Tribolium confusum.* 1,8-Cineole from leaves of this plant is responsible for insecticidal activity (Mann and Kaufman, 2012). In the present study, extract of *M. pulegium* caused 25–73% reduction in the population of various groups of insect pests. A previous study by Franzios *et al.* (1997) showed that insecticidal properties of this plant species are mainly due to its essential oil. Its extract also showed insecticidal activity against *Sitophilus oryzae* (Zekri *et al.,* 2013). It also showed repellent properties against insects (Amoura *et al.*, 2021). Recently, Ramzi *et al.* (2022) reported that monoterpenes and essential oils of this plant showed remarkable insecticidal properties against female *Culex pipiens*. The essential oils of this plant were also highly effective against two aphid species namely *Aphis spiraecola* and *A. gossypii* (Behi).

The population of beneficial insects was almost absent in the field where application of lambda cyhalothrin was done. On the other hand, beneficial insects were found on the plants of negative control as well as on the plants where application of plant extracts was carried out (Table 1).

Table 1. Treatment effects on harmful and beneficial arthropods with brinjal crop yield.

Treatments	Pests			Beneficial Insects			Yield (No. of fruits)
	Aphids	Jassids	Leaf hoppers	Hoverfly	Green Lacewing	Others	
Azadirachta indica	1.67d	1.00c	0.33b	Present	Present	Present	244 b
Mentha pulegium	8.00c	8.00b	6.00a	Present	Present	Present	211 cd
Eucalyptus globulus	3.33d	4.00bc	0.67b	Present	Present	Present	222 c
Allium saivum	21.00b	27.33a	6.33a	Present	Present	Present	195 de
Lambda Cyhalothrin	0.33d	0.67c	0.33b	Absent	Absent	Absent	350 a
Control	25.7a	29.66a	8.00a	Present	Present	Present	178 e
$LSD_{0.05}$	3.72	4.92	2.33				19.95

In a column, values with different letters show significant difference as determined by LSD test.

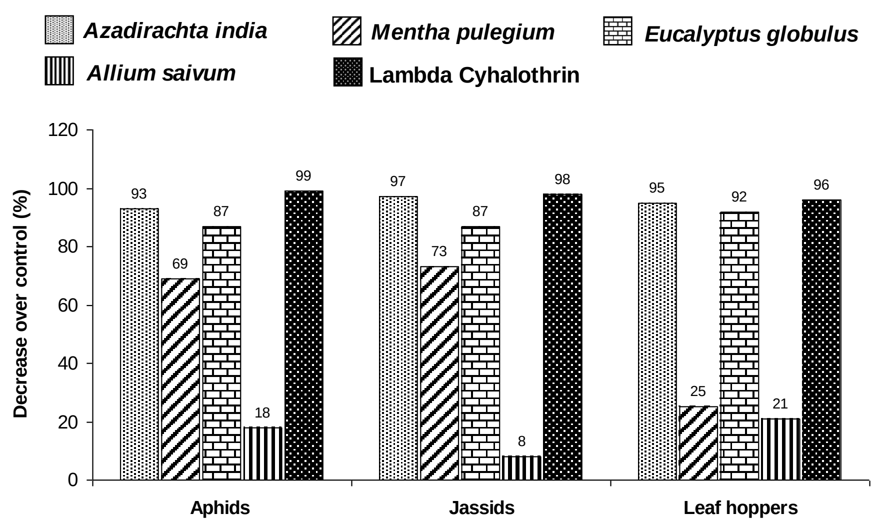

Fig. 1. Percentage decrease in pests' population on brinjal due to application of pesticide and plant extracts.

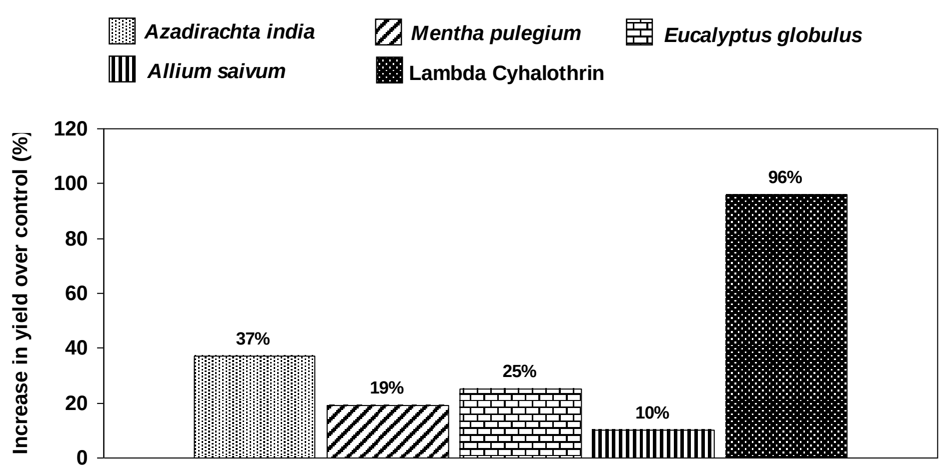

Fig. 2. Percentage increase in yield of brinjal due to application of pesticide and plant extracts.

Effect of plant extracts on crop yield

The yield of crop was also affected significantly ($P \leq 0.05$) by the application of plant extracts and lambda cyhalothrin over negative control as shown in Table 1 and Fig. 2. The control treatment showed the lowest yield of the crop in terms of number of fruits i.e. 178. The highest yield (350 fruits) was obtained when application of synthetic Lambda cyhalothrin was carried out. It increased yield by 96% over control. In the case of plant extracts application, the maximum yield was obtained by spray of *A. indica* extract and the lowest yield was obtained by the application of *A. sativum* extract that was 37% and 10% higher than the negative control, respectively. Application of extracts of *M. pulegium* and *E. globulus* increased brinjal yield by 19% and 25% over control, respectively.

CONCLUSION

The highest control of insect pests (96–99%) was obtained by the application of insecticide Lambda Cyhalothrin. Efficacy of extracts of *A. indica* and *E. globulus* was very close to this insecticide, which caused 93–97% and 87–92% reduction in population of various pests and significantly increased yield of brinjal over control.

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