Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2018; 6(3): 113-117

Received: 28-03-2018
Accepted: 30-04-2018

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# Comparative efficacy of Neem derivatives and imidacloprid against some cotton pests

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**Abstract**
Jassid (*Amrasca devastans*) and thrips (*Thrips tabaci*) have become major pests due to the introduction of Bt cotton. Development of resistance to synthetic insecticides is another menace, keeping in view these facts synthetic insecticide (imidacloprid) and neem derivatives viz., neem oil and neem seed water extract both at 1%, 3% and 5% were assessed against jassid and thrips with two applications. The experiment was conducted from the month of May to October during the year 2016. Eight treatments including untreated control replicated thrice were maintained following RCBD. Two applications of each treatment were made when the pest population reached ETL. Data were recorded after the interval of 1, 3 and 7 days of application. The results revealed that imidacloprid and all the neem derivatives had significantly suppressed the target pests population compared to control. Imidacloprid found to be more toxic than neem derivatives at any interval against the targeted pests. Among the neem derivatives, neem oil at 5% was most efficient bringing about highest percent mortality of jassid (72.03%) and thrips (68.02%) followed by 5% neem seed water extract and 3% neem oil. Higher yield was recorded in plots treated with imidacloprid (2626.7 kg/ha), neem oil (2551.1 kg/ha) and neem seed water extract (2437.8 kg/ha) at 5% concentrations as compared to that in control (1703.3 kg/ha). The study concluded that neem derivatives can be a good alternative of synthetic insecticides to control sucking pests of cotton.

**Keywords:** efficacy, neem derivatives, jassid, cotton, imidacloprid, thrips

## Introduction
Cotton is a prime source of foreign exchange earning in Pakistan. Millions of peoples are involved in its production, industry and trade. In addition to provide cotton lint, it also has a share of 66.5% in oil production [1]. Moreover, cake of cotton seed is a healthy concentrated feed of livestock. In Pakistan, the area under cotton cultivation is approximately 2.48 million hectares with 9.91 million bales annual production [2]. The yield per hectare of cotton is substantially below average as compared to other developed countries. Many factors are responsible for this loss but the most salient factor is the attack of insect pests [3]. It is estimated that insect pest complexes that includes bollworms and sucking pests cause 20-40% yield losses [4].

Among the sucking pests, thrips, whitefly and jassid are of a vital significance. They reduced both the quality and yield of the crop [5]. Mostly synthetic insecticides are used to control these insect pests but owing to their adverse effects, plant derivatives are also used as an alternative method to control insect pests as they comprise huge proportion of bio-active compounds [6]. These plant derivatives pose no harmful effects on beneficial and non-target organisms and also considered as environment friendly. At least 46 families related to flowering plants are found to have insecticidal properties [7]. Neem (*Azadirachta indica*) has been used in subcontinent for years as pest remedial and is also a common well known practice nowadays in distant localities for the control of storage pests [8, 9]. The most important bio-active compound in neem against insect pests is Azadirachtin and has acquired the utmost attention few years back [10]. Though, various compounds such as vepol, meliantriol, deacetyl-azadiractinol, sulfulr compounds and salannin etc. possess varying degree of insect repellent, deterrent, growth regulating, anti-ovipositional, anti-feedant properties [11, 12].

WTO regulations and market desire of low residual cotton drive the farming community to look for alternatives and judicious use of pesticides. Neem being a native plant and with various pest control properties could be a good source [13].

Formulations of neem oil produced better results against sucking insect pests of cotton and other field crops when used in comparison with synthetic chemicals. Seed cotton yield was also enhanced with the usage of mineral oil, neem oil and nicotine sulphate to control insect pests of cotton [14]. The comparable results were found when anti-molting and anti-feedant properties of crude neem extract were determined against different lepidopteran pests. The insects related to this order have been documented as particularly sensitive to neem products [15]. In view of the significance of cotton crop, the economic damage caused by the sucking pests and the environment friendly nature of neem derivatives, efforts were undertaken in the present investigation to study insecticidal properties of neem seed water extracts and neem oil in comparison to synthetic insecticide against some sucking pests of cotton.

