



INNSPUB

RESEARCH PAPER

**Journal of Biodiversity and Environmental Sciences (JBES)**

ISSN: 2220-6663 (Print) 2222-3045 (Online)

Vol. 7, No. 1, p. 272-280, 2015

<http://www.innspub.net>**OPEN ACCESS**

## Population density of jassids ( *Amrasca Biguttula Biguttula* ) and thrips ( *Thrips Tabaci* ) on cotton crop and efficacy of some botanical insecticides against cotton jassids and thrips

Zahid Latif<sup>1</sup>, Sajjad Ahmed<sup>1</sup>, Kamran Sohail<sup>1</sup>, Laila Khan<sup>1\*</sup>, Muhammad Ishfaq<sup>2</sup>

<sup>1</sup>Department of Entomology, Faculty of Crop Protection Sciences, The University of Agriculture Peshawar-Pakistan

<sup>2</sup>Plant protection department, Sahiwal, Pakistan

Article published on July 12 2015

**Key words:** *Thrips tabaci*, *Amrasca biguttula biguttula*, Population fluctuation, Botanicals insecticides.

### Abstract

Experiment on the population dynamics of jassids and thrips on cotton crop and the effectiveness of five botanicals i-e lemon oil, neem oil, neem leaf extract, bitter gourd extract and bakain extract against them was conducted during May to October, 2014 in Research area of Plant protection department in Sahiwal, Pakistan. Results showed that the density of jassids and thrips reached their peak during the second and third week of August respectively whereas the density of both the pests kept on fluctuating in the preceeding and following months. The jassids and thrips population declined in October probably due to the maturity of the crop. The botanicals were applied on plants three times during the experiment, first spray was done when the pests reached the economic injury level and the other two were done at 20 days interval. Maximum percent reduction of jassids was recorded with lemon oil followed by bakain leaf extract and neem oil. Minimum percent reduction of jassids was recorded with bitter gourd extract followed by neem leaves extract. Similarly, for thrips, lemon oil worked maximum in reducing their number followed by neem leaves extract, bitter gourd extract neem oil and bakain leaf extract. Maximum number of thrips and jassids was recorded in the control plot which indicated that all the botanicals had a significant effect in reducing both the pests. Therefore it is recommended that botanicals can prove a good alternative to the use of synthetic pesticides.

\*Corresponding Author: Laila Khan ✉ [lailakhan367@yahoo.com](mailto:lailakhan367@yahoo.com)

## Introduction

Jassids (*Amrasca biguttulabigulla*) and thrips (*Thrips tabaci*) are very important sucking insect pests of cotton. They damage the foliage by sucking the cell sap reducing the photosynthetic area of the plant (Parkash and Verma, 1986). Both nymphs and adult jassids cause damage to the lower surface of leaves by injecting its toxic saliva into tissues which cause large number of leaves, young bolls to shed and fruiting capacity is reduced greatly (Ratanonara *et al.*, 1994). Thrips attack cotton crop early in the season but high population can be seen during second fortnight in September (Gupta *et al.*, 1990). Both nymphs and adults of thrips damage the tissues and destroy leaves on the underside by sucking the cell sap which cause curling up of leaves and plant remained stunted at stage of severe injury. To avoid losses due to insect pests, the entire reliance has always been on synthetic pesticides as a control measure and their indiscriminate and continuous use cause high toxicity to non-target organisms and non- biodegradable properties of chemical pesticides and its residual effects in soil, water resources and crops negatively affect health. On the other hand natural products are relatively good alternative to synthetic chemicals because of its less negative effects on environment and human health (Isman and Machial, 2006). Many plants extracts are tested for their efficacy against insect pest of cotton crop (Siddiq *et al.*, 1986). Numbers of plant extracts have been identified for having insecticidal effects against different stored grain insects (Schmutterer, 1984). There has always been a need to develop a comprehensive control program aimed at minimizing the use of pesticides to overcome the insect pest problem. Khaliq *et al.*, (2014) found that the botanicals (neem, datura and bitter apple) gave more than 60% control of onion thrips and they had negligible adverse effects on their predators, while among chemical insecticides (acephate, spirotetramat and spinetoram), acephate was found to be the most effective but chemical insecticides gave better control than the botanicals. Khan *et al.*, (2013) applied different plant extracts (neem oil, garlic, eucalyptus and datura) on the population of jassids,

