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<td>Juma Khan Kakarsulemankhel, Ph.D.</td>
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<td>Department of Zoology, University of Balochistan, Saryab Road, Quetta, Pakistan.</td>
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<td><a href="mailto:dr.jumakhanakkakarsulemankhel@yahoo.com">dr.jumakhanakkakarsulemankhel@yahoo.com</a></td>
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EFFECTS OF BIOPESTICIDE AND SYNTHETIC PESTICIDES TO CONTROL THE BERRY BUGS (HEMIPTERA: PENTATOMIDAE)

NASREEN KHAN¹, NAJMUS-SAHAR¹ AND FARZANA IBRAHIM¹

¹Department of Zoology, Jinnah University for Women, Karachi. E-mail: nasreen_khan2007@yahoo.com.

ABSTRACT
Toxic effects of Biosal (neem extract), Cypermethrin and Deltamethrin (pyrethroids), pesticides are used to test three species of berry bugs, Halys fabricii Fabricius, Salixocoris sindellus Ahmed and Kamaluddin and Halys sulcatus (Thunberg) which are minor pests of different host plants. Regression models for toxicity of insecticides and test species were also developed to calculate the lethal concentrations after 24 hours of treatment. LC₅₀s were observed and calculated with the toxicity of these insecticide.

KEYWORD: Biosal, Lethal concentrations, insecticide, pyrethroids Cypermethrin and Deltamethrin

INTRODUCTION
Various types of bug species have been affecting the plants worldwide. Species of haylines known as berry bugs, usually attack berry, apple, and mulberry. Ahmed et al. (1997) studied the effect of RBa (neem extract) on the toxicity and nucleic acid contents in H. dentatus (=H. fabricii) for the first time in Pakistan. Pesticides are only short-term solution to the problem of pest control for many reasons, i.e., toxic chemicals have strong positive effects on several species other than pests, immune system of many pest species become strong and resist against toxic chemicals, which produce a pest problem by disorder of the natural enemies of the pest i.e. parasites and predators (Stern et al., 1959; Croft, 1990) but also the outbreak of secondary pests (Leigh and Mulham., 1966, Eveleens et al., 1973, Stoltz and Stern, 1978).

MATERIAL AND METHODS
Experiments were conducted on adults and nymphs of the three bug species i.e. S. sindellus, H. fabricii, and H. sulcatus which were collected respectively from various host plants i.e. Conocarpus erectus L. at Saifee park N. Nazimabad, (Gulmohar) Albizia lebbeck (L.) at Quaid-e-Azam Park Gulshan-e-Hadeed, Karachi. lignum vitae or guaiacum sanctum, from Polo Ground, near P.C Hotel, Karachi. Bugs were caught especially in day time between 2 pm to 5 pm. To find out the accurate toxicity of insecticides, bugs were carried in the Department of Zoology, Jinnah University for Women, Karachi. Specimens of all the species were taken more or less same age, size and weight, different pesticides i.e. Deltamethrin, Cypermethrin and neem formulation were used to find out their 50% lethal concentration.

RESULTS AND DISCUSSION
Toxic effects of Biosal (neem extract), Cypermethrin and Deltamethrin (pyrethroid), were studied by using different concentrations, mortality rates were observed and compared with the toxicity of these three insecticides against three tested insects H. fabricii, S. sindellus, H. sulcatus. Mortality was observed at 24 hours of treatment, the mortality values were analysed statistically. Regression models for toxicity of insecticide and test species were also developed to calculate the lethal concentrations after 24 hours of treatment.

The LC₅₀ values of Cypermethrin were calculated to be 0.00625, 0.0125, and 0.025 against test species. S. sindellus, H. fabricii, H. sulcatus.
In case of LC$_{90s}$ the values of Cypermethrin was noted 0.025, 0.025 and 0.05 against test insects. No remarkable difference was seen.

The LC$_{50s}$ values of Deltamethrin were calculated to be 0.00625, 0.00625, and 0.0125 against test species. *S. sindellus, H. fabricii, H. sulcatus* respectively followed by LC$_{90s}$ 0.025, 0.0125 and 0.025 against test insects. No remarkable difference was seen.

LC$_{50s}$ values of biosal were calculated to be 0.75, 0.75, and 1, against test species. *S. sindellus, H. fabricii, H. sulcatus*. Respectively followed by LC$_{90s}$ which is to be calculated by 1.25, 1.25 and 1.5 against test insects. No remarkable difference was seen.

In this experiment *H. sulcatus* was found to be more tolerance to all tested insecticides including Neem product.

![Figure 1](image1.png)

**Figure-1** Regression model of Biosal toxicity to LC$_{50}$ against *H. fabricii*.

![Figure 2](image2.png)

**Figure-2** Regression model of Biosal toxicity to LC$_{50}$ against *S. sindellus*. 
Effect of Bio-pesticide and Synthetic Pesticides to Control the Berry Bugs

Figure 3  Regression model of Biosal toxicity to LC$_{50}$ against *H. sulcatus*

Figure 4  Regression model of Deltamethrin toxicity to LC$_{50}$ against *H. fabricii*

Figure 5  Regression model of Deltamethrin toxicity to LC$_{50}$ against *S indellus.*
Figure-6  Regression model of Deltamethrin toxicity to LC₅₀ against *H. sulcatus*.

Figure-7  Regression model of Cypermethrin toxicity to LC₅₀ against *H. fabricii*.

Figure-8  Regression model of Cypermethrin toxicity to LC₅₀ against *S. sindellus*. 
Effect of Bio-pesticide and Synthetic Pesticides to Control the Berry Bugs

Figure- 9 Regression model of Cypermethrin toxicity to LC$_{50}$ against *H. sulcatus*.

Table-1. Toxic effects of Biosal, Deltamethrin and Cypermethrin against *H. fabricii*

<table>
<thead>
<tr>
<th>Specie</th>
<th>Biosal</th>
<th>Deltamethrin</th>
<th>Cypermethrin</th>
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<tr>
<td></td>
<td>No.</td>
<td>Doses 100%</td>
<td>Mortality</td>
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<tr>
<td><em>Halys fabricii</em></td>
<td>1</td>
<td>1.25ml</td>
<td>90%</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0.1ml</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>0.075ml</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>0.5ml</td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>0.25ml</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Control</td>
<td>00%</td>
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Table-2. Toxic effects of Biosal, Deltamethrin and Cypermethrin against *S. sindellus*

<table>
<thead>
<tr>
<th>Specie</th>
<th>Biosal</th>
<th>Deltamethrin</th>
<th>Cypermethrin</th>
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<tr>
<td></td>
<td>No.</td>
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<td>Solivaecoris sindellus</td>
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<td>1.25ml</td>
<td>90%</td>
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<tr>
<td></td>
<td>2</td>
<td>0.1ml</td>
<td>80%</td>
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<tr>
<td></td>
<td>3</td>
<td>0.075ml</td>
<td>50%</td>
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<td>20%</td>
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<td></td>
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<td>10%</td>
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<td></td>
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<td>Control</td>
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Table-3. Toxic effects of Biosal, Deltamethrin and Cypermethrin against *H.sulcatus*

<table>
<thead>
<tr>
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<th>Biosal</th>
<th>Deltamethrin</th>
<th>Cypermethrin</th>
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<tr>
<td></td>
<td>No.</td>
<td>Doses100%</td>
<td>Mortality</td>
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<td>Halys sulcatus</td>
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<td>1.50ml</td>
<td>90%</td>
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<td></td>
<td>2</td>
<td>1.25ml</td>
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Table 4. Toxic effects of Deltamethrin, Cypermethrin (Synthetic pesticide) and Biosal, (Botanical Pesticide) against H. fabricii, S. sindellus and H. sulcatus.

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<thead>
<tr>
<th>S. No.</th>
<th>Name of insecticides and Test insect</th>
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<th>LC$_{90}$</th>
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<tr>
<td>1</td>
<td>Biosal H. fabricii</td>
<td>Y=35.418x+33.811</td>
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<td>1.25</td>
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<tr>
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<td>S. sindellus</td>
<td>Y=34.04x+30.597</td>
<td>0.75</td>
<td>1.25</td>
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<tr>
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<td>H. sulcatus</td>
<td>Y=23.908x+42.377</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>2</td>
<td>Cypermethrin H. fabricii</td>
<td>Y=9365x+(-107.935)</td>
<td>0.00625</td>
<td>0.025</td>
</tr>
<tr>
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<td>S. sindellus</td>
<td>Y=12155x+(-229.84)</td>
<td>0.0125</td>
<td>0.025</td>
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<tr>
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<td>H. sulcatus</td>
<td>Y=9925x+(-140.575)</td>
<td>0.025</td>
<td>0.05</td>
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<tr>
<td>3</td>
<td>Deltamethrin H. fabricii</td>
<td>Y=3734.66x+20.388</td>
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<td>0.025</td>
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<tr>
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<td>S. sindellus</td>
<td>Y=49.242x+66.656</td>
<td>0.00625</td>
<td>0.0125</td>
</tr>
<tr>
<td></td>
<td>H. sulcatus</td>
<td>Y=4897x+16.007</td>
<td>0.0125</td>
<td>0.025</td>
</tr>
</tbody>
</table>

REFERENCES


Fig. 10
Dorsal View of H. fabricii

Fig. 11
Dorsal view of H. sulcatus

Fig. No. 12
Dorsal view of S. sindellus
EFFICACY OF DIFFERENT ACARICIDES ON OKRA

1Bhai Khan Solangi, 2Veelo Suthar, 3Riffat Sultana 1Abdul Qadir Baloch and 4Muhammad Ali Shaikh

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1Corresponding Author, Email: bhai Khan_solangisau@yahoo.com
(Revised)

ABSTRACT

The efficacy of different acaricides against okra mites, was determined at the experimental fields of Entomology section Agriculture Research Institute (ARI) Tandojam during the year 2014. Five acaricides including Nissuran, Oberon Ethion, Polo and Shogan, were tested for their efficacy against mites in okra and their efficacy was compared with control (untreated). The results revealed that all the acaricides tested were effective to control mite population in okra and after 15 days of 1st and 2nd spray, Oberon (24%Sc) resulted in the highest efficacy of 94.52 and 98.01 percent, respectively with overall average efficacy of 96.27 percent. Shogan (1.8EC) ranked 2nd in effectiveness with 91.00 and 92.20 percent efficacy after 15 days of 1st and 2nd sprays, respectively averaging 91.60 percent; while the efficacy of Polo (500Sc) was 75.32 and 79.16 percent averaging 77.24 percent, Nissuran (72WP) displayed efficacy of 75.03 and 78.74 percent averaging 76.89 percent and the efficacy of Ethion (46EC) after 15 days of 1st and 2nd spray was 73.58 and 77.21 percent averaging 75.40 percent, respectively. The highest amount of additional income Rs. 46171 ha\(^{-1}\) was achieved from the plots sprayed with Oberon acaricide against mites; followed by an additional income of Rs. 32723 ha\(^{-1}\), Rs. 30507 ha\(^{-1}\) and Rs. 20710 ha\(^{-1}\) realized from the plots sprayed with Shogan, Polo, Nissuran and Ethion, respectively over control; while the lowest additional income of Rs. 19255 ha\(^{-1}\) was realized from the plots as compared to income of Rs. 121715 ha\(^{-1}\) from plots sprayed with acaricide Ethion as compared to control.