## 2. Materials and Methods

The present field study was conducted at the research area of Nuclear Institute of Agriculture (NIA), Tandojam to evaluate the effect of neem derivatives against jassid and thrips on cotton. For this purpose, neem oil was purchased from local market and different concentrations i.e. 1%, 3% and 5% were prepared by dilution for application in field. Dried neem seeds (2 kg) were collected from the experimental field of NIA, Tandojam to prepare neem seed water extracts. The seeds were grinded, tied in a cotton cloth and then dipped in 5 liters of water at $80^0$C for 16 hours to obtain 20% concentrated solution. The concentrated solution was then further diluted to prepare 1%, 3% and 5% of neem seed water extract. The study was conducted from the month of May to October during the year 2016. Plant to plant and row to row distance maintained at 30cm and 75cm. The experiment was laid out under RCBD with eight treatments (3 concentration of neem oil, 3 concentrations of neem seed water extract, synthetic insecticide and untreated control) and each treatment was replicated thrice. An area of 8 m x 3 m was maintained in each replicated plot of the treatments. One meter buffer zone was maintained between adjacent plots to avoid spray drift. The crop was observed regularly for pest status. The neem derivatives and synthetic insecticide (imidacloprid) were applied twice when the population of jassid and thrips attain the ETL. Leaves (upper, middle and lower) of five plants selected randomly in each replicate were observed to record the insect pests population after 1, 3 and 7 days of each application.

The yield was recorded at the picking of cotton and then transformed into kg/ha. The difference in population means at different intervals and yield were analyzed by Statistix 8.1 and then compared through LSD test at 5% probability level. The percent reduction of pest population was calculated with formula given by Abbott *et al*. [16]

$$\text{Percent Reduction} = \frac{\text{Population in Control} - \text{Population in each Treatment}}{\text{Population in Control}} \text{ x } 100$$

## 3. Results

### 3.1 Cotton jassid (*Amrasca devastans*)

The mean percent reduction in jassid population recorded after 1, 3 and 7 days of first application of neem derivatives and imidacloprid is presented in Table 1. The results revealed that all the treatments were effective and caused significant reduction in jassid population at different time intervals compared to control treatment. After 1 day of first application imidacloprid was found highly effective with significant population reduction of 79.43% followed by 5% concentration of neem oil (48.59%) and neem seed water extract (42.05%). While 1% neem oil and 1%, 3% neem seed water extract were least performing and statistically at par with 28.03%, 34.57% and 20.56% reduction, respectively. After 3 days of application efficacy increased as imidacloprid gave maximum reduction (86.40%) followed by neem oil at 5% with 67.96% and neem seed water extract at 5% with 64.07% reduction. Similarly, after 7 days of first application maximum reduction (71%) was observed in plots treated with imidacloprid and had non-significant difference with application of neem seed water extract and neem oil at 3% and 5%. In the second application trend was similar and significant reduction in jassid population was recorded after 1, 3 and 7 days of application (Table 2). After 1 day imidacloprid was superior over others with 77.47% reduction followed by neem oil (54.05%) and neem seed water extract (46.84%) at 5%. While neem oil and neem seed water extract at 1% showed lowest percent reduction of 33.33% and 27.02%, respectively. Similarly, after 3 days of second application imidacloprid (88.13%) followed by neem oil (72.03%) at 5% showed highest reduction in jassid population and statistically at par with each other. Neem oil at 3% and neem seed water extract at 5% resulted in to 66.10% and 68.64% jassid reduction, respectively. After 7 days of application, all the neem derivatives had non-significant difference with each other. Again, imidacloprid was ranked 1st with maximum percent reduction of 67.96% followed by neem oil (57.28%) and neem seed water extract (50.48%) at 5%. While neem oil and neem seed water extract at 1% were least efficient with 35.92% and 32.03% reduction, respectively.