whitefly and thrips in Bt cotton and found that Datura proved to be the most effective against pest population followed by neem oil. Garlic and eucalyptus also produced significant results compared to untreated check but they were less effective than datura and neem. Fiaz *et al.*, (2012) investigated the repellency and phagodeterrent effects of five plants derivative *viz.*, Lemon oil, bittergourd extract, bakain leaf extract, neem oil and neem leaf extract against cotton jassid and thrips and concluded that lemon oil proved to be the most effective plant derivative against jassids whereas bakain leaf extract, neem oil and neem leaf extract showed comparatively higher mortality of the thrips as compared to other plant derivatives. Keeping in view these facts the present study was conducted to determine the population dynamics of jassids and thrips on cotton crop and to study the comparative efficacy of different botanicals i-e lemon oil, neem oil, neem leaf extract, bitter gourd extract and bakain extract for the control of jassids and thrips.

## Materials and methods

The experiment was conducted in Research area of Plant Protection Department in Sahiwal to determine the population dynamics of jassids and thrips on cotton crop and to test the effect of plant derivatives on thrips and jassids on cotton variety SLH-317 during Kharif 2014. The experiment was laid out in Randomized Complete Block design (RCBD) with six treatments including control and three replications. The treatments used were five botanical insecticides *viz* lemon oil, neem oil, neem leaf extract, bitter gourd extract and bakain extract and control. Plot size was 17.5 × 25 ft and contained 42 lines. Each treatment had 7 lines and each line had 17 plants. Plant to plant distance was kept at 12 inches and row to row distance was 30 inches. Population trend of jassids and thrips were obtained from the control plots. Data was recorded from the time of appearance of the pests at weekly intervals and continued till the crop maturity. For the assessment of sucking insect pests of cotton a diagonal method was used, data was recorded early in the morning by counting number of thrips and jassids with the help of magnifying lens on three randomly

selected plants per treatment. Three leaves per plant were observed randomly from top, middle and lower portion of the plants.

#### *Preparation of Plant Extracts*

##### *Neem oil*

Neem seeds were collected from neem tree and were dried in sun shine and after dehulling, oil extraction was carried out from dried seed kernels by seed oil expeller (Anwar *et al.*, 2005). The 5% oil was obtained from the neem seeds kernels and sprayed in the field.

##### *Neem leaf extracts*

One kg of fresh leaves of *Azadirachta indica* were plucked from neem trees from Plant Protection Department at Sahiwal. The leaves were dried in an oven at 80°C for the period of 72 h. The dried leaves were ground separately into a fine powder with the help of pestle and mortar, tied in a cotton cloth in the form of a bag and dipped in five liter of water at 80 °C for 16 hours. The mixture was thoroughly shaken with mechanical shaker for 24 h and allowed to settle overnight and later decanted. The decanted solutions were then filtered using filter paper (Oladimeji and Kannike, 2010).

##### *Bakain extract*

One kilo gram fresh bakain (*Melia azadarach*) leaves were collected from the wild trees Plant Protection Department at Sahiwal, sun dried and grinded in pestle and mortar, tied in a cotton cloth in the form of a bag and dipped in five liter of water at 80 °C for 16 hours. In this way concentrated solution of 20% was obtained and diluted to 5% spray in field. (Salijoqi *et al.*, 2006).

##### *Bitter gourds extract*

One kilo grams dried bitter gourd (*Momordica charantia*) seeds collected from the Plant Protection Department at Sahiwal, were grinded and tied in a cotton cloth bag, dipped in five liter of hot water at 80 °C for the period of 16 hours. Concentrated solution of 20% was obtained and diluted to 5% for spray in the field (Gasperi-Company *et al.*, 1980).

##### *Lemon oil*

Lemon seeds were collected from citrus fruits and collected seeds were ground in electric grinder. Powder was put in Soxhlet apparatus for extraction of oil by steam distillation method (Vogel, 1998). 5% solution was prepared from stock solution using Murugan 2007. This is modified method as used by Akram *et al.*, (2010).

The crop was sprayed three times during the experiment. Each treatment was sprayed with Knapsack hand operated sprayer. The first spray was done on 10<sup>th</sup> of May when the pest attack reached Economic Threshold level. Second and third spray was carried out after 20 days interval. Pre-treatment data was recorded 24 hours before spray and post treatment data were recorded 24 h, 48 h and 72 h and 7- days after spray to determine the effect of plant extracts. Percent corrected mortality was determined using Abbott formula (1925).

$$\% \text{ Corrected Mortality} = \frac{\text{Observed mortality} - \text{Control mortality}}{100 - \% \text{ control Mortality}} * 100$$

##### *Data analysis*

Thus the final data was analyzed using STATISTIX 8.1®, 2005 software with analysis of Variance (ANOVA) and means separated using Least Significant Different (LSD) test at  $P < 0.005$ . The mean populations of sucking insect pests from sprayed plots were considered to be an indirect reflection of efficacy of different botanicals.