INTRODUCTION

Okra, *Abelmoschus esculentus* L., a member of Malvaceae family, is an important vegetable crop cultivated in most parts of the world. Okra is one of the world’s oldest cultivated crops. The first reference of okra as vegetable was recorded by the Egyptians in 1216 A.D. (Mays et al. 1990). It is originated in tropical Africa and was also grown in Mediterranean region and its wild forms are found in India. It is now grown in all parts of the tropics and during the summer in the warmer parts of the temperate region (Baloch, 1994). Its tender green fruits are used as a vegetable and are generally marketed in the fresh state, but one times in canned or dehydrated form (Henry, 2001). It can be fried in butter or oil and cooked with necessary ingredients (Yadav et al. 2001). So far the nutritional value of okra is concerned, a 100 g portion of okra contains 129 kJ (31 kcal) Energy, 7.03 g Carbohydrates, 1.20 g Sugars, 3.2 g Dietary fiber, 1.10 g fat, 2 g protein, 90.17 g water and 81 mg calcium. A 100 g edible portions of okra contains moisture 89.6 g, minerals 0.7 g, protein 1.9 g, carbohydrates 6.4 g, fat 0.2 g, calcium 66 mg, fibre 1.2 g, iron 0.35 mg, calories 35, potassium 103 mg, phosphorus 56 mg, thiamine 0.07 mg, sodium 6.9 mg, nicotinic acid 0.6 mg, sulphur 30 mg, vitamin C 13 mg, riboflavin 0.1 mg, magnesium 53 mg, oxalic acid 8 mg and copper 0.19 mg (Gopalan et al. 2007). Okra crop is infested by numerous insect and mite pests (Kumar, 2004). Sucking pests in the early stage and the fruit borers in the later stage causes extensive damage to fruits and results in 69 percent yield loss (Mani et al., 2005; Jagtab et al., 2007). Insect pests have always been a threat to agricultural productivity, in result the crop productivity per unit area in Pakistan is far less than the potential crop yields or when comparison is made with the yields achieved by agriculturally advanced countries of the world. Thus for controlling these harmful insects, different chemicals (pesticides) are applied against different insect pests (Pearson, 2004). Application of insecticides had been found to provide acceptable solution to tackle these problems (Pawar et al., 1988; Verma, 1989; Mazumder et al., 2001). About 145 species of insect pests are recorded on
cotton plant and almost all of these attack okra plant (Priya and Misra, 2007).

Mites belong to the subclass Acari and are among the most diverse and successful of all the invertebrate groups; they have exploited an incredible array of habitats. Some of the plant pests include the so-called spider mites (family Tetranychidae), thread-footed mites (family Tarsenomidae), and the gall mites of the family Eriophyidae (Halliday et al., 2000). The mites are highly host specific and have only been recorded on plants of Malvaceae family. Damage of mites on okra, another member of the Malvaceae plant family has been reported in other countries. Plants can be infested with the pest with no visible symptoms. Once damage is evident, it is too late because the mites are already established within the plant tissue. However, Insecticides and miticides are effective for reducing crop damage during periods of pest outbreaks. Using selective insecticides/miticides to kill the target pest without killing natural enemies helps maximize as well as integrate chemical and biological controls. Selectivity usually arises from the specific chemical aspects of the insecticide. Nonselective insecticides and miticides, however, can be made more selective by careful application rates and timings (Heethoff and Koerner, 2007). Application of insecticides is practiced to protect the crop throughout the season are reported to provide protection. More frequent sprays may be needed during the main growth period. Existing galls will persist on the plant until the affected tissue dies, making it difficult to judge the success of any spray program. The number of effective pest control materials for controlling mites is limited (Halliday et al., 2000). Pesticide products with transmamellar properties are best. Foliar application of insecticides Newmectin 1.8 EC and/or Cure 1.8 EC (a.i. Abamectin) and Confidor 70WG (a.i. Imidaclorpid), Diafelatheron (50%) and Profenophos (45%) showed good results in controlling mites infestation (Redes, 2011). Miticides also known as Acaricides control unwanted mite pests and protect crops from their damaging effects. Acracmite 50WS is a broad-spectrum miticide for controlling mites of field crops and horticultural plants; and Omit 30WS miticide controls a broad-spectrum of mite species while being easy on beneficial insects and mite predators. Floramate SC miticide provides outstanding control of a variety of mite pests on vegetables and ornamental plants; while Temprano is a Acaricide/insecticide effective means to control a host of crop damaging pest mites, as well as leaf feeding worms and beetles, psyllids, thrips, and leaf miners. Consult the label for a complete list of different crops and pests (Redes, 2011). The present research was carried out to investigate the efficacy of different acaricides for the control of mites in okra and to identify the most effective acaricide for control of mites.

**MATERIALS AND METHODS**

This research was conducted at the experimental fields of Entomology Section, Agriculture Research Institute (ARI) Tandojam, during 2014. The land was prepared by giving 2 dry plowings; and when the land was ploughed up, the clods were crushed, and leveling of land was carried out to eradicate the weeds and to make the soil surface leveled for uniform distribution of irrigation water during soaking dose. Finally ridges were prepared according to the plan of work. The test was conducted using a randomized block design with three replications of each treatment. Plots were 8m long by 3m wide rows with one border row between treated plots. After soaking dose, the crop was planted by manually on ridges. Five Acaricides were applied to okra crop to evaluate their efficacy against mites. A single variety (Subz pari) of okra vegetable was grown. The following Acaricides were used to evaluate their efficacy against target pests on okra.

**Treatments and Doses (Acaricides)**

1. Polo (500SC)  2. Shogan (1.8EC)  3. Nissuran (72WP)  4. Oberon (24%SC)


The recommended doses of acaricides per acre were as below:

1. Polo (250ml), 2. Shogan (250ml)  3. Nissuran (250gm), 4. Oberon (100ml/100 liters of water) and 5. Ethion (500ml).

The recommended dose of NPK fertilizers was applied. The nitrogen was applied in the form of urea, phosphorus in the form of single super phosphate (SSP) and potash in the form of sulphate of potash (SOP). 1/3rd of N along with all P and K was applied at the time of land preparation and preparation of ridges by mixing in the soil, while the remaining N was divided into two equal doses and was applied with a fortnight interval after first harvest. The first
irrigation was applied after 10 days of sowing and subsequent irrigations at weekly intervals.

Acaricides were applied in 25 gal of water per hectare using TX-4 hollow cone nozzles. In all two sprays were carried out when it was felt that the insect population is crossing economic injury level. The population dynamics of the target insect pests, mites were counted visually using magnifying glass from five leaves per plant from five plants per replication per treated plot. Pretreatment observation were recorded one day before application and post treatment observations were recorded 2, 4, 6, & 15 days after application. Data from each plot were averaged and the plot means were analyzed using analysis of variance and least significant difference (LSD).

**RESULTS**

In order to test the efficacy of different acaricides against mites in okra, the studies were carried out during the Kharif season of 2014. The experimental crop was sown in the experimental Field of Entomology section, Agriculture Research Institute (ARI), Tandojam. The okra crop was sprayed by Polo, Shogan, Nissuran, Oberon and Ethion for control of mites on okra and the mites infestation and acaricide efficacy was compared by Control (untreated). Two sprays were carried out when the fast increase in the mite infestation was noted.

**First spray**

Before first spray of acaricides on okra, the pre-treatment count of mites on per leaf basis were recorded and the data showed that the mite population declined significantly after 2-days of first spraying acaricides (F=57.56; DF=17; P<0.05), 4-days after spray (F=73.97; DF=17, P<0.05), 6-days after spray (F=176.86; DF=17, P<0.05) and 15-days after spray (F=1369.13; DF=17, P<0.05); while non-significant for pre-treatment between pesticides (F=2.47; DF=17; P>0.05).

The data indicated that okra crop spraying with acaricide Oberon showed tremendous effect to suppress mites infestation and mite population was 2.81, 1.83, 0.99 and 0.24/leaf after 2, 4, 6 and 15 days of spray, respectively as compared to pre-treatment mite population of 4.33/leaf (Table-1); while the population of mites on okra crop sprayed with shogan was 3.18, 2.19, 1.34 and 0.42/leaf after 2, 4, 6 and 15 days of first spray, respectively as compared to pre-treatment population of 4.61/leaf. The population of mites on okra sprayed with Polo, Nissuran and Ethion after 14 days of first spray was 1.18/leaf, 1.13/leaf and 1.30/leaf, respectively as compared to 4.74/leaf, 4.57/leaf and 4.92/leaf, respectively. In control (untreated) plots, the mites population was in the range of 4.61/leaf to 5.21/leaf during 14 days after spray. It was observed that all the acaricides were found to be effective in reducing the mite population in okra. However, Oberon proved to be highly effective to suppress mite infestation maximally.

**Table-1. Mites population per leaf on okra as affected by various acaricides at different intervals after first spray.**

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Pre-treatment</th>
<th>Post-treatment observations / leaf after:</th>
<th>Efficacy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2 days</td>
<td>4 days</td>
</tr>
<tr>
<td>Polo</td>
<td>4.57</td>
<td>3.29 b</td>
<td>2.37 b</td>
</tr>
<tr>
<td>Shogan</td>
<td>4.61</td>
<td>3.18 b</td>
<td>2.19 a</td>
</tr>
<tr>
<td>Nissuran</td>
<td>4.74</td>
<td>3.46 c</td>
<td>2.53 b</td>
</tr>
<tr>
<td>Oberon</td>
<td>4.33</td>
<td>2.81 a</td>
<td>1.83 a</td>
</tr>
<tr>
<td>Ethion</td>
<td>4.92</td>
<td>3.64 c</td>
<td>2.69 b</td>
</tr>
<tr>
<td>Control</td>
<td>4.85</td>
<td>4.61 d</td>
<td>4.78 c</td>
</tr>
<tr>
<td>S.E.</td>
<td>0.1440</td>
<td>0.1141</td>
<td>0.1718</td>
</tr>
<tr>
<td>LSD 0.05</td>
<td>-</td>
<td>0.2542</td>
<td>0.3828</td>
</tr>
<tr>
<td>CV%</td>
<td>3.78</td>
<td>3.99</td>
<td>7.70</td>
</tr>
</tbody>
</table>

2nd spray

Pre-treatment and post-treatment population of mites on okra was recorded before second spray of acaricides on per leaf basis and the results indicated that the mite population diminished significantly after 2-days of second spray of acaricides (F=42.95; DF=17; P<0.05), 4-days after spray (F=127.00; DF=17, P<0.05), 6-days after spray (F=1853.03; DF=17, P<0.05) and 15-days after spray (F=12279.4; DF=17, P<0.05).
DF=17, \( P<0.05 \); while non-significant for pre-treatment between pesticides (\( F=1.28; \) DF=17; \( P>0.05 \)).