### 3.2 Cotton thrips (*Thrips tabaci*)

The results showed significant difference in mean percent reduction of thrips population after 1, 3 and 7 days of two applications. It is clearly evident from Table 3 that all the neem derivatives and insecticide caused significant mortality even at 7 days after application. Imidacloprid was ranked 1st in its toxicity by producing 65.10% reduction of thrips infestation after 1 day of spray followed by neem oil and neem seed water extract at 5% with 45.05% and 43.04% thrips reduction, respectively. Neem oil and neem seed water extract at 3% resulted into 40.38% and 37.27% reduction while at 1% concentration both were least effective with 29.85% and 25.09% reduction, respectively. Similarly after 3 days of application efficacy was increased as imidacloprid followed by neem oil and neem seed water extract at 5% gave maximum reduction of 75.07%, 67.39% and 67.01%, respectively and were statistically at par with each other. After 7 days imidacloprid remained superior with percent reduction of 71.23% followed by neem oil (58.69%) at 5%. However their mean population did not differ significantly. The next best were neem oil and neem seed water extract at 3% with percent reduction of 55.78% and 52.18%, respectively. The effects of imidacloprid and neem derivatives against thrips on cotton in second application were identical to the results of first application. Significant percent reduction of 69.82%, 73.18% and 70.37% in thrips population was achieved with imidacloprid at 1, 3 and 7 days after application followed by neem oil and neem seed water extract at 5%.

Neem oil and neem seed water extract at 1% though produced significant results compared to untreated control however neem seed water extract at 1% was less efficient in suppressing thrips population (Table 4).

### 3.3 Seed Cotton Yield

The results presented in Table 5 revealed that seed cotton yield differ significantly among the treatments with enhanced yield compared to untreated control (1703.3 kg/ha). However, highest yield of 2626.7 kg/ha was picked in plots treated with imidacloprid followed by neem oil (2551.1 kg/ha) and neem seed water extract (2437.8 kg/ha) at 5%. Neem oil and neem seed water extract at 3% resulted into yield of 2413.3 kg/ha and 2320.0 kg/ha, respectively. It is also apparent from the results that neem oil (2170.0 kg/ha) and neem seed water extract (1963.3 kg/ha) at 1% were non-significantly different from each other and failed to surpass control treatment.

## 4. Discussion

Botanical insecticides offers safer and much better approach for insect pest management programs compared to synthetic insecticides [17]. Neem products are compatible with IPM programs and non-threatening to predators and parasitoids [18]. In the present study neem oil and neem seed water extract at 5% and 3% concentrations significantly declined the infestation of jassid and thrips in cotton but the synthetic insecticide (imidacloprid) proved more toxic against both insect pests. These results are in agreement with those of Rashid *et al*. [13] who observed that neem oil at 2% and neem seed water extract at 3% significantly reduced the thrips, whitefly and jassid population up to twelve days as compared to untreated control. They also concluded that among all treatments Polytrin-C was most effective in all cases against the test insect. Similarly, Nimbalkar *et al*. [19] summarized that neem extracts and *Pongamia glabra* were less toxic than endosulfan against bollworms. Kumawat and Jheeba [20] recommended monocrotophos, endosulfan and azadirachtin for the management *Helicoverpa armigera.* Imidacloprid and nitenpyram were more effective against thrips and jassid in cotton [21]. Fiaz *et al*. [22] reported that neem derivatives viz., neem oil (37%) and neem leaf extract (39%) at 5% gave significant jassid mortality at different intervals compared to control. Khan *et al*. [23] tested the efficacy of some plant products against the cotton pests. They concluded that datura and neem oil were most effective and caused significant reduction in the population of jassid, thrips and whitefly at different time intervals.

Many other workers reported similar results regarding the effects of derivatives of neem on the insect pests of cotton. Rashid *et al*. [24] conducted laboratory studies to determine the toxic, anti-feedant and deterrent effects of neem oil and neem seed water extracts at 1, 2 and 3% concentrations against cotton jassid. The results revealed that neem seed water extract at 3% and neem oil at 2 and 3% concentration was very effective against the tested pest. Jat and Jeyakumar [25] found that neem seed extract was less efficient than neem oil against jassid and its population reduced by 20.4%, 34.4% and 42.5% at 1%, 2% and 3% concentration of neem oil, respectively. Mansoor *et al*. [26] observed that significant control of aphids, thrips and jassid was achieved by the application of neem samples and also prolonged their nymphal period. Similarly, bollworms and *B. tabaci* successfully controlled where neem was used alternatively with pyrethroids and *Bacillus thuringiensis*. Nymphal instars of many insect species and small bodied insects were killed by neem derivatives [27]. Khan *et al*. [28] confirmed that insecticidal combinations and neem extracts significantly inhibited the bollworms and thrips population on cotton after 17 days of application. However, their toxic effect decreased gradually against the test insect. Aslam and Naqvi [29] evaluated dimethoate and neem products against sucking insect pests (whitefly, thrips, aphid and jassid) and found neem products very effective in reducing population of sucking pests of cotton. Sharma *et al*. [30] recorded 25% larval mortality of diamond back moth when these were fed on foliage treated with oil and leaf extracts of neem.

The present results revealed that plots treated at 3% and 5% of neem seed water extract and neem oil produced significantly more yield as compared to control treatment. These results are similar to Rashid *et al*. [13] who recorded that plots treated with 1.5% and 2% of neem oil and 3% of neem seed water extract produced higher seed cotton yield. Likewise, Khattak *et al*. [31] reported that cotton treated with neem extracts and insecticidal combinations gave significantly more yield as compared to untreated control. Deling *et al*. [32] obtained more yield from the cotton treated with azadirachtin due to its effects on the infestation of bollworm.

## 5. Conclusion

In the present study, all neem derivatives suppressed the population of jassid and thrips below economic threshold level. However, neem oil and neem seed water extract at 5% recorded the highest percentage mortality of the target pests. It is clearly indicated that use of plant products for the management of insect pests can be good alternative of insecticides with less residual action, eco-friendly nature, environmental safety and have specific toxicity to target pest.

**Table 1:** Comparison of mean percent reduction of jassid at 1, 3 and 7 days intervals after first application.

| Treatments | | Mean Percent Reduction of Jassid | | |
|---|---|---|---|---|
| | | After One Day | After 3 Days | After 7 Days |
| $T_1$ | Imidacloprid | 79.43 (0.22) d | 86.40 (0.14) c | 71 (0.29) c |
| $T_2$ | Neem Oil 1% | 28.03 (0.77) bc | 42.71 (0.59) b | 38 (0.62) b |
| $T_3$ | Neem Oil 3% | 38.31 (0.66) bc | 61.16 (0.40) bc | 52 (0.48) bc |
| $T_4$ | Neem Oil 5% | 48.59 (0.55) c | 67.96 (0.33) bc | 63 (0.37) bc |
| $T_5$ | Neem seed water extract 1% | 20.56 (0.85) ab | 39.80 (0.62) b | 34 (0.66) b |
| $T_6$ | Neem seed water extract 3% | 34.57 (0.70) bc | 57.28 (0.44) bc | 49 (0.51) bc |
| $T_7$ | Neem seed water extract 5% | 42.05 (0.62) bc | 64.07 (0.37) bc | 60 (0.40) bc |
| $T_8$ | Control | (1.07) a | (1.03) a | (1.00) a |

Means sharing similar letters are not significantly different at $p<0.05$.

**Table 2:** Comparison of mean percent reduction of jassid at 1, 3 and 7 days intervals after second application.

| Treatments | | Mean Percent Reduction of Jassid | | |
|---|---|---|---|---|
| | | After One Day | After 3 Days | After 7 Days |
| $T_1$ | Imidacloprid | 77.47 (0.25) d | 88.13 (0.14) d | 67.96 (0.33) c |
| $T_2$ | Neem Oil 1% | 33.33 (0.74) bc | 47.45 (0.62) b | 35.92 (0.66) b |
| $T_3$ | Neem Oil 3% | 44.14 (0.62) bc | 66.10 (0.40) c | 42.71 (0.59) bc |
| $T_4$ | Neem Oil 5% | 54.05 (0.51) cd | 72.03 (0.33) cd | 57.28 (0.44) bc |
| $T_5$ | Neem seed water extract 1% | 27.02 (0.81) b | 44.06 (0.66) b | 32.03 (0.70) b |
| $T_6$ | Neem seed water extract 3% | 44.14 (0.62) bc | 59.32 (0.48) bc | 39.80 (0.62) b |
| $T_7$ | Neem seed water extract 5% | 46.84(0.59) bc | 68.64 (0.37) c | 50.48(0.51) bc |
| $T_8$ | Control | (1.11) a | (1.18) a | (1.03) a |

Means sharing similar letters are not significantly different at $p<0.05$.

**Table 3:** Comparison of mean percent reduction of thrips at 1, 3 and 7 days intervals after first application.

| Treatments | | Mean Percent Reduction of Thrips | | |
|---|---|---|---|---|
| | | After One Day | After 3 Days | After 7 Days |
| $T_1$ | Imidacloprid | 65.10 (3.81) e | 75.07 (2.63) c | 71.23 (2.96) d |
| $T_2$ | Neem Oil 1% | 29.85 (7.66) bc | 45.59 (5.74) b | 47.52 (5.40) bc |
| $T_3$ | Neem Oil 3% | 40.38 (6.51) d | 52.60 (5.00) b | 55.78 (4.55) c |
| $T_4$ | Neem Oil 5% | 45.05 (6.00) d | 67.39 (3.44) c | 58.69 (4.25) cd |
| $T_5$ | Neem seed water extract 1% | 25.09 (8.18) b | 42.84 (6.03) b | 38.09 (6.37) b |
| $T_6$ | Neem seed water extract 3% | 37.27 (6.85) cd | 49.85 (5.29) b | 52.18 (4.92) bc |
| $T_7$ | Neem seed water extract 5% | 43.04 (6.22) d | 67.01 (3.48) c | 55 (4.63) c |
| $T_8$ | Control | (10.92) a | (10.55) a | (10.29) a |

Means sharing similar letters are not significantly different at $p<0.05$.

**Table 4:** Comparison of mean percent reduction of thrips at 1, 3 and 7 days intervals after second application.

| Treatments | | Mean Percent Reduction of Thrips | | |
|---|---|---|---|---|
| | | After One Day | After 3 Days | After 7 Days |
| $T_1$ | Imidacloprid | 69.82 (2.96) d | 73.18 (2.70) d | 70.37 (2.85) e |
| $T_2$ | Neem Oil 1% | 25.28 (7.33) b | 44.88 (5.55) b | 42.72 (5.51) bc |
| $T_3$ | Neem Oil 3% | 47.60 (5.14) c | 62.85 (3.74) cd | 50.41 (4.77) bcd |
| $T_4$ | Neem Oil 5% | 51.68 (4.74) c | 68.02 (3.22) cd | 55.82 (4.25) d |
| $T_5$ | Neem seed water extract 1% | 20.79 (7.77) b | 40.11 (6.03) b | 39.18 (5.85) b |
| $T_6$ | Neem seed water extract 3% | 43.83 (5.51) c | 57.39 (4.29) c | 44.59 (5.33) bcd |
| $T_7$ | Neem seed water extract 5% | 47.19 (5.18) c | 66.93 (3.33) cd | 51.97 (4.62) cd |
| $T_8$ | Control | (9.81) a | (10.07) a | (9.62) a |

Means sharing similar letters are not significantly different at $p<0.05$.

**Table 5:** Comparison of mean yield (kg/ha) among different treatments.

| Treatments | | Yield (kg/ha) |
|---|---|---|
| $T_1$ | Imidacloprid | 2626.7 a |
| $T_2$ | Neem Oil 1% | 2170.0 abc |
| $T_3$ | Neem Oil 3% | 2413.3 ab |
| $T_4$ | Neem Oil 5% | 2551.1 a |
| $T_5$ | Neem seed water extract 1% | 1963.3 bc |
| $T_6$ | Neem seed water extract 3% | 2320.0 ab |
| $T_7$ | Neem seed water extract 5% | 2437.8 ab |
| $T_8$ | Control | 1703.3 c |

Means sharing similar letters are not significantly different at $p<0.05$.

## 6. Acknowledgement

Authors are thankful to Director, Nuclear Institute of Agriculture, Tandojam and Farm Management Committee for providing the necessary facilities and support for carrying out the study successfully.

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