## **Results and discussion**

### *Population dynamics of Jassids*

The data on population density of jassids is given in fig I. It is evident from the data that jassids density was lower in the month of May. Jassids started appearing in the first week of May where its number was 4.33/leaf and increased till second week (4.67/leaf) after which it decreased in the third week (2.00/leaf) and again increased in the 4<sup>th</sup> week (3.33/leaf). The first, second, third and fourth week of June recorded 4.67/leaf 5.00/leaf 5.56/leaf and 3.33/leaf

respectively. Similarly the first, second, third and fourth week of July recorded 5.00/leaf 3.33/leaf 4.67/leaf and 3.33/leaf respectively. The jassids population showed a tremendous increase during the

month of August and peak population was recorded during the 2<sup>nd</sup> week of this month. Its number recorded was 4.67/leaf in the 1<sup>st</sup> week.

**Table I:** Percent Reduction in population of jassids on cotton treated with different botanicals during 2014.

1st Spray	2 <sup>nd</sup> Spray					3 <sup>rd</sup> Spray									
	24 hr	48 hr	72 hr	7days	Mean	24 hr	48 hr	72 hr	7days	Mean	24 hr	48 hr	72 hr	7days	Mean
Treatments	24 hr	48 hr	72 hr	7days	Mean	24 hr	48 hr	72 hr	7days	Mean	24 hr	48 hr	72 hr	7days	Mean
Neem oil	51.6c	51.6 d	50.0d	56.0 a	52.3ab	40.0 b	37.3 a	40.3 b	37.6 a	38.8 a	27.0 e	39.0 bc	34.6 b	44.0 a	36.1 a
Neem leaves	47.6 d	49.3 e	46.0 e	47.3 d	47.5 b	38.6 c	32.6c	33.6 c	31.6 bc	34.1 b	32.0 c	36.0 d	41.0 a	39.0 c	37.0 a
Bakian leaf	54.0 bc	55.0 c	56.3 b	54.6 b	55.0 a	40.3 b	35.6 b	34.6 c	32.6 b	35.8ab	38.6 a	43.0 a	36.0 b	42.0 b	39.9 a
Bitter gourd	56.0 ab	58.0 b	52.3 c	45.0 e	52.8 a	40.6 b	33.6 c	41.6 a	30.3 d	36.5ab	30.0 d	38.0 c	35.0 b	41.0 b	36.0 a
Lemon oil	58.0 a	61.3 a	58.6 a	50.3 c	57.0 a	42.3 a	37.6 a	40.6ab	30.6cd	37.8ab	36.0 b	40.0 b	37.0 b	38.0 c	37.7 a
Control	0.00 e	0.00 f	0.00 f	0.00 f	0.00 c	0.00 d	0.00 d	0.00 d	0.00 e	0.00 c	0.00 f	0.00 e	0.00 c	0.00 d	0.00 b
LSD	2.34	1.89	0.91	0.87	4.79	1.19	1.19	1.19	1.19	3.77	1.03	1.36	2.88	1.52	4.76

**Table I1:** Percent Reduction in population of thrips on cotton treated with different botanicals during 2014.

1st Spray	2 <sup>nd</sup> Spray					3 <sup>rd</sup> Spray									
	24 hr	48 hr	72 hr	7days	Mean	24 hr	48 hr	72 hr	7days	Mean	24 hr	48 hr	72 hr	7days	Mean
Treatments	24 hr	48 hr	72 hr	7days	Mean	24 hr	48 hr	72 hr	7days	Mean	24 hr	48 hr	72 hr	7days	Mean
Neem oil	37.6d	39.3c	41.6c	43.3 b	40.5 b	35.6 b	33 e	41.3 a	35.3a	36.3 a	40.6 b	44.6 a	44.6 b	41.6 d	42.9ab
Neem leaves	38.6c	39.6c	41.3c	41.6c	40.3b	33.6c	34.3d	40.6a	32.6b	35.3a	43.67a	42.6b	46.0a	47.3a	44.9a
Bakian leaf	40.3a	41.3b	43.3b	43.6b	42.1a	37.6a	35.6c	34.6c	34.6a	35.6a	38.6d	41.6b	41.3d	43.6c	41.3b
Bitter gourd	40.6a	42.6a	43.6b	45.3a	43.0a	34.3c	37.6b	37.6b	30.6c	35.0a	39.67c	39.6c	41.6d	45.6b	41.6b
Lemon oil	39.6b	41.6ab	44.6a	45.6a	42.9a	34.6bc	41.6a	41.6a	31.6bc	37.4a	37.34e	38.6c	43.6c	43.6c	40.8b
Control	0.00e	0.00d	0.00d	0.00d	0.00c	0.00d	0.00f	0.00d	0.00d	0.00b	0.00f	0.00d	0.00e	0.00e	0.00c
LSD	0.57	0.87	0.63	0.63	1.51	1.19	1.18	1.19	1.28	4.06	0.99	1.35	0.71	0.57	2.64

The peak population 7.67/leaf was observed during the 2<sup>nd</sup> week of August which was highest during the entire jassid infestation period whereas population in 3<sup>rd</sup> week and 4<sup>th</sup> week was 6.67/leaf and 3.33/leaf respectively. The population remained lower during the month of September. The number of jassids recorded were 3.67/leaf 6.67/leaf 7.00/leaf 5.00/leaf in the first, second, third and fourth week of September. The jassids population tended to decline in October due the maturity of the crop and lowest population was noted in the last week of this month. Jassid population was 5.67/leaf in the first week, 4.67/leaf, 3.33/leaf and 2.11/leaf in the second, third and fourth week respectively. The findings are in conformity with those of Ashfaq *et al.*, (2011) who reported that densities of insect pests and natural enemies peaked from June to October. They recorded the highest density of (6.56) jassids per leaf on 10th of August. Mohapatra (2008) recorded highest density of jassids during 41<sup>st</sup> standard week (August8-Oct14) 44<sup>th</sup> standard week (Oct. 29-Nov -4) and 35<sup>th</sup> standard

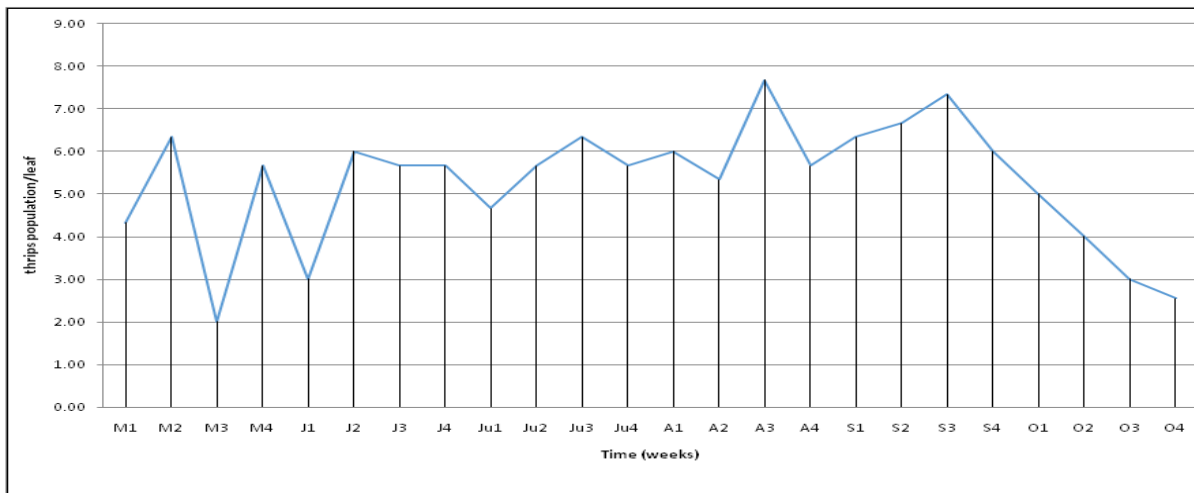
week (Aug 27-Sept.2). She also justified that temperature have positive correlation with Jassids density. The findings are not in accordance with those of Mari (2013) who indicated that jassid population reached to its highest value of 11.35/ leaf on October, 29 when vegetative growth and succulence of leaves was at its peak, and then decreased to reach its lowest value of 1.46/leaf on December 13<sup>th</sup>.