The results (Table-2) showed that okra crop spraying with acaricide Oberon displayed marvelous control of mites and mite population was 1.81, 1.09, 0.45 and 0.06/leaf after 2, 4, 6 and 15 days of spray, respectively as compared to pre-treatment mite population of 3.14/leaf; while the population of mites on okra crop sprayed with Shogan was 2.10, 1.45, 0.89 and 0.27/leaf after 2, 4, 6 and 15 days of second spray, respectively as compared to pre-treatment population of 3.52/leaf. The population of mites on okra sprayed with Polo, Nissuran and Ethion ranked 3\textsuperscript{rd}, 4\textsuperscript{th} and 5\textsuperscript{th} with 0.76/leaf, 0.79/leaf and 0.87/leaf after 14 days of second spray as compared to 3.65/leaf, 3.73/leaf and 3.83/leaf, respectively. In control (untreated) plots, the mites population was in the range of 3.62/leaf to 3.93/leaf during 14 days after spray. It was observed that all the acaricides were found effective in reducing the mite population in okra. However, Oberon displayed high performance with minimizing the mite population upto the negligible level.

Table-2. Mites population per leaf on okra as affected by various acaricides at different intervals after second spray.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Pre-treatment</th>
<th>Post-treatment observations / leaf after:</th>
<th>Efficacy %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2 days</td>
<td>4 days</td>
</tr>
<tr>
<td>Polo</td>
<td>3.65</td>
<td>2.22 b</td>
<td>1.60 b</td>
</tr>
<tr>
<td>Shogan</td>
<td>3.52</td>
<td>2.10 b</td>
<td>1.45 b</td>
</tr>
<tr>
<td>Nissuran</td>
<td>3.73</td>
<td>2.32 b</td>
<td>1.69 c</td>
</tr>
<tr>
<td>Oberon</td>
<td>3.14</td>
<td>1.81 a</td>
<td>1.09 a</td>
</tr>
<tr>
<td>Ethion</td>
<td>3.83</td>
<td>2.44 c</td>
<td>1.81 c</td>
</tr>
<tr>
<td>Control</td>
<td>3.87</td>
<td>3.71 d</td>
<td>3.62 d</td>
</tr>
<tr>
<td>S.E.</td>
<td>0.3370</td>
<td>0.1425</td>
<td>0.1115</td>
</tr>
<tr>
<td>LSD 0.05</td>
<td>-</td>
<td>0.3176</td>
<td>0.2485</td>
</tr>
<tr>
<td>CV%</td>
<td>11.39</td>
<td>7.17</td>
<td>7.28</td>
</tr>
</tbody>
</table>

**Efficacy (%)**

The efficacy of various acaricides against mites on okra was worked out on the basis of mite population after 14 days of each spray and pre-treatment counts of mites before each spray. The data regarding the efficacy of different pesticides against mites on okra is shown in Table-3 and it was noted that regardless the number of sprays, the acaricide Oberon resulted the highest efficacy of 94.52 and 98.01 percent after 1\textsuperscript{st} and 2\textsuperscript{nd} spray, respectively with overall average efficacy of 96.27 percent. Shogan ranked 2\textsuperscript{nd} in effectiveness with 91.00 and 92.00 percent efficacy after 14 days of 1\textsuperscript{st} and 2\textsuperscript{nd} sprays, respectively averaging 91.60 percent; while the efficacy of Polo, Nissuran and Ethion was 79.16, 78.74 and 77.21 percent efficacy, respectively. The results of the study indicated that Oberon ranked 1\textsuperscript{st} being most effective acaricide to control mites in okra, followed by Shogan; while Polo, Nissuran and Ethion showed sort of similarity in the effectiveness with slight variation.

Table-3. Comparative efficacy (%) of various acaricides against mites on okra after first and second spray.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>1\textsuperscript{st} spray</th>
<th>2\textsuperscript{nd} spray</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polo</td>
<td>75.32</td>
<td>79.16</td>
<td>77.24</td>
</tr>
<tr>
<td>Shogan</td>
<td>91.00</td>
<td>92.20</td>
<td>91.6</td>
</tr>
<tr>
<td>Nissuran</td>
<td>75.03</td>
<td>78.74</td>
<td>76.89</td>
</tr>
<tr>
<td>Oberon</td>
<td>94.52</td>
<td>98.01</td>
<td>96.27</td>
</tr>
<tr>
<td>Ethion</td>
<td>73.58</td>
<td>77.21</td>
<td>75.4</td>
</tr>
</tbody>
</table>
Average okra yield

The data regarding okra pod yield was gathered on weekly basis for 10 weeks period and the results (Table-4) indicated that pod yield was remarkably higher (8252 kg ha\(^{-1}\)) in plots sprayed with Oberon acaricide against mites; followed by the plots sprayed with Shogan (7588 kg ha\(^{-1}\)), Polo (7492 kg ha\(^{-1}\)), Nissuran (6994 kg ha\(^{-1}\)) and Ethion (6923 kg ha\(^{-1}\)) as compared pod yield of control (untreated) plots of 5960 kg ha\(^{-1}\). This indicated that Oberon acaricide resulted in more positive impact on the crop yield as compared to rest of the acaricides.

Table-4. Average pod yield (kg ha\(^{-1}\)) of okra as affected by different acaricides against okra mites

<table>
<thead>
<tr>
<th>Pesticides</th>
<th>1(^{st}) week</th>
<th>2(^{nd}) week</th>
<th>3(^{rd}) week</th>
<th>4(^{th}) week</th>
<th>5(^{th}) week</th>
<th>6(^{th}) week</th>
<th>7(^{th}) week</th>
<th>8(^{th}) week</th>
<th>9(^{th}) week</th>
<th>10(^{th}) week</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polo</td>
<td>456</td>
<td>802</td>
<td>983</td>
<td>1020</td>
<td>1102</td>
<td>1180</td>
<td>992</td>
<td>712</td>
<td>187</td>
<td>58</td>
<td>7492</td>
</tr>
<tr>
<td>Shogan</td>
<td>467</td>
<td>721</td>
<td>1004</td>
<td>1052</td>
<td>1130</td>
<td>1210</td>
<td>1017</td>
<td>734</td>
<td>193</td>
<td>60</td>
<td>7588</td>
</tr>
<tr>
<td>Nissuran</td>
<td>439</td>
<td>674</td>
<td>850</td>
<td>972</td>
<td>1059</td>
<td>1133</td>
<td>955</td>
<td>678</td>
<td>179</td>
<td>55</td>
<td>6994</td>
</tr>
<tr>
<td>Oberon</td>
<td>499</td>
<td>775</td>
<td>1065</td>
<td>1143</td>
<td>1211</td>
<td>1398</td>
<td>1088</td>
<td>798</td>
<td>210</td>
<td>65</td>
<td>8252</td>
</tr>
<tr>
<td>Ethion</td>
<td>435</td>
<td>667</td>
<td>843</td>
<td>960</td>
<td>1049</td>
<td>1122</td>
<td>946</td>
<td>670</td>
<td>176</td>
<td>55</td>
<td>6923</td>
</tr>
<tr>
<td>Control</td>
<td>361</td>
<td>571</td>
<td>721</td>
<td>701</td>
<td>916</td>
<td>971</td>
<td>902</td>
<td>618</td>
<td>158</td>
<td>41</td>
<td>5960</td>
</tr>
</tbody>
</table>

Income received (Rupees, ha\(^{-1}\))

The income received from the marketing of green pods of okra was worked out on the basis of actual marketing price of the okra edible green pods on weekly basis and the results (Table-5) indicated that the highest income of Rs. 167886 ha\(^{-1}\) was achieved from the plots sprayed with Oberon acaricides against mites; followed by the plots sprayed with Shogan (Rs. 154438 ha\(^{-1}\)), Polo (Rs. 152222 ha\(^{-1}\)), Nissuran (Rs. 142425 ha\(^{-1}\)) and Ethion (Rs. 140970 ha\(^{-1}\)) as compared to income of Rs. 121715 ha\(^{-1}\) from control plots.

Table-5. Income (Rs. ha\(^{-1}\)) of okra as affected by different acaricides against okra mites

<table>
<thead>
<tr>
<th>Pesticides</th>
<th>1(^{st}) week</th>
<th>2(^{nd}) week</th>
<th>3(^{rd}) week</th>
<th>4(^{th}) week</th>
<th>5(^{th}) week</th>
<th>6(^{th}) week</th>
<th>7(^{th}) week</th>
<th>8(^{th}) week</th>
<th>9(^{th}) week</th>
<th>10(^{th}) week</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polo</td>
<td>8664</td>
<td>14436</td>
<td>18677</td>
<td>20400</td>
<td>22040</td>
<td>22420</td>
<td>21824</td>
<td>17088</td>
<td>5049</td>
<td>1624</td>
<td>152222</td>
</tr>
<tr>
<td>Shogan</td>
<td>8873</td>
<td>12978</td>
<td>19076</td>
<td>21040</td>
<td>22600</td>
<td>22990</td>
<td>22374</td>
<td>17616</td>
<td>5211</td>
<td>1680</td>
<td>154438</td>
</tr>
<tr>
<td>Nissuran</td>
<td>8341</td>
<td>12132</td>
<td>16150</td>
<td>19440</td>
<td>21180</td>
<td>21527</td>
<td>21010</td>
<td>16272</td>
<td>4833</td>
<td>1540</td>
<td>142425</td>
</tr>
<tr>
<td>Oberon</td>
<td>9481</td>
<td>13950</td>
<td>20235</td>
<td>22860</td>
<td>24220</td>
<td>26562</td>
<td>23936</td>
<td>19152</td>
<td>5670</td>
<td>1820</td>
<td>167886</td>
</tr>
<tr>
<td>Ethion</td>
<td>8265</td>
<td>12006</td>
<td>16017</td>
<td>19200</td>
<td>20980</td>
<td>21318</td>
<td>20812</td>
<td>16080</td>
<td>4752</td>
<td>1540</td>
<td>140970</td>
</tr>
<tr>
<td>Control</td>
<td>6859</td>
<td>10278</td>
<td>13699</td>
<td>14020</td>
<td>18320</td>
<td>18449</td>
<td>19844</td>
<td>14832</td>
<td>4266</td>
<td>1148</td>
<td>121715</td>
</tr>
</tbody>
</table>

Additional income (Rupees ha\(^{-1}\)) received over control

The additional income was worked out by subtracting the income received in the control plots from the income received from the plots treated with various acaricides and the data is presented in Table-6. It was observed that the highest amount of additional income Rs. 46171 ha\(^{-1}\) was achieved from the plots sprayed with Oberon acaricide against mites; followed by an additional income of Rs. 32723 ha\(^{-1}\), Rs. 30507 ha\(^{-1}\) and Rs. 20710 ha\(^{-1}\) realized from the plots sprayed with Shogan, Polo, Nissuran and Ethion, respectively over control; while the lowest additional income of Rs. 19255 ha\(^{-1}\) was realized from the plots sprayed with acaricide Ethion as compared to control.
Table 6. Additional pod yield (kg ha⁻¹) and income (Rs. ha⁻¹) received from the plots sprayed with different acaricides over control

<table>
<thead>
<tr>
<th>Acaricides sprayed</th>
<th>Additional pod yield (kg ha⁻¹) received over control</th>
<th>Additional income (Rs ha⁻¹) realized over control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polo</td>
<td>1532</td>
<td>30507</td>
</tr>
<tr>
<td>Shogan</td>
<td>1628</td>
<td>32723</td>
</tr>
<tr>
<td>Nissuran</td>
<td>1034</td>
<td>20710</td>
</tr>
<tr>
<td>Oberon</td>
<td>2292</td>
<td>46171</td>
</tr>
<tr>
<td>Ethion</td>
<td>963</td>
<td>19255</td>
</tr>
</tbody>
</table>

**DISCUSSION**

Okra is a vegetable liked by rich and poor alike; while this crop is infested by many insect pests including mites and are among the most diverse and successful of all the invertebrate groups; they have exploited an incredible array of habitats (Halliday et al., 2000). The mites are highly host specific and have only been recorded on plants of Malvaceae family. Damage of mites on okra, another member of the Malvaceae plant family has been reported in other countries (Heethoff and Koerner, 2007). Specific insecticides have been developed for controlling mites and generally these named as Acaricides (Klenerman and Lipworth, 2008).

The findings of the present research indicated that all the acaricides tested were effective to control mite population in okra and after 15 days of 1st and 2nd spray, Oberon resulted in the highest efficacy of 94.52 and 98.01 percent, respectively with overall average efficacy of 96.27 percent. Shogan ranked 2nd in effectiveness with 91.00 and 92.00 percent efficacy after 15 days of 1st and 2nd sprays, respectively averaging 91.60 percent; while the efficacy of Polo was 75.32 and 79.16 percent averaging 77.24 percent, Nissuran displayed efficacy of 75.03 and 78.74 percent averaging 76.89 percent and the efficacy of Ethion after 15 days of 1st and 2nd spray was 73.58 and 77.21 percent averaging 75.40 percent, respectively. The highest amount of additional income Rs. 46171 ha⁻¹ was achieved from the plots sprayed with acaricide Ethion as compared to control. These results are further supported by the studies of Halliday et al. (2000) who concluded that application of acaricides against mites protects the crop throughout the season and more frequent sprays may be needed during the main growth period. Elbert et al. (2005) reported that Oberon (spiromesifen) with excellent activity against spider mites in vegetables and field crops in USA. Oberon is a valuable tool for mite control and for resistance management. Kumar and Singh (2005) reported that Omite @ 2 ml/l alone proved significantly best in control of mites (T. urticae and T. neocacedonicus) on okra but addition of Dhanuvit @ 1 ml/l (a surfactant) enhanced the efficacy of mite culminating in the Ethionity of mites 94.88, 98.77, 90.99 and 71.20 per cent on okra after 1, 3, 7 and 10 days, respectively. Ethion and Phosalone were found only moderately effective and NSKE, gronim and sulphur have shown very poor control at Varanasi. Nauen and Konanz (2005) reported that spiromesifen was highly active against tetranychid mite, T. urticae by contact. The product was shown to have similar or even superior efficacy compared to many commercial standards. Similarly, Varadaraju (2010) The higher fruit yield of 17.59 t/ha was recorded in abamectin 1.9 EC with highest cost benefit ratio of 1: 4.80. The next best treatments were diafenthiuron 50 WP (17.15 t/ha) and fenazaquin 10 EC (16.15 t ha⁻¹). The standard check i.e., dicofol recorded 14. 83 tons fruit yield per ha.

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SCREENING THE VARIETIES OF BRINJAL AGAINST PESTS AND THEIR NATURAL ENEMIES

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ABSTRACT

The experiment on screening of the brinjal varieties against pests and their natural enemies was carried out at Latif Farm of SAU, Tandojam. Nine varieties viz Long-12, Zar-1, Sarwan, Hybrid eggplant, Long botanist, Round Pakistan, Dil nashhen, Purple king and Tarnab of brinjal varieties were grown on one acre of land. The results showed that less whitefly mean population of (7.70± 0.80) per plant was found on Long-12 whereas Zar-1 received maximum whitefly population (10.19 ± 0.92). Minimum mean population was observed in Long-12 (5.58± 0.77) per plant. Comparatively proved resistant whereas Dil nasheen received maximum population of jassid (8.32 ± 0.83) Minimum Mites mean population were recorded in Tarnab (2.34±0.32) per plant comparatively resistant whereas, maximum mean number was recorded on Sarwan (3.77±0.39). The minimum mean population of Maxican Bean beetle was recorded in Long botanist ( 0.37 ± 0.06) per plant and maximum population was found on Zar-1( 1.21 ± 0.21) . The less population of fruit borer was recorded in Long-12 (19.39 ± 1.56) per plant and maximum mean population was recorded on Dil nasheen variety (32.07 ± 2.02%) and. Spider (natural enemies) was found on Round Pakistani (1.36 ± 0.31) per plant. And maximum population on Zar-1 having mean (1.80 ± 0.28) per plant and minimum population Brumus suturalis was recorded on Hybrid egg plant (0.36± 0.24) per plant and Maximum overall mean number of (0.63 ± 0.23) per plant was recorded on Zar-1

Key notes. Screening, Varieties, Pest, Natural Enemies, Eggplant

INTRODUCTION

Brinjal (egg plant) is one of the most important vegetable crops. It is widely consumed by all sections of the population in the world. Though egg plant is a summer crop, it is being grown throughout the year under irrigated condition. Hence, the numbers of insect pests attack right from nursery stage till harvesting (Regupathy et al., 1997). The highest production of eggplant is shown with 93 percent of output coming from seven countries. Eggplant is grown on over 678,000 ha, which is about 37% of the world eggplant area, with a production of 10.50 million ton (FAO, 2007). The crop seedlings are mostly transplanted in March to April and remain on fruiting till October. Due to long cropping season the crop is exposed to the attack of a huge number of different insect pests, which losses their yield and growth. Brinjal, (Solanum melongena L.) is the most important vegetable and usually it’s grown more than 5 lack hectares in India producing 8.2 million tons annually only next to China. A horde of insect pests attack this crop due to cultivation throughout the year, out of which brinjal shoot/fruit borers (Leucinodes orbonalis Guenee, Pyralidae: Lepidoptera) is most serious pest (Sardana et al., 2004). Eggplant contains 92.7% water, 1.1% Protein and 0.02% Carbohydrate. The fuel of calories is 13016 and it rich from vitamin A and B (Shanmugavelu, 1989).

Crop infested many insect pests and suffer economic loss to the marketable yield. Among the insect pests infesting eggplants, the major ones are fruit borer, Leucinodes orbonalis (Guen.), whitefly, Bemicia tabaci (Genn.), leafhopper, Amrasca biguttula biguttula (Ishida), Epilachna beetle, Henosepilachna vigintioctopunctata (Fab.) and non-insect pest, red spider mite, Tetramychus macfurlanei. The brinjal fruit borer, L. orbonalis is considered the main constraint as it damages the crop throughout the year and damage in early vegetative growth of fruit. This pest is found
from all brinjal growing areas of the world (Eswara and Srinivasa, 2001). The yield loss of brinjal due to the pest is to the extent of 70-92 percent (Eswara Reddy and Srinivas, 2004; Khuhrro et al; 2011) Screening of brinjal cultivars against insect pests has been attempted by several workers in India. However, the cultivars available in particular region need to be screened and efforts were made to determine the biochemical basis of resistance in selected brinjal entries against shoot and fruit borer, Leucinodes orbonalis Guen and other pests. Therefore, it was required to conduct the present investigations.

MATERIALS AND METHOD

The present research work on screening of the different varieties of brinjal against pests and their natural enemies was carried out at Latif Farm of Sindh Agriculture University Tandojam on during 2013. Nine varieties viz Long-12, Zar-1, Sarwan, Hybrid Eggplant, Long Botanist, Round Pakistani, Dilnasheen, Purple King and Tarnab of brinjal varieties were grown. The each varieties was grown separately in a plot size of 60×60 sq ft. the growing varieties of the brinjal was done in 1st week of August 2013. The weekly observations were recorded from September to December. The population of pests jassid, whitefly, mite, Mexican beetle and fruit/shoot borer along with their natural enemies spiders and coccinellid beetles were recorded till harvest. Ten plants and 5 leaves/plants were observed randomly at weekly intervals. Predators (spider’s and coccinellids) per plant were recorded. The ANOVA of data was done and correlations with temperature and humidity was determined through statistically program.

RESULTS

Whitefly: Bemisia tabacci (Gennadius)

The data in the table-1 indicate that all the varieties were infested by the pest whitefly. Maximum mean numbers of whitefly were recorded during first two week of September with range of 12.84 to 16.63 per plant on all varieties. There after the whitefly population declined on all varieties. With regards the varieties maximum over all mean population was recorded on Zar-1(10.19± 0.92) per plant followed by Hybrid eggplant (9.88± 0.90), Long botanist (9.86± 0.91), Dilnasheen (9.05± 0.86), Sarwan (8.83± 0.85), Round Pakistani (8.01± 0.81), , Purpal King and Tarnab (7.70± 0.80) and Long-12 (7.24± 0.77). ANOVA results showed that treatments mean of all varieties were found non-significant at 0.05 level indicating that almost whitefly population behind similar on all varieties of brinjal. The mean of whitefly with temperature showed positive correlation ($r^2$ =0.0092) and positive correlation ($r^2$ = 0.0122) with R.H%. Weekly population of White flies per plant on different varieties of brinjal.

Jassids: Amrasca bigutulla bigutulla (Ishida)

The data in the table-2 indicate that all the varieties were infested by the pest jassid. The jassid population increase gradually from September to 1st week October on all varieties. There after jassid population reached its peak (10.46- 11.62) per plant during the 3rd week of October to 1st week of November. Again population declined (7.79-9.11) upto harvest on all varieties. With regards the varieties attacks maximum over all mean was recorded on Tarnab variety (8.32 ± 0.83) per plant followed by Dilnasheen (8.10±0.85), Purpal King (7.87± 0.87), Sarwan (7.80±0.82) Zar-1(7.31±0.81), Hybrid eggplant (7.19±0.86), Long botanist (6.80± 0.73), Round Pakistani (6.63±0.86) and Long-12 (5.58± 0.77) per plant. ANOVA of jassid data showed that treatments mean of all varied significantly from each other (0.000) at 0.05 levels. The correlation of jassid with temperature was significant ($r^2$=0.3553) and with R.H% was non-significant and negative with ($r^2$= 0.295) value.

Mites: Tetranychus spp:

The data in table 3 reveals that all brinjal varieties harboured units round the season. However, maximum mean numbers on all varieties were (3.83- 8.09) per plant during
month of September. There after the population declined and continued up to harvest. With regards to mite population on different varieties the maximum mean number was recorded on Sarwan (3.77±0.39) per plant followed by Round Pakistani (3.46±0.58), Zar-1 (3.24±0.50), Dinhasheen (2.96±0.52), Long-12 (2.95±0.57), and (2.84±0.35) Long Botnist, (2.83±0.51), Hybrid egg plant (2.82±0.45) and Tarnab (2.34±0.32) per plant. The ANOVA results showed that varietal mean varied significantly at (P=0.05) levels. The correlation between mite population and tempreture was non-significant and positive with R.H % was non-significant and negative with $r^2=0.0005$ value.

**Mites: Tetranychus spp:**

The data in table 3 reveals that all brinjal varieties harboured units round the season. However, maximum mean numbers on all varieties were (3.83- 8.09) per plant during month of September. There after the population declined and continued up to harvest. With regards to mite population on different varieties the maximum mean number was recorded on Sarwan (3.77±0.39) per plant followed by Round Pakistani (3.46±0.58), Zar-1 (3.24±0.50), Dinhasheen (2.96±0.52), Long-12 (2.95±0.57), and (2.84±0.35) Long Botnist, (2.83±0.51), Hybrid egg plant (2.82±0.45) and Tarnab (2.34±0.32) per plant. The ANOVA results showed that varietal mean varied significantly at (P=0.05) levels. The correlation between mite population and tempreture was non-significant and positive with R.H % was non-significant and negative with $r^2=0.0005$ value.

**Epilachna varivestis (Mulsant)**

The data in table 4 indicates all the varieties harbored the pests attacks. The variety means remaind higher with a range (0.75-1.78) per plant in the month of September. Than the population declined up to harvest on all the varieties with regard to varietal behaviour of maxican bean beetles . maximum mean was recorded on Zar-1( 1.21 ± 0.21) per plant followed by long-12 ( 0.81 ± 0.21) , Sarwan (0.72 ± 0.21) , Purple king (0.69 ± 0.71), Round pakistani ( 0.61 ± 0.20) , Hybrid egg plant (0.60 ± 0.12) Tarnab (0.52 ± 0.09 ) , Dil Nasheen (0.46 ± 0.12) and logn botnist ( 0.37 ± 0.06). The ANOVA of data showed that varietal mean were statically deffirent at (P= <0.05) level and 4 different groups i-e A,AB,BC and C were formed the co relation in between mean population with temperature was non-significant and positive with $r^2=0.3416$ value. Similarly the co relation between R.H % with mean population was non-significant and positive with $r^2=0.0880$ value.

**Jassids: Anrasca bigutulla bigutulla (Ishida)**

The data in the table-2 indicate that all the varieties were infested by the pest jassid. The jassid population increase gradually from September to 1st week October on all varieties. There after jassid population reached its peak (10.46- 11.62) per plant during the 3rd week of October to 1st week of November. Again population declined (7.79-9.11) upto harvest on all varieties. With regards the varieties attacks maximum over all mean was recorded on Tarnab variety (8.32 ± 0.83) per plant followed by Dil nasheen (8.10±0.85), Purpal King (7.87± 0.87), Sarwan (7.80±0.82) Zar-1(7.31±0.81), Hybrid eggplant (7.19±0.86), Long botanist (6.80± 0.73), Round Pakistani (6.63±0.86) and Long-12 (5.58± 0.77) per plant. ANOVA of jassid data showed that treatments mean of all varied significantly from each other (0.000) at 0.05 levels. The correlation of jassid with temperature was significant ($r^2=0.3553$) and with R.H % was non-significant and negative with ($r^2= 0.295$) value.

**FRUIT BORER Leucinodes orbanalis K.**

The data in table no 05 indicates that the fuit borer infestation was recorded in all the varieties of brinjal. However, maximum infestation % was recorded in the month of November. The picking of fruits at the experimental from was
continuous therefore the healthy and infested fruits varied during October and November with regards two varietal behavior two fruit borer infestation % maximum infestation was recorded in Dil Nasheen with mean of (32.07 ± 2.02%) followed by the Round Pakistani (29.80 ± 1.93 %) Purple King (29.78 ± 1.93 %) Sarwan (29.73 ± 1.93) Long Botanist (29.44 ± 1.92%) Zar-1 (28.73 ± 1.90) Hybrid Eggplant (26.17 ± 1.81%) Tarnab (23.36 ± 1.71 %) and Long-12 (19.39 ± 1.56 5). The ANOVA of data short that treatment varietal mean varied significantly at (P=0.05) level. The co-relation between mean % infestation of fruit borers with temperatures was significant and negative with (r² = 0.8159) value and with R.H % was non-significant and negative with r² = 0.0425 value.

Natural Enemies (Unidentified spiders)

The spider’s (undefined) appeared one month after sowing when pests were present already on the crop. The data in table 8 indicate that (0.52 – 1.03) per plant on all varities were recorded there after the numbers increased (1.05 – 2.44 ) per plant during month of october and declined during november with a range of (1.54 – 1.78 ) per plant on all varities of brinjal. The ANOVA results showed that maximum numbers of spiders of was recorded on Zar-1 with mean of with mean of (1.80 ± 0.28) per plant followed by the long-12 (1.66 ± 0.35) Dil Nasheen (1.60 ± 0.34) Sarwan (1.59 ± 0.38) Tarnab (1.55 ± 0.36 ) Purple King (1.52 ± 0.38) Long Botnist (1.47 ± 0.33 ) Hybrid egg plant (1.44 ± 0.35 ) and round pakistani (1.36 ± 0.31) per plant. The ANOVA of data revealed that population on all varieties varied significantly at (P=0.05) level. The correlation between mean population of spiders and temperature was significant and negative with (r² = 0.1077) value Simillarly the correlation with R.H% was non-significant and negative with r² = 0.0542 value.

Lady bird beetle. Brumus suturalis F

The data in table-7 reveal that appeared on the pest s of all the varieties in the month of September. The mean numbers increased in October to November with a range of (0.37-0.85) per plant. Maximum overall mean number of (0.63 ± 0.23) per plant was recorde on Zar-1 Followed by Dil nasheen (0.55± 0.26), Tarnab (0.50± 0.20), Long-12 (0.46± 0.23), Purple king (0.48± 0.26), long botnist (0.47± 0.23), Sarwan (0.45± 0.25), Round Pakistani (0.44± 0.21) and Hybrid egg plant (0.36± 0.24) per plant. The ANOVA of data showed on all varities varied significantly at (P= 0.05) level. The correlation between coccinellids beetle and temperature was significant and negative with R.H% was non-significant and negative with r² = 0.0579 value.

DISCUSSION

The results on seasonal population of whitefly averages through ANOVA showed that there population of whitefly were non-significant. The results further showed that varieties Purple king and Tarnab (7.70± 0.80) per plant varities were found comparatively resistance varities followed by the Long-12 (7.24 ) round pakistani (8.01 ± 0.81) where as Zar-1 (10.19 ± 0.92 ) Hybrid eggplant , long botnist (9.86 ± 0.90) , Dil Nasheen (9.05 ± 0.86 ) were found susceptible .the white fly population remained higher on all varities with means 12.84 – 16.63 per plant during 1st second weeks of Sept 28.11 – 30.86 and lower varities means of (5.49 – 8.66) at 22.63 – 24.43 °C indicating mature broad leaves short positive correlation the results of present study agree with those of Akram et al. 2013 who reported that maximum and minimum temperature short significant positive effect on white fly population.
Table 1: Weekly means population of whitefly on different brinjal varieties

<table>
<thead>
<tr>
<th>Dates Observation:</th>
<th>V1 Long-12</th>
<th>V2 Zar-1</th>
<th>V3 Sarwan</th>
<th>V4 Hybrid egg plant</th>
<th>V5 Long botanist</th>
<th>V6 Roun</th>
<th>V7 Dil Nasheen</th>
<th>V8 Purple</th>
<th>V9 Tarnab</th>
<th>Varietal Means</th>
<th>Temp °C</th>
<th>RH%</th>
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<tbody>
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<td>Sep: 1st week</td>
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<td>5.90</td>
<td>8.54</td>
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<td>30.81</td>
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<td>7.50</td>
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<td>6.69</td>
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Table 2 Weekly mean population of jassid per plant on different varieties of brinjal.

<table>
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<tr>
<th>Dates Obs:</th>
<th>V1 Long-12</th>
<th>V2 Zar-1</th>
<th>V3 Sarwan</th>
<th>V4 Hybrid egg plant</th>
<th>V5 Long botanist</th>
<th>V6 Roun Pakistani</th>
<th>V7 Dil Nasheen</th>
<th>V7 Purple king</th>
<th>V9 Tarnab</th>
<th>Varietal Mean</th>
<th>Temp °C</th>
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<td>0.52</td>
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<td>1.99</td>
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<td>55.25</td>
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<td>1.00</td>
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<td>3.96</td>
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<td>3.92</td>
<td>2.71</td>
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<td>5.81</td>
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<td>7.80</td>
<td>21.75</td>
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</table>

Mean±S.E

| | 5.58±0.77 | 7.31±0.81 | 7.80±0.82 | 7.19±0.86 | 6.80±0.73 | 6.63±0.86 | 8.10±0.85 | 7.87±0.87 | 8.32±0.83 | 7.29±0.82 | 27.43±1.45 | 58.90±2.12 |
Table 2 Weekly mean population of jassid per plant on different varieties of brinjal.

<table>
<thead>
<tr>
<th>Dates Obs:</th>
<th>V1</th>
<th>V2</th>
<th>V3</th>
<th>V4 Hybrid egg plant</th>
<th>V5 Long botanist</th>
<th>V6 Roun</th>
<th>V7 Dil Nasheen</th>
<th>V7 Purple king</th>
<th>V9 Tarnab</th>
<th>Varietal Mean</th>
<th>Temp °C</th>
<th>RH%</th>
</tr>
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<td>2.41</td>
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<td>4.67</td>
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<td>10.72</td>
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<td>52.75</td>
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</tr>
<tr>
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<td>7.60</td>
<td>7.41</td>
<td>8.31</td>
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<td>11.61</td>
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<td>79.71</td>
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<tr>
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<td>9.61</td>
<td>7.80</td>
<td>21.75</td>
<td>48.25</td>
</tr>
</tbody>
</table>

Mean±S.E

5.58±0.77 | 7.31±0.81 | 7.80±0.82 | 7.19±0.86 | 6.80±0.73 | 6.65±0.86 | 8.10±0.85 | 7.87±0.87 | 8.3±0.83 | 7.29±0.82 | 27.4±4.5 | 58.9±6.12
Table- 4 Weekly population of Maxican bean beetle per plant on different varieties of brinjal.

<table>
<thead>
<tr>
<th>Dates Obs:</th>
<th>V1 Long-12</th>
<th>V2 Zar-1</th>
<th>V3 Sarwan</th>
<th>V4 Hybrid egg plant</th>
<th>V5 Long botanist</th>
<th>V6 Roun Pakistani</th>
<th>V7 Dil Nasheen</th>
<th>V7 Purple king</th>
<th>V9 Tarnab</th>
<th>Overall Mean</th>
<th>Temp °C</th>
<th>RH%</th>
</tr>
</thead>
<tbody>
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<td>1.05</td>
<td>0.79</td>
<td>0.31</td>
<td>0.69</td>
<td>28.11</td>
<td>55.25</td>
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<td>0.19</td>
<td>0.96</td>
<td>0.54</td>
<td>1.69</td>
<td>0.60</td>
<td>1.78</td>
<td>30.13</td>
<td>62.25</td>
</tr>
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<td>1.33</td>
<td>1.66</td>
<td>1.32</td>
<td>1.46</td>
<td>0.56</td>
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<td>1.34</td>
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<td>0.81</td>
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<td>0.69</td>
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<td>0.56</td>
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<td>0.69</td>
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<td>0.29</td>
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</table>

Mean±S.E

| Mean±S.E | 0.8±0.21 | 1.2±0.21 | 1.2±0.21 | 0.7±0.21 | 0.6±0.12 | 0.3±0.06 | 0.6±0.20 | 0.4±0.12 | 0.6±0.17 | 0.5±0.09 | 0.6±0.16 | 27.4±1.45 | 58.9±2.12 |
|-----------|---------|---------|---------|---------|--------|--------|--------|--------|--------|--------|--------|---------|-----------|-----------|
Table 5 Percentage of Fruit borer infestation on Eggplant Fruit.

<table>
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<tr>
<th>Dates Obs:</th>
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<th>V2 Zar-1</th>
<th>V3 Sarwan</th>
<th>V4 Hybrid eggplant</th>
<th>V5 Long botanist</th>
<th>V6 Round Pakistani</th>
<th>V7 Dil Nasheen</th>
<th>V7 Purple king</th>
<th>V9 Tarnab</th>
<th>Overall Mean</th>
<th>Temp °C</th>
<th>RH%</th>
</tr>
</thead>
<tbody>
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<td>-</td>
<td>-</td>
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<td>-</td>
<td>-</td>
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<td>-</td>
<td>28.11</td>
<td>55.25</td>
</tr>
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<td>62.25</td>
</tr>
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<td>63.71</td>
</tr>
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<td>-</td>
<td>-</td>
<td>-</td>
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<td>64.87</td>
</tr>
<tr>
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<td>5.26</td>
<td>11.84</td>
<td>30.81</td>
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<td>23.06</td>
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<td>12.9</td>
<td>12.12</td>
<td>10.78</td>
<td>19.35</td>
<td>14.59</td>
<td>30.18</td>
<td>64.12</td>
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<td>8.16</td>
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<td>14.58</td>
<td>11.43</td>
<td>28.0</td>
<td>43.12</td>
</tr>
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<tr>
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<td>44.73</td>
<td>41.93</td>
<td>55.18</td>
<td>22.63</td>
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</tr>
<tr>
<td>Mean±S.E</td>
<td>19.39±1.56</td>
<td>28.73±1.90</td>
<td>29.73±1.93</td>
<td>26.17±1.81</td>
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</table>
Screening the Varieties of Brinjal Against Pests and their Natural Enemies

Table 6: Weekly means population of spiders on different varieties of brinjal

<table>
<thead>
<tr>
<th>Dates Obs:</th>
<th>V1 Long-12</th>
<th>V2 Zar-1</th>
<th>V3 Sarwan</th>
<th>V4 Hybrid egg plant</th>
<th>V5 Long botanist</th>
<th>V6 Roun Pakistani</th>
<th>V7 Dil Nasheen</th>
<th>V7 Purple king</th>
<th>V9 Tarnab</th>
<th>Mean</th>
<th>Temp °C</th>
<th>RH%</th>
</tr>
</thead>
<tbody>
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<td>0.58</td>
<td>0.58</td>
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<td>28.11</td>
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<td>1.23</td>
<td>1.03</td>
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<td>64.87</td>
</tr>
<tr>
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<td>1.62</td>
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<td>2.91</td>
<td>2.00</td>
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<td>1.06</td>
<td>1.33</td>
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<td>2.11</td>
<td>1.76</td>
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<td>1.90</td>
<td>1.60</td>
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<td>1.73</td>
<td>1.54</td>
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Table- 7 Weekly mean population of lady bird beetle on different varieties of brinjal

<table>
<thead>
<tr>
<th>Dates Obs:</th>
<th>V1 Long-12</th>
<th>V2 Zar-1</th>
<th>V3 Sarwan</th>
<th>V4 Hybrid egg plant</th>
<th>V5 Long botanist</th>
<th>V6 Roun Pakistani</th>
<th>V7 Dil Nasheen</th>
<th>V7 Purple king</th>
<th>V9 Tarnab</th>
<th>Mean</th>
<th>Temp °C</th>
<th>RH%</th>
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<td>0.05</td>
<td>0.50</td>
<td>0.50</td>
<td>0.31</td>
<td>0.12</td>
<td>0.28</td>
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<td>0.05</td>
<td>0.20</td>
<td>0.05</td>
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<td>30.13</td>
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<td>0.21</td>
<td>0.34</td>
<td>0.46</td>
<td>0.14</td>
<td>0.29</td>
<td>30.86</td>
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<td>0.05</td>
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<td>0.40</td>
<td>0.24</td>
<td>0.50</td>
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<td>0.87</td>
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<td>0.60</td>
<td>0.50</td>
<td>28.0</td>
<td>43.12</td>
</tr>
<tr>
<td>Nov: 1st week</td>
<td>0.60</td>
<td>0.50</td>
<td>0.70</td>
<td>0.37</td>
<td>0.97</td>
<td>0.45</td>
<td>0.57</td>
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<td>0.85</td>
<td>0.61</td>
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<tr>
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<td>0.92</td>
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</tr>
<tr>
<td>3rd week</td>
<td>0.80</td>
<td>0.60</td>
<td>0.58</td>
<td>0.91</td>
<td>0.84</td>
<td>0.72</td>
<td>0.80</td>
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<td>1.45</td>
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<tr>
<td>4th week</td>
<td>0.70</td>
<td>0.70</td>
<td>0.83</td>
<td>0.73</td>
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<td>0.60</td>
<td>0.89</td>
<td>0.90</td>
<td>0.50</td>
<td>0.73</td>
<td>22.63</td>
<td>54.25</td>
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</table>
Scening the Varieties of Brinjal Against Pests and their Natural Enemies

**Scatter Plot of Whitefly vs Temperature**

- $r^2 = 0.0092$
- $P = 0.7670$ (P< 0.05)

**Scatter Plot Whitefly vs R.H%**

- $r^2 = 0.0122$
- $P = 0.7329$ (P< 0.05)

Fig: No. 1 Regression analysis between Whitefly vs Temperature

Fig: No. 1. Correlation Analysis Between Whitefly Vs R.H%
Screeing the Varieties of Brinjal Against Pests and their Natural Enemies

r^2 = 0.3553
P = 0.0408 (P < 0.05)

r^2 = 0.0295
P = 0.5934 (P < 0.05)
Screeing the Varieties of Brinjal Against Pests and their Natural Enemies

Scatter Plot of Mites vs Temperature

$r^2 = 0.0362$
$P = 0.5539 (P < 0.05)$

$r^2 = 0.0005$
$P = 0.9433 (P < 0.05)$

Fig: No. 1 Regression analysis between Mites vs Temperature

Scatter Plot of Mites vs R.H%

$r^2 = 0.0005$
$P = 0.9433 (P < 0.05)$

Fig: No. 1 Regression analysis between Mites vs R.H%
Screeing the Varieties of Brinjal Against Pests and their Natural Enemies

Scatter Plot of Maxican Beetle vs Temp:

$r^2 = 0.5845$
$P = 0.0460 (P < 0.05)$

Mean Population of Maxican Beetle

Fig: No. 1 Regression analysis between Maxican Beetle vs Temperature

Scatter Plot of Maxican Beetle vs R.H%

$r^2 = 0.2966$
$P = 0.3492 (P < 0.05)$

Mean Population of Maxican Beetle

Fig: No. 1 Regression analysis between Maxican Beetle vs R.H%
Sceening the Varieties of Brinjal Against Pests and their Natural Enemies

Scatter Plot of Borers vs Temperature

Fig: No. 1 Regression analysis between Fruit/Shoot Borers vs Temperature

Scatter Plot of Borers vs R.H%

Fig: No. 1 Regression analysis between Fruit/Shoot Borers vs R.H%
Scanning the Varieties of Brinjal Against Pests and their Natural Enemies

Scatter Plot of Spider vs Temperature

\[ r^2 = -0.3282 \]
\[ P = 0.2976 \text{ (P < 0.05)} \]

Fig: No. 1 Regression analysis between Spider vs Temperature

Scatter Plot of Spider vs R.H%

\[ r^2 = -0.2267 \]
\[ P = 0.4786 \text{ (P < 0.05)} \]

Fig: No. 1 Regression analysis between Spider vs R.H%
Screening the Varieties of Brinjal Against Pests and their Natural Enemies

Scatter Plot of Coccinellid vs Temperature

- $r^2 = -0.8553$
- $P = 0.0004$ (P < 0.05)

Mean Population of Coccinellid Beetles

Fig: No. 1 Regression analysis between Coccinellid Beetles vs Temperature

Scatter Plot of Coccinellid vs R.H%

- $r^2 = -0.2406$
- $P = 0.4512$ (P < 0.05)

Mean Population of Coccinellid Beetles

Fig: No. 1 Regression analysis between Coccinellid Beetles vs R.H%
Whereas relative humidity exerted negative effective during 2010 with regards to thrip population on brinjal varieties on ANOVA result indicate nonsignificant and negative correlation with temperature. The study further showed that variety Dil Nasheen receive minimum mean of \(1.42 \pm 0.26\) followed by long-12 \((1.51 \pm 0.29)\) and Sarwan \((1.52 \pm 0.16)\) were found comparatively resistance and varieties with maximum population purple King \((1.84 \pm 0.29)\), Turnab \((1.76 \pm 0.30)\) and Zar-1 \((1.70 \pm 0.29)\) receive maximum population and found comparatively susceptible however maximum mean population of \((1.83-3.92)\) were recorded during first three weeks of September. With higher temperatures of 28.11 – 30.86°C therefore at could be inferred that varieties Dil Nasheen, Long12, and Sarwan were comparatively resistance whereas purple king, Turnab and Zar-1 were found comparatively susceptible the result of present study partially agree with those of Shivanna et al. (2011) who reported that simple correlation analysis revealed that maximum temperature showed significant positive effect on all the sucking pests on different varieties of brinjal. However, from present studies it could be concluded that Dil nasheen and long twelve proved comparatively resistance to purple king and turnab found comparatively susceptible varieties thrips Jassid the ANOVA of relative infestation of jassid on brinjal varieties on revealed that the jassid means on all varieties were significant and negatively correlated with temperature and R.H % the results of present study agree with those of Shivanna (2011). The results further revealed that variety long-12, Round Pakistani and long botanist received minimum jassid population and proved comparatively resistance than all other brinjal varieties which received maximum jassid population and comparatively susceptible.

The Anova results of mite population on different brinjal varieties non significant and positively correlated with temperature and negatively correlated with R.H %. The study further showed that varieties Zar-1, Purple king and Hybrid eggplant received minimum mite population therefore it could be inferred that these varieties comparatively resistance to the mites than all others tested varieties. The results of present should agree with those of Khuhro and Shahajahan. Who reported that maximum temperature had significant positive correlation \((r = 0.701)\) with two sported spider population dynamic where as relative humidity and rainfall had negative correlation \((r = -0.47)\).

The studies showed that all varieties received the attack of maxican beetle through period under study maximum attack was \((0.69-1.78)\) per plant during September when weekly temperature ranged between 28.11-30.91°C. There after the population decreased with decrease in temperature and maturity of leaves. Comparatively variety Long botanist \((0.37\pm0.06)\) per plant, Dilnasheen \((0.46\pm0.12)\) and Tarnab variety \((0.52\pm0.09)\) were found resistant to the pest whereas as varieties Zar-1 \((1.21\pm0.21)\) and Long-12 \((0.81\pm0.21)\) received maximum mean number of the Beetle and were comparatively susceptible. The positive and significant correlation between mean population and temperature was found with \(r^2 = 0.3416\).

The ANOVA of percentage attack of fruit borer indicate negative and significant correlation with \(r^2 = 0.0333\) values the pest population caused attack to all the varieties during advanced age of brinjal varieties when fruit varieties when fruits were formed in October and November. Least attack was recorded on Long-12 \((0.77\pm0.34)\) and Hybrid egg plant \((0.88\pm0.37)\) and Tarnab \((0.97\pm0.39\%)\) proved comparatively resistant varieties comparatively susceptible varieties were Long botanist \((1.21\pm0.50\%)\), Sarwan \((1.14\pm0.43\%)\) and Purple king with mean attack of \((1.06\pm0.49\%)\) per plant.

The study showed that the pre dominant natural enemy unidentified spider walking on ground and plants, webs formed by the spiders were on
plants. Spider’s population was recorded on all the varieties of brinjals. Immediately the spider population was (0.25±1.03) per plant on all varieties in the month of September. Later on, their population increased due more pests and lush green bigger brinjal plants in October to November. Maximum number of spiders was (1.80±0.28) per plant on Zar-1 and (1.66±0.35) on Long-12 and (1.60±0.34) per plant on Dil nashhen and least number (1.36±0.31) per plant on Round Pakistani variety. Significant and negative correlation was found between temperature and spider population with \( r^2 = 0.1077 \). The results of study agree with those of Khuhro and Shahjahan who recorded different spiders and species and found that spiders os Hippasa ageleoides, Cheiracanthum danieli reported whitefly, thrips, mites and jassids under laboratory.

**RECOMMENDATIONS:**

In view of the present studies, it is suggested that long-12 variety should be cultivated against sucking and chewing pests.

**REFERENCES**


**PSEUDOSUBHIMALUS BICOLOR** (PRUTHI, 1936) (CICADELLIDAE: DELTOCEPHALINAE: ATHYSANINI) FROM PAKISTAN

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(Received for publication 23-10-2015)

**ABSTRACT**

Potato pest *Pseudo subhimalusbicolor* (Pruthi, 1936) is presented here with new locality, images of habitus and genitalial parts are given, current distributional map is also provided.

**Key words:** *Pseudo subhimalusbicolor*, digital images, Pakistan.

**INTRODUCTION**

Leafhoppers belong to the family Cicadellidae, could be easily recognized by the presence of row of spines on hind tibia. Athysanini is the largest tribe of Deltocephalinae, including 228 genera and 1123 species. This group contains numerous vectors of crop diseases and can be found in nearly all terrestrial ecosystems (Zahniser 2007).

From Indo Pak Subcontinent on cicadellidae, after Distant 1908, 1909 &1912. Hem Singh Pruthi made major contribution from 1930, 1934 & 1936. The species *Pseudosubhimalus bicolor* was described by Pruthi 1936:123 in a genus *Ophiola* Edwards 1922. It is recorded on potato crop as pest (Misra, 1997).

Later Ghauri, 1974, erected a new genus *Pseudosubhimalus*, and treated *Ophiola bicolor* as type species of new genus, other species *Ophiola yatungensis* 1936, 125, was also presented as new combination by Ghauri, (1974: 353). Recently on internet database resource of Zahniser, 2007, genus *Ophiola* is treated under subgenus *Limotettix* (*Scleroracus*) Van Duzee, 1894. Present images of genitalia are provided for the first time to add the data of this group.

**MATERIALS & METHODS**

Place of work: Leafhoppers were collected from Mirpurkhas on grass. Collection was made with the help of aerial net and killed in jar containing potassium cyanide.

For the study of male genitalia abdomen was put in a 10 percent potassium hydroxide overnight and next day was examined under microscope.

For habitus images, the Stereo Zoom trinocular microscope, model no. SZM405 was used, and for the images of genitalia, 350 k pixel, USB camera fitted on microscopes, Kyowa Medilux 20 was used.

**RESULTS AND DISCUSSION**

**Taxonomy**

Cicadellidae, Latreille 1802
Deltocephalinae, Fieber 1869
Athysanini Van Duzee, 1892
*Pseudosubhimalus bicolor* (Pruthi, 1936, *Ophioloa*)

**Original description**
The species shows distinct sexual dimorphism. The male is small, delicate and of dark colour, the female being large robust and dark grey or ochraceous in colour. Vertex about half the breadth between the eyes, flat, medially faintly sulcate, anteriorly sub-angulate, dark grey in the female, almost piceous in the male, with a row of dark markings near the anterior margin and a pair of minute black dots near the base in both sexes.

Face almost as long as broad, dark brown and marked with extensive black markings in the female, almost entirely piceous in the male; frons fairly raised, clypeus rectangular; loria large and well marked. Eyes small.

Pronotum slightly narrower than the head, about twice as long as the vertex, slightly raised, anteriorly almost rounded, the posterior margin straight with a pair of minute black dots and an arcuate stripe of the same colour, sometimes broken into small markings, near the anterior margin, especially distinct in the female. Scutellum about half the length of pronotum, with two pairs of black dots. One minute near the medial line, the other large near the anterior margin. Tegmina longer than the body in both sexes, very slightly overlapping at apices, ochraceous(♀) and piceous(♂), semi-transparent; venation of *Thammotettix* type.

Length- Female: 4.25 mm; male: 3.0 mm

**Male Genitalia.** Pygofer long, produced in the posterior direction, with numerous stiff hair in the distal region. Sub-genital plate leaf-like, triangular. Parameres large, elongated and narrow in the distal region. Basal plates small, their prolongation short. Aedeagus large, curved, with a stout basal strut.

**Female Genitalia.** Valve very large, narrow and deeply concave at the posterior margin. Pygofer elongated and narrow, with a few long hair in the posterior region. Ovipositor rather delicate.

**Material examined**
1 ♂ Pakistan: Sindh, Mirpurkhas, 04.iii.2015, grass.

Remarks. Hem Singh Pruthi reported from present territory of Pakistan, from Chhangla Gali (8450 ft), Hazara, District, Khyber Pakhtoonkhuwah, 03.X, 1928.

**REFERENCES**
GHAURI, M. S. K., (1974). New genera and species of Cicadelloidea (Homoptera, Auchenorrhyncha) from economic plants in India. Bulletin of Entomological...
Pseudosubhimalus bicolour from Pakistan


http://zahniser.speciesfile.org/

Figure 1. Distributional map of Pseudosubhimalus bicolour (Pruthi, 1936)
Plate 1. *Pseudosubhimalus bicolor* (Singh-Pruthi, 1936)

a, habitus; b, face; c, pygofer lateral view; d, pygofer ventral view; e, connective and aedeagus dorsal view; f, style; g, male plate ventral view; h, aedeagus and connective lateral view.
EFFECT OF BOTANICAL PESTICIDES AGAINST RED SPIDER MITE *TETRANYCHUS URTICAE* (KOCH) OF OKRA CROP

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ABSTRACT

Field evaluation of some botanical extracts against red spider mite *Tetranychus urticae* (Koch) of okra was carried out during the year 2014 at Entomology Section, Agriculture Research Institute, (ARI) Tandojam. Five treatments with three replications were applied. The treatments were: T1 = Neem (*Azadirachta indica*), T2 = Tobacco (*Nicotiana tabacum*), T3 = Tooh (*Citrullus colocynthus* Schwat L.) and their efficacy was compared with chemical control (Oberon @ 200 ml/acre); while an untreated control plot was also kept to check the overall efficacy of pesticides against the target pest. Pre-treatment and post treatment observations were recorded. The results indicated that after 24, 48, 72, hours, 1-week and 2-weeks of 1st spray the pre-treatment population of red spider mite *Tetranychus urticae* in plots treated with neem extract (3.73/leaf) decreased to 3.40, 3.23, 2.87, 1.24 and 1.42/leaf, followed by tobacco extract where the pre-treatment red spider mite *Tetranychus urticae* population (3.53/leaf) decreased to 3.29, 3.25, 2.93, 1.24 and 1.54/leaf and Tooh extract (*Citrullus colocynthus*) decreasing pre-treatment mite population (3.57/leaf) to 3.36, 3.02, 2.60, 1.48 and 1.64/leaf, respectively. However, chemical control (Oberon @ 200 ml/acre) decreased pre-treatment mite population (3.40) to 2.52, 1.76, 1.20, 0.30 and 0.48/leaf respectively. The biopesticides were moderately and synthetic pesticide was highly effective to control red spider mite *Tetranychus urticae* population on okra. The pest population started marginally increasing when observed after 2-weeks of spray after both the sprays. Hence, apart from the overall treatments ranking, the biopesticides showed moderate efficacy against target pest and kept below the economic injury level. Hence, the chemical control of this pest can be minimized by inclusion of botanical extracts in the spray program.

Key words: Effect, Botanical extract, Red spider mite, Okra.

INTRODUCTION

Among vegetables, Okra, *Abelmoschus esculentus* L., is cultivated in most parts of the world and considered to be one of the world’s oldest cultivated crops. Okra is the only vegetable crop of significance in the Malvaceae family and is very popular in the Indo-Pak subcontinent (Oyelade et al. 2003). Its tender green fruits are used as a vegetable and are generally marketed in the fresh state, but one times in canned or dehydrated form. It can be fried in butter or oil and cooked with necessary ingredients (Yadav et al., 2001). There are many insect pests which may attack okra, but among those most likely to be troublesome are silverleaf whitefly, heliothis, rough bollworm, looper caterpillars and green vegetable bugs. Aphids and mites may also occur on okra crops. Inspecting the field regularly is very important, since the population builds up of the mites is very rapid. At the beginning of the infestation the distribution of mites is very patchy. Control must start early. It is very difficult to control the mite population once they are established. Less experienced farmers sometimes have difficulties with early identification of the mites, since the symptoms resemble a nutrient deficiency or plant disease. Close inspection of the underside of affected leaves shows mites as tiny moving specks (red or yellow-greenish depending on the species) and whitish particles (shed skins of mites) (Dhaka and Pareek, 2007).
Red spider mite *Tetranychus urticae* is tiny in size, barely visible with the naked eye as reddish or greenish spots on leaves and stems; the adult females measure about 0.4 mm long. The red spider mite which can be seen in greenhouses and tropical and temperate zones, spins a fine web on and under leaves. *Tetranychus urticae* is extremely polyphagous; it can feed on hundreds of plants. These include most vegetables and food crops including okra, peppers, tomatoes, potatoes, beans, maize and strawberry; and ornamental plants such as roses. It is the most prevalent pest of *Withania somnifera* in India. It lays its eggs on the leaves, and it poses a threat to host plants by sucking cell contents from the leaves cell by cell, leaving tiny pale spots or scars where the green epidermal cells have been destroyed. Although the individual lesions are very small, attack by hundreds or thousands of spider mites can cause thousands of lesions and thus can significantly reduce the photosynthetic capability of plants (Raworth et al., 2002).

Though the synthetic pesticides are used to combat insect pests, but their widespread use has created a variety of problems and has become a threat to human health. The chemical insecticides should be applied only if the insect population crosses the economic threshold level (ETL) and control measures should be taken when population exceeds ETL (Solangi et al., 2013). However, the application of synthetic insecticides has contributed to the environmental pollution through air or as residues in food. In the last years the use of environmentally biopesticides, such as plant extracts widely increased. The diverse biological activities of biopesticides (plant extracts) include feeding and oviposition deterrence, repellency, growth disruption, reduced fitness, and fertility (Schmutterer, 1997).

Biopesticides are natural control of crop insect pests and these naturally occurring substances control pests by non-toxic mechanisms; while synthetic pesticides may adversely affect the organisms such as birds, beneficial insects and mammals. However, for achieving high results from biopesticides effectively, users need to know a great deal about managing pests (Adalbert et al. 2013). Prasad and Devappa (2006) reported that the biopesticides were found to be effective in suppressing the larval population of the *P. xylostella* as compared to other insecticides with higher yield of cabbage per hectare. Jeyarani and Kennedy (2004) reported that biopesticides being highly effective in reducing larval population of diamondback moth with highest yield in cauliflower. Waghmare et al. (2006) also found biopesticides being effective against diamondback moth in cabbage, while Hemchandra and Singh (2006) reported the effect of some indigenous plant products against insect pests on okra including red mites. The farmers use various synthetic pesticides to reduce the damage by this pest, but with limited success.

Therefore, considering the importance of this pest vis-à-vis the ill-effects of using synthetic chemicals, the use of botanical extracts is needs to be attempted (Vishwakarma et al. 2009). The extract from *Citrullus colocynthus* (L.) Schrad (locally named as Tumma in Punjabi and Tooh in Sindhi) is a member of Cucurbitaceae family and the fruits are generally fed to animals for deworming and fruit extract of *Citrullus colocynthus* is also effective against various insect pests of different crops. *Calotropis procera* Alton. F. (locally named Akk) is a famous medicinal plant and extracts made from its leaves and flowers is used for treatment of various human and animal diseases and disorders. The akk extract is reportedly effective to control crop insect pests (Sultana et al., 2006). Moreover, neem based products have also been very effective against insect pests of okra (Ahmad et al., 2010).

Sarode et al., (1995) found that neem seed kernel extract @ 6 was the most effective treatment for controlling the okra insect pests, particularly for combating the mite infestation. Rita et al., (2000) reported that tetranychid mites appeared and two weeks of June the population was 3.33 mites per leaf; and from July to September (1.02-3.48 mites per leaf) but increased to 7.55 and 7.98 mites per leaf in October and November, respectively. Singh and Kumar (2003) reported that Achook and NSKE (3%), was the most effective in controlling the okra insect pests including sucking insect pests and mites. Binage et al., (2004) found that among botanicals, 5% neem seed extract resulted in lowest infestation of okra insect pests. Efeito et al. (2005) reported that botanical extracts controlled the okra insect pests effectively and their efficacy was almost equal to the synthetic products. Janaki et al. (2006) studied the bioefficacy of some biopesticides and these botanical products lowered the mean population of insect pests. Similarly, Haq (2006) found
that application of different neem products effectively controlled the sucking complex on okra; while Adilakshmi et al. (2008) evaluated the bioefficacy of various botanical insecticides against okra mite (Cv. Go-2) and found that NSKE (5%) proved to be more effective against mites, *T. telarius* infesting okra and was at par with recommended conventional insecticide (endosulfan). Roopa and Nandihalli (2009) reported that neem oil at 2% exhibited maximum acaricidal action and NSKE 5% (7.22) and sweet flag rhizomes extract (7.47). Muzemue et al. (2011) reported that plant extracts significantly reduced pest numbers including aphids than mites. The proposed research work was carried on the field evaluation of some botanical extracts against red spider mite *Tetranychus urticae* (Koch) of okra.

**MATERIALS AND METHODS**

The experiment on field evaluation of some botanical extracts against red spider mite *Tetranychus urticae* (Koch) of okra was conducted during the year 2014 at Entomology Section, Agriculture Research Institute, (ARI) Tandojam. The land was prepared in off-season. Initially, the hard pan of the experimental soil was removed by running disc plow and left for 15 days. Later, the clods were crushed using tractor drawn clod crusher, and leveling was performed.

After soaking dose, when the land came in condition, the plots were finally prepared by giving separation strips and forming feeding channels. The experiment was conducted in a three replicated Randomized Complete Block Design in a sub-plot size of 3m x 3 (9m²). A total of 15 plots were prepared and these were divided into three separate blocks as replications to manage five treatments. Homogenous seeds of okra variety Mirpurkas-1 were dibbled on well prepared ridges, keeping a ridge to ridge distance of 75 cm. Just before 1st irrigation seedlings were thinned and a plant to plant distance of 30 cm was adjusted. On occurrence of the red spider mite *Tetranychus urticae* (Koch), the extracts of the following botanicals plants were prepared and used to investigate their efficacy against the target mite pest.

**There were five treatments shown below:**

- **T1** Neem (*Azadirachta indica*)
- **T2** Tobacco (*Nicotiana tabacum*)
- **T3** Tooh (*Citrullus colocynthus* Schrad. L.)
- **T4** Chemical control (Oberon @200 ml/acre)
- **T5** Control (untreated)

**Preparation of botanical extract:**

For preparation of plant extract, 10 kg leaves each of Neem (*Azadirachta indica*), Tobacco (*Nicotiana tabacum*) and Tooh (*Citrullus colocynthus* Schrad. L.), were collected and processed for getting the extract. Each treatments stock weight was 10 kg boiled in 10 liters of water. The leaves of each plant species were taken separately and filtered through muslin cloth. When water remained 5 liters stock solution was ready to spray. After preparing the extracts, the okra plants were sprayed with a knapsack hand sprayer. In both sprays were carried out, and the efficacy was examined after 24, 48, 72 hours, 1-week and 2-weeks of spray and compared with control. Recommended pesticide for okra was sprayed for chemical control (Oberon) 200 ml per acre (0.44 ml/ plot) and biopesticides 5 liters/ acre (12 ml/ plot) was sprayed. All the data collected were subjected to analysis of variance to discriminate the superiority of treatment mean L.S.D (Least significance difference) test (Gomez and Gomez 1984) was applied to compare different treatments for their efficacies against the mite pest.

**RESULTS**

Organic farming is gaining importance in food production and in the agriculturally advanced countries of the world the application of synthetic pesticide on vegetables and fruits has been reduced considerably and emphasis has been given towards the use of naturally available botanical extracts for combating insect pests.

The experiment on field evaluation of some botanical extracts against red spider mite *Tetranychus urticae* (Koch) of okra was conducted during the year 2014 at Entomology Section, Agriculture Research Institute, (ARI) Tandojam. Treatments included the spray of three botanical extracts T1=Neem extract (*Azadirachta indica*), T2=Tobacco extract (*Nicotiana tabacum*), T3=Tooh, (*Citrullus colocynthus* Schrad. L); and their efficacy was compared with chemical control (Oberon @200 ml/acre); while an untreated control plot was also
kept to check the overall efficacy of pesticides against the target mite pest.

First spray

The analysis of variance demonstrated that statistically, the differences in population after first spray of some botanical extracts against red spider mite Tetranychus urticae (Koch) of okra were non-significant for pre-treatment (F=0.30; DF=12; P>0.05), 24 hours after treatment (F=2.71; DF=12; P>0.05) and the Tetranychus urticae (Koch) population decreased significantly after 48 hours of treatment (F=9.71; DF=12; P<0.05) and 72 hours after treatment (F=18.95; DF=12; P<0.05); after one week of treatment (F=45.19; DF=12; P<0.05) and after two weeks of treatment (F=30.77; DF=12; P<0.05).

The data (Table-1) showed that after 24 h, 48 h, 72 h, one week and two week of spray the pre-treatment population of Tetranychus urticae in plots treated with neem extract (3.73/leaf) decreased to 3.40, 3.23, 2.87, 1.24 and 1.42/leaf, respectively with highest efficacy among biopesticides (61.95%); followed by the plots sprayed with tobacco extract where the pre-treatment Tetranychus urticae population (3.53/leaf) decreased to 3.29, 3.25, 2.93, 1.24 and 1.54/leaf after 24 h, 48 h, 72 h, one week and two week of spray, respectively showing efficacy of 56.28%. Similarly, the okra crop sprayed with tooh extract, the pre-treatment Tetranychus urticae population (3.57/leaf) decreased to 3.36, 3.02, 2.60, 1.48 and 1.64/leaf after 24 h, 48 h, 72 h, one week and two week of spray, respectively showing efficacy of 53.52%. However, overall, the highest efficacy against Tetranychus urticae population (85.82%) was obtained in plots under chemical control (Oberon @200 ml/acre), where the pre-treatment Tetranychus urticