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Impact of botanical pesticides against sucking insect pests and their insect predators in brinjal crop

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Abstract
Sucking pests of brinjal cause significant losses to its yield. Considering the negative impacts of synthetic pesticides, field studies were conducted to evaluate the impact of neem *Azadirachta indica*, tobacco *Nicotina tabbacium*, trooh *Citrullus collocynthus*, Movanto (Spirotetramat) against sucking insect pests of brinjal and their predators during 2016-2017. Two sprays were done during the study. Observations were taken for population reduction of insect pests due to the application of pesticides using Abbot's formula. All the botanical pesticides especially neem showed potential to cause population reduction of aphids, whitefly, jassid and thrips. Trooh also showed significant mortality of aphid and thrips, whereas tobacco caused more mortality of whitefly and jassid. Comparatively neem showed less persistency in comparison to trooh and tobacco as mostly pest populations started rebuilding after 72 hours of its application. In comparison to Movanto, botanical pesticides particularly trooh were less toxic against the coccinellid predators i.e., *C. septempunctata*, *B. suturalis* and *M. sexmaculatus* recorded in the study.

Keywords: sucking pests, predators, brinjal, botanical pesticides

Introduction
Brinjal (*Solanum melongena* L.) is one of the commonly consumed vegetable in many countries of the world, especially in Asia [1]. It belongs to Solanaceae family and is the native of India and Pakistan [2]. It is grown on a fairly-wide scale in China, Japan India and Pakistan during all seasons [3]. The brinjal fruit is a rich source of iron, phosphorous, calcium and vitamins like A, B and C. Normally, its fruit is consumed as vegetable, however, it is also used in the manufacturing of pickles and other by products [4]. Brinjal is cultivated round the year due to the availability of water, therefore, it is very susceptible to be damaged by many pests including insects throughout its growth period [5]. Among the major insect pests infesting brinjal are shoot and fruit borer (*Leucinodes orbonalis*), whitefly (*Bemesia tabaci*), leafhopper (*Amrasca biguttula biguttula*), aphid (*Aphis gossypii*), thrips (*Thrips tabaci*) and non-insect pest *i.e.*, red spider mite, (*Tetranychus macfurlanei*) [6]. Sucking pests of brinjal cause significant losses to crop directly by sucking the cell sap using their piercing and sucking mouth parts and indirectly by transmitting viral diseases or developing sooty mould on their honey dews [7]. Some sucking pests are cosmopolitan, polyphagous and widely distributed in tropical, subtropical and temperate regions and are also serving as vectors for a number of viral diseases in diversified plant species [8]. As a result of pest attack, considerable damage has been recorded to the yield and quality of the brinjal crop on regular basis [9, 10].
Among predators observed on sucking pests of brinjal, the lady bird beetles hold the key importance. The adults and larvae of ladybird beetles attack aphids, whiteflies, psyllids, scales and many other soft bodied insects and found to be effective predators in brinjal fields. The green lacewings and hemipteran bugs also perform significant contribution in lowering the sucking pest population by predating various life stages of these pests [11].
Mostly, insect pests are controlled by synthetic insecticides for their quick knock down effect [12]. However, careless and indiscriminate use of these chemicals leads to a number of problems like contamination of food, soil, ground water, lakes, rivers, oceans, and air with toxic residues which carry side effects on non-target insects and other organisms. Moreover, injudicious use of pesticides may also develop resistance among pests against these pesticides and thus, pest resurgence occurs frequently in recent years [13]. In addition, many non-lethal

and lethal accidents occur among human beings due to mishandling of highly toxic synthetic products. Because of these hazards of the pesticides, there is a growing awareness among the people, not only in developed but in developing countries for the safe use of synthetic pesticides [14]. Biopesticides or biological pesticides based on plants or pathogenic microorganisms and specific to the target pest, offer an ecologically sound and effective solution to pest problems [15]. Moreover, use of these pesticides is safe to the humans and their environment [16]. Accordingly, the use of bio and botanical pesticides offer potential benefits to agriculture and public health programmes are considerable [17]. Therefore, in recent years, focused has been shifted towards the use of potential botanical plants to manage the pest populations below the threshold levels. Neem, tobacco, eucalyptus, castor, hing and dhatura are some of the widely tested plant materials against insect pests [18]. However, evaluation of botanical pesticides on the population and effectiveness of insect predators has yet not been exhaustively studied, especially in Sindh province. Moreover, the utilization of natural enemies effectively as the basis of an IPM program, it is crucial to put in place strategies and techniques that can establish and concentrate the predators in crop system followed by integration of natural enemies with other control tools that are least disruptive to the natural enemy activity [19]. Therefore, the research was conducted to evaluate the impact of botanical pesticides against insect pests of and their associated predators in brinjal crop under field conditions with the following objectives.

Materials and Methods

Study location

The study was conducted at the Experimental Field, Entomology Section, Agriculture Research Institute, Tandojam, Sindh during the cropping season of 2016-2017.

Cultivation of Brinjal

The brinjal variety (Janak) was obtained from Horticulture Institute, Agriculture Research Institute, Mirpur Khas and transplantation in the field was carried out @ the recommended rate (120 grams / acre). All the agronomic practices were done as recommended.

Treatments

Following treatments were used in the experiment at their prescribed recommended rate as given against each pesticide:
T1 = Neem (*Azadirachta indica* A.Juss.) @ 4 kg/acre
T2 = Tobacco (*Nicotiana tabacum* L) @ 3 kg/acre
T3 = Trooh (*Citrullus colocynthus* L) @ 4 kg/acre
T4 = Movento 240 SP (Spirotetramat 240 g/L)
T5 = Control

Preparation of Botanical Extracts

One kg seeds of Neem, 500 kg leaves of tobacco and 1kg fruit of trooh were collected and processed to get plant extracts. Each plant material was kept in water i.e., the neem seeds in 2 liters of water, tobacco leaves in 4 liter of water and trooh in 2 liter of water and were left for an overnight. On the next day, the prepared stock solutions were filtered through the muslin cloth to get the desired plant extracts. The different plant extracts thus, obtained were stored in glass bottles till their application in the field. The different plant extracts and a pesticide were applied using a hand operated knapsack sprayer at the following rates:
Neem @ 4 kg / acre (88 ml/plot)
Tobacco @ 3kg / acre (196 ml/plot)
Trooh @ 4 kg/acre (222 ml/plot)
Movento 240% SC @ 0.5 ml/plot
During the study, two sprays were carried out keeping in view the threshold levels of various sucking pests in brinjal.

Experimental Design

The experiment was conducted in a Randomized Complete Block Design (RCBD). Each treatment used in the study was replicated five times. Size of each replicated unit was 402 sq. ft., resulting in the total experimental area size of 10,057sq/ft.

Data collection and analysis

Five plants were randomly selected from each replication for the observations. The data for insect pests of brinjal was collected by direct observation from five leaves of each selected plant (two leaves from top and middle, whereas one leaf from bottom of plant). The entire plant was looked into to observe the population of insect predators of insect pests. Pre-observation was taken just before the application of individual treatments. The subsequent observations were recorded after 24, 48, 72 and 96 hour and finally at the end of one week after pesticide application. Data for second spray was also collected as mentioned above. The collected data was checked for normality and was square root transformed to normalize the data before statistical analysis, where necessary. Analysis of Variance using SAS 9.4 computer software was used to analyze the data whereas means with significant difference was separated using Least Square Difference (LSD) at 0.5 probability level. Moreover, percentage reduction in pest population after the application of individual pesticide was collected by using Abbots (1925) formula as given below:

$$Pt = \frac{Po - Pc}{100 - Pc} \times 100$$

Where Pt = Corrected population, Po = Observed population, Pc = Control population.

Results & Discussion

During the study, among sucking pests, population of whitefly, jassids and aphids were recorded during the both spray schedules, whereas, thrips population was only recorded during the time of 1st application of botanical pesticides. Among predators, during pre-observations, population of coccinellid (0.04±0.04 predators / plant) and spiders (0.08±0.04 spiders / plant) were recorded. However, during the 2nd spray, population of various coccinellid were recorded and affected due to the application of various botanical pesticides.
The results regarding the percent reduction of whiteflies due to the application of botanical pesticides indicated at 24 and 48 hours intervals, no significant reduction was recorded due to the application of botanicals. However, afterwards significant reduction was recorded in whitefly population especially due to the application of Neem (59.05%) at 72 hours after application that reached to 62.42% at 96 hours. After Neem, Movanto application cause the population reduction percentage of 26.14% at 72 hours of application, but the population started rebuilding afterwards in the treatment. After 72 hours, percentage population reduction in Tobacco and Trooh treatments were 22.79% and 15.44%, respectively that increased in tobacco to 35.90% at 96 hours intervals, whereas, showed a declining trend in trooh (Fig. 1). The percentage population reduction of whiteflies due to the

application of various pesticides indicated that up to 24 hours, no significant reduction in population was recorded in any of the treatment. However, at 48 hours of application, the highest reduction percentage in population of whiteflies was recorded with the application of Movanto 240 SC (69.86%) that reached upto 80.62% at 96 hours of application. The highest reduction percentage in Neem (61.90%) and Tobacco (68.25%) was recorded at 72 hours after their application, whereas, Trooh treatment showed 66.21% population reduction of whiteflies after 96 hours of application (Fig. 2).

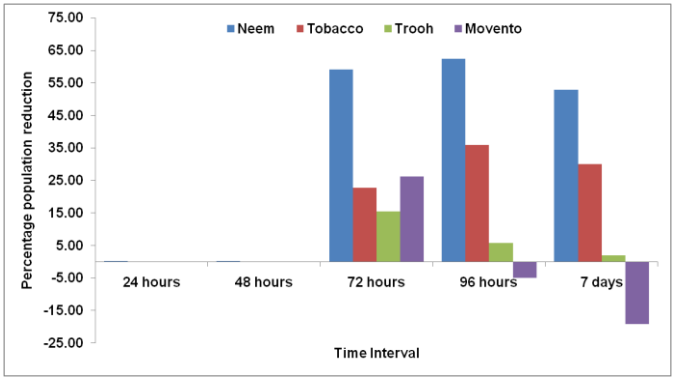

Fig 1: Corrected percentage reduction in population of *B. tabaci* after 1st spray of botanical pesticides at various intervals under field conditions

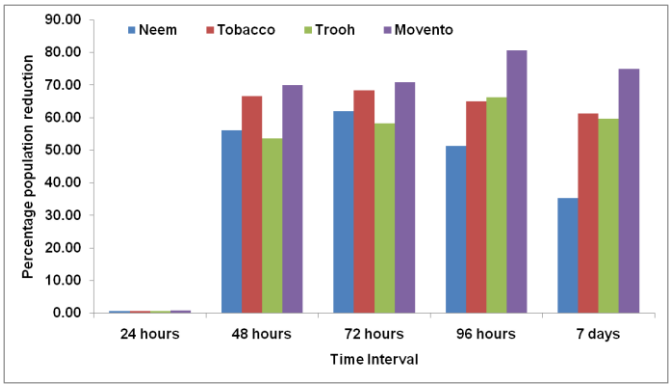

Fig 2: Corrected percentage reduction in population of *B. tabaci* after 2nd spray of botanical pesticides at various intervals under field condition

Fig. 3 gives the percentage population reduction of jassids after 1st spray. The results indicated that the application of Neem showed the highest population reduction percentage (77.62%) after 48 hours of application but the same declined afterwards and reached to 66.80% after seven days of the application. Application of Movanto exhibited 58.50% population reduction after 48 hours that reached to 59.06% at 72 hours of application but showed declining trend afterwards. Among the botanicals, Tobacco showed the lowest population reduction percentage 59.43% after 72 hours of application that further reduced to 43.66% after 7 days. The corrected percentage population reduction results after 2nd spray indicated that all the applied chemicals started reducing the population after 24 of exposure. The highest reduction percentage after 48 hours was observed in Movanto treatment (54.69%) that peaked (61.85%) at 72 hours of exposure. Among the botanical pesticides used, application of neem reduced up to 56.09% of jassids population after seven days, Tobacco (54.94%) after 72 hours and trooh (54.00%) after seven days of application (Fig. 4).

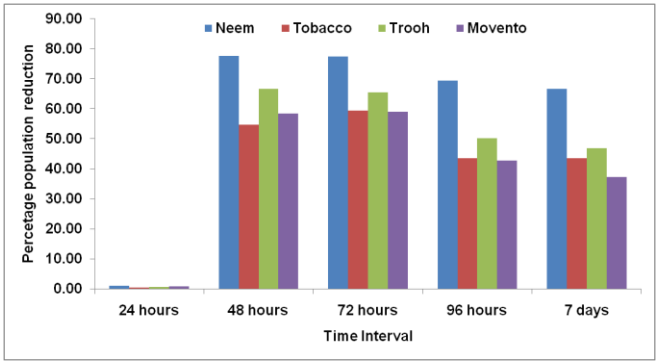

Fig 3: Corrected percentage reduction in population of *A. biguttula biguttula* after 1st spray of botanical pesticides at various intervals under field conditions

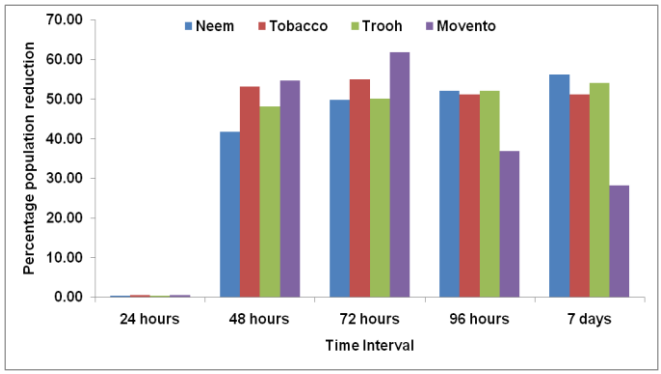

Fig 4: Corrected percentage reduction in population of *A. biguttula biguttula* after 2nd spray of botanical pesticides at various intervals under field conditions

The percentage population reduction results indicate that in comparison to movanto, various botanical pesticides showed greater efficiency against the aphids as the highest reduction percentage of aphids was recorded in neem treatment (60.84%) after 48 hours of application followed by tobacco (54.56%) and trooh (51.82%) after 72 hours after application. Movanto reduced the population upto 48.42% after 72 hours of application. However, efficacy of various pesticides started reducing after 72 hours of application against aphids (Fig. 5). Fig. 6 shows the percentage population reduction of aphids after second spray. The results indicated that the highest reduction percentage of aphid population was recorded with the application of movanto (75.29% after 96 hours) followed by neem (71.56% after 48 hours), trooh (65.87% after 96 hours) and tobacco (61.81% after 96 hours), respectively.

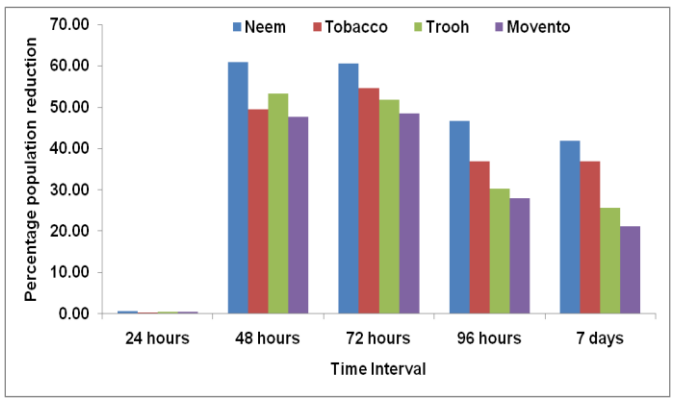

Fig 5: Corrected percentage reduction in population of *A. gossypii* after 1st spray application of botanical pesticides at various intervals under field conditions

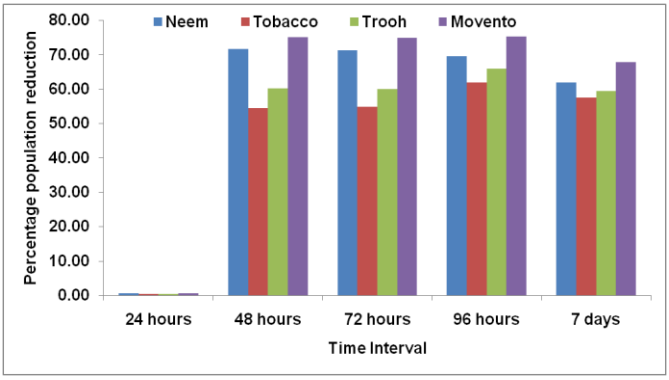

Fig 6: Corrected percentage reduction in population of *A. gossypii* after 2nd spray of botanical pesticides at various intervals under field conditions

Efficiency of various botanical pesticides in the percentage population reduction of thrips at various intervals is given in Fig. 7. The results indicated that maximum population reduction of thrips (88.46%) was recorded in Movanto and tobacco treatments after seven days, followed by trooh (84.62% after seven days) and neem (80.00% after 48 hours).

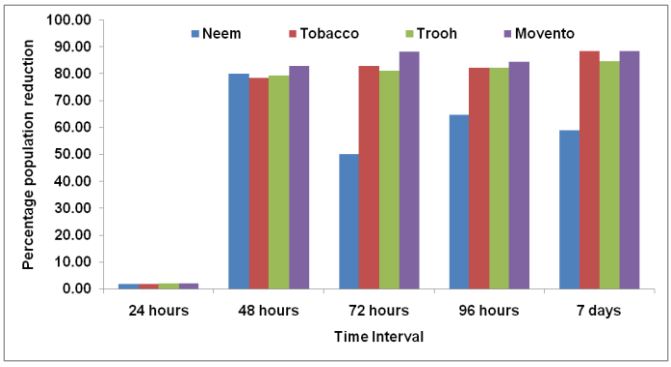

Fig 7: Corrected percentage reduction in population of *T. tabaci* after 1st spray of botanical pesticides at various intervals under field conditions

Populations of whiteflies, jassids and aphids were observed throughout the study period, whereas thrip population was recorded only at the time of first spray. Although a minimal population of coccinellid predators was recorded during the 1st spray; however, a significant population was recorded at the time of second spray, especially in the botanical pesticide treatments. Finding of the study indicated that among all the pests observed, Neem extracts showed significant reduction in the population of various pests observed and was either higher or in accordance with the synthetic pesticides used i.e., Movanto. Other botanicals, especially trooh also showed a considerable impact against the population of sucking pests especially thrips and aphids. Many previous studies confirmed the significant role of botanical pesticides in the population reduction of sucking insect pests of various crops. Among the botanicals used against the sucking insect pests, neem, tobacco, garlic, trooh and others were found to be effective but, less persistence than the synthetic pesticides used [20, 21, 22, 23, 24, 25]. It was also observed in the study that application of botanicals especially trooh were less determinant against the natural enemies i.e., coccinellid predators. Moreover, although the application of Movanto significantly reduced the population of sucking pests but it was also more dangerous and reduced the population of coccinellid predators. Experiments has showed that synthetic pesticides insecticides have showed comparatively higher toxicity against insect sucking pests of cotton and brinjal, however, botanical pesticides were not found less hazardous against the predators, but also enhanced their population in some incidences [6, 26].

Conclusions

All the botanical pesticides showed potential in the management of sucking insect pests of brinjal. Neem showed comparatively more effectiveness against the sucking pests followed by Tobacco and Trooh. Trooh showed more effectiveness in population reduction of aphids and thrips than whiteflies and jassids. All the botanicals were found less persistant especially Neem, followed by Tobacco and Trooh. Although, a minimum population of coccinellid was recorded at the time of first spray, their population showed a rising trend during second spray. All the botanicals showed less toxicity against the predators observed, with the highest population of predators recorded in Trooh treatment, followed by Neem and Tobacco. Movanto showed the highest toxicity against the predators.

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