*Population dynamics of Thrips*

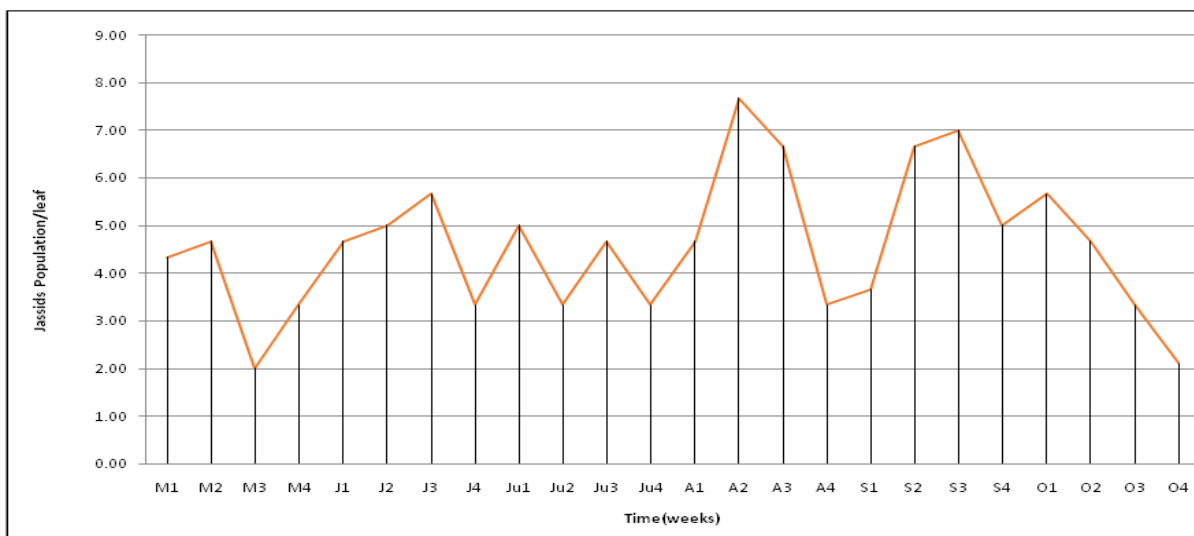
The data on the population of thrips was given in Fig I1 which indicates that the thrips started to appear on cotton leaves during the first week of May, it was lower in the month of May and recorded 4.33/leaf, 6.33/leaf, 2.00/leaf and 5.67/leaf in the first, second, third and fourth week respectively. Similarly, thrips population density in first, second, third and fourth week of June was 3.00/leaf, 6.00, 5.60 and 5.67/leaf respectively. In the month of July the average thrips population recorded was 4.66/leaf in first week followed by 5.66/leaf in the second week, in the third week it

reached to 6.33/leaf and came down to 5.66/leaf. In August the thrips population was 6.00/leaf that reduced to 5.33/leaf in the second week. Thrips population reached its peak and was maximum during the third week of August during the whole thrips infestation period and was 7.66/leaf during the whole crop period, while it was 5.66/leaf in the last week of the August. Similarly, thrips population density in first, second, third and fourth week of September was 6.33/leaf, 6.66/leaf, 7.33/leaf and 6.00/leaf respectively. The thrips population tended to decline in October due the maturity of the crop. The number of thrips in first week was 5.00/leaf followed by 4.00/leaf in the second week. In last two weeks of

October the number of thrips was 3.00 and 2.55/leaf. These results are supported by findings of Shahid *et al.*, (2012) who recorded maximum thrips in the month of June and found that thrips population generally boosted in the months of May, June and July. These results are also in accordance with the findings of Gosalwad *et al.*, (2009) who stated that thrips attained its peak in August and November. Our findings are not in conformity with those of Shivanna *et al.*, (2011) who recorded the sucking pest population throughout the year except in July and August months. They found the highest population (26.81/ three leaves) of thrips during April second fortnight for thrips.



**Fig I:** Population dynamics of thrips (*Thrips tabaci*) on cotton crop from May to October.

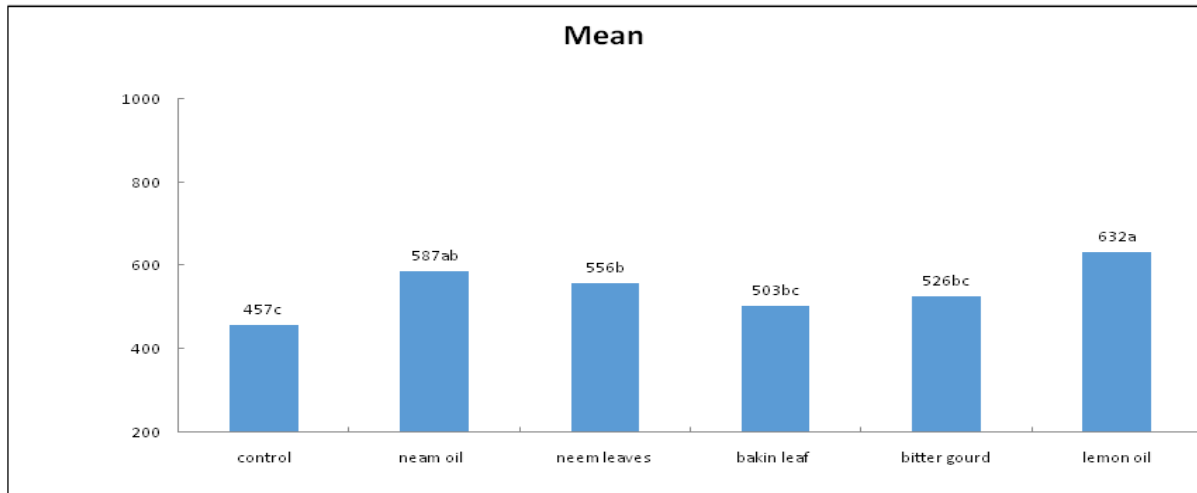


**FIG I1:** Population dynamics of Jassids (*Amrasca biguttula biguttula*) on cotton crop from May to October.

*Mean percent reduction in jassid population after first, second and third spray*

Data regarding percent reduction of jassid treated with different botanicals is given in table 1. Statistical analysis of the mean data recorded before 24 hours

and after 24hours, 48hours, 72 hours and 7 days of first, second and third spray application indicated significant difference in the percent population reduction of jassids after application of different botanicals extracts.



**Fig I I1:** Means of the yield of cotton (kg/ha) treated with different botanicals.

The results indicated that application of lemon oil spray was most effective showing maximum percent reduction of jassids after first spray till end of the spray effect i.e. 7 days. It was followed by bakian leaf extract and then Bitter gourd extract. The application of neem leaves extract resulted in minimum percent population reduction of the pest. There was no reduction in pest population in untreated which indicated that there was no botanical extract factor involved in population reduction of jassids. After the 2<sup>nd</sup> spray, the result was somewhat different from the first spray and maximum reduction of the pest was observed in Neem oil followed by lemon oil. The percent reduction in population of all the botanicals was lower than that of the first spray. The lowest reduction in population was recorded for the neem leaf extract. Bakain leaf extract gave maximum percent reduction in population of the pest after 3<sup>rd</sup> spray. Neem leaves extract provided the least percent reduction in population of the jassids after 3<sup>rd</sup> spray. Minimum population reduction was observed in neem leaves extract after all the three sprays. The results of maximum reduction in population were different after each spray. However lemon oil resulted in highest percent population

reduction. Bakain leaf extract and Neem oil also gave measurable reduction in population of the pest. The findings of Fiaz *et al.*, (2012) are in accordance with our results they reported that lemon oil proved to be the most effective plant derivative against jassid followed by neem oil, bakain, bitter gourd and neem leaf extract in all three applications. These findings are also in conformity with those of Khan *et al.*, (2013) who found that lemon oil was the most effective bringing about significant reduction in the pest population followed by neem oil. Bitter gourd extract also produced significant results compared to untreated check.

*Mean percent reduction in thrips population after first, second and third spray*

Data regarding percent reduction of thrips treated with different botanicals is given in table 2. The presented results regarding thrips revealed that pest population reduction was variable for different botanicals after each spray. Application of bitter gourd extract produced maximum control and reduced significantly the pest population after 1<sup>st</sup> spray. The percent reduction of lemon oil was also good and produced a

high control of the pest population. Minimum reduction in population of the pest was observed in neem leaves extract. After the 2<sup>nd</sup> spray a measurable reduction in population of the pest was recorded in lemon oil which was followed by neem oil. The bitter gourd extract was not more effective and resulted in minimum pest population reduction. Highest pest population control results were observed for neem leaves extract after third application of the spray. Overall mean on thrips population reduction after first, second and third application showed that lemon oil resulted in over all maximum reduction in the pest population and bakain leaves gave minimum pest reduction. The untreated or control plants concluded in zero percent reduction in pest population due to the normal activities of thrips. These results are in accordance with the findings of Dehghani *et al.*, (2012) who reported that the extracts of lemon oil and *M. azedarach* had the most significant effect on decreased percentage of adults population. The highest mean reduction percentage of the population was calculated in the lemon oil treatments (92.21%) during the last record. These results are also in conformity with those of Fiaz *et al.*, (2012) who tested lemon oil, bittergourd (*Momordica charantia* L) extract, bakain (*Melia azadarach*) leaf extract, neem (*Azadirachta indica*) oil and neem (*A. indica*) leaf extract, each at a 5% concentration for their repellency and phagodeterrent effects against jassid and thrips. In case of thrips all plant derivatives controlled thrips population significantly. Bakain leaf extract, neem oil and neem leaf extract showed comparatively higher mortality of the thrips as compared to other plant derivatives.

#### Yield

Results regarding the yield are given in Fig I I1. Statistical analysis of the data revealed that in case of various treatments significant maximum average yield of 632 kg ha<sup>-1</sup> was recorded in the plots treated with lemon oil, which was followed by neem oil with total yield of 587 kg ha<sup>-1</sup>. Whereas the neem leaves extract, bitter gourd and bakain leaves extract application resulted in 556, 526 and 503 kg yield per hectare respectively. There was significant difference in yield

of cotton treated with bakain leaves extract and bitter gourd extract plots. The lowest yield of 457 kg ha<sup>-1</sup> was observed in control. These results are in accordance with the findings of Kumar (1989) who reported that addition of 2% neem oil significantly increased the yield and it was effective in increasing the yield. Mandal *et al.*, (2008) reported that the use of bio pesticides can increase in yield of cotton crop.

#### Conclusion

It may be concluded from the present research that the thrips and aphids infestation began in the month of May on cotton and continued till October after which a decline was observed in their population. The peak infestation of both jassids and thrips was recorded in the month of august and September. Overall mean on their population recorded after the application of various botanicals showed that for jassids, lemon oil proved to be the most effective in reducing the population of jassids followed by Bakain leaf extract which also reduced its population to a significant level bitter gourd extract and neem leaves extract were found less effective against it. Similarly, for thrips, lemon oil worked maximum in reducing their number followed by neem leaves extract, bitter gourd extract, neem oil and bakain leaf extract. Maximum number of thrips and jassids were recorded in the control plot. Therefore, these botanicals can prove a good alternative to the use of synthetic pesticides on small areas because use of botanical insecticides greatly influence the activity of pests through their biochemical factors, thereby suppressing the pest population. Further investigations regarding influence of biochemical factors of botanicals on jassids and thrips and other soft bodied pests is strongly recommended. Such investigations may potentially contribute towards devising an IPM strategy for other insect pests of cotton crop.

#### References

Akram WHA, Khan A, Hafeez F, Bilal H, Kim YK, Lee JJ. 2010. Potential of citrus seed extracts against dengue fever mosquito, *Aedes albopictus*



(Skuse) (Culicidae: Diptera). Pakistan Journal of Botany **42**, 3343-3348.

**Anwar M, Ashfaq M, Hassan M UL, Anjum FA.** 2005. Efficacy of *Azadirachta indica* L. on bagging material against some insect pests of wheat stored in warehouses at Faisalabad. 2005. Pakistan entomologist **27**, 89-94.

**Ashfaq M, Saif-ur-Rehman, Sagheer M, Wakil W.** 2011. Efficacy of some plant extracts against rice borers and leaf folder in integration with biocontrol agents (*Chrysoperla carnea* and *Trichogramma chilonis*). Pakistan Entomologist **33(2)**, 81-85.

**Dehghani M, Ahmadi K, Zohdi H.** 2012. Evaluation of some plant extracts and convention insecticides against *Tarialeurodes vaporariorum* (West wood) (Homoptera) (leyrodidea) in Green house Condition. Munis Entomology and Zoology Journal **7**, 2.

**Fiaz M, Hameed A, Hassan M, Wakil W.** 2012. Efficacy of plant extracts on some cotton (*Gossypium hirsutum*) Pests: *Amrasca bigutulla bigutulla* Ishida and *Thrips tabaci* Lindeman. Pakistan Journal of Zoology **44(1)**, 277-283.

**Gasperi-campani A, Barbieri L, Morelli P, Stirpe, F.** 1980. Seed extracts inhibiting protein synthesis in vitro. Biochemical Journal **186**, 439-441.

**Gosalwad SS, Kamble SK, Wadnerkar DW, Awaz HB.** 2009. Population dynamics of major insect-pests of cotton and their natural enemies. Journal of Cotton Research and Development **23(1)**, 126-129.

**Gupta MP, Sandeep S, Shrivastava SK, Sharma S.** 1997. Population buildup of some sap sucking insect on cotton in Madhaya Pardesh. Journal of insect Science **10(2)**, 153-156.

**Isman, MB. Machial CM.** 2006. Pesticides based on plant essential oils: from traditional practice to commercialization. In M. Rai and M.C. Carpinella (eds.), Naturally Occurring Bioactive Compounds, Elsevier, BV, 29-44 p.

**Khaliq R, Grissa-Lebdi K, La Torre I, Zappalà L, Russo A.** 2014. Preliminary study on mealybugs in two vineyards of the Cap-Bon region (Tunisia). Tunisian Journal of Plant Protection. **4**, 185-196.

**Khan AK, Saini S, Singh K, Aneja A.** 2013. Persistence and residual toxicity of some insecticides against *Phenococcus solenopsis* on cotton (*Gossypium* spp). Indian Journal of Agricultural Science **79(3)**, 203-206.

**Kumar ARV, Sangappa HK.** 1989. A note on the performance of plant product in the control of gram caterpillar in Bengal gram. Current Research **13**, 38-40.

**Mandal S, Patel AM, Patel CC.** 2008. Efficacy of certain commercially available biopesticides against boll worm of cotton. Indian Journal of Applied Entomology **22(2)**, 128-130.

**Mari JM.** 2013. Impact of trap crops on the population of jassid (*Amrasca devastans* (dist.) in okra. Wudpecker Journal of Agricultural Research. **2(9)**, 252 - 255.

**Mohapatra LN.** 2008. Population dynamic of sucking pests in *Gossypium hirsutum* cotton and influence of weather parameters on its incidence in western orissa. Journal of Cotton Research and Development **22(2)**, 192-194.

**Murugan K, Murugan P, Noortheen A.** 2007. Larvicidal and repellent potential of *Albizzia amara* Boivin and *Ocimum basilium* Linn. against dengue vector *Aedes aegypti*. Bioresource technology. 198-201.



- Oladimeji A, Kannike MA.** 2010. Comparative studies on the efficacy of neem basil leaf extract and synthetic insecticides, lambda\_cyhalothrin, against *Podogria* spp. on okra. African Journal of Microbiology Research. **4**, 33-37.
- Parkash O, Verma AN.** 1986. Effect of different plant extract applied by different method against jassid (*Amrasca biguttula biguttlua*) (Dist) and white fly (*Bemisia tabaci*) on brinjal during Pre fruiting crop. Indian Journal of Entomology. **47**, 66-77.
- Ratanoara A, Sheikh M, Patel JR, Patel NM.** 1994. Effect of weather parameter on brinjal jassid (*Amrasca biguttula biguttlua*). Ishida. Gujarat Agricultural University Research Journal **19**, 39-43.
- Saljoqi AUR, Afridi MK, Khan SA, Rehman S.** 2006. Effect of six plant extracts on rice weevils *Sitophilus oryzae* L. in the stored wheat grains. Journal of Agriculture and Biological science **1**, 1-5.
- Schumtterer H.** 1984. Possibilities for using plant compound for the control of pests. Mitteilungen aus der Biologischen bundesatalt Land ForstwirtSch. Review of Applied Entomology. Berlin **13**, 223-333 p.
- Shahid MR, Farooq J, Mahmood A, Ilahi F, Riaz M, Shakeel A, Valentin Petrescu-Mag I, Farooq A.** 2012. Seasonal occurrence of sucking insect pest in cotton ecosystem of Punjab, Pakistan. International Journal of Bioflux Society **4(1)**, 26-30.
- Shivanna BK, Naik BG, Basavaraja MK, Nagaraja R, Kalleswara Swamy CM, Karegowda C.** 2011. Impact of abiotic factors on population dynamics of sucking pests in transgenic cotton ecosystem. International Journal of Science and Nature **2(1)**, 72-74.
- Siddiq SA.** 1986. A proposed pest management program including neem treatments for combating potato pests in the Sudan. *Proceedings of 3rd International Neem Conference. Nairobi, Kenya.* 10-15 July, 449-459.
- Statistix.** Statistix user manual, version 8, Analytical Software, Tallahassee, FL. 2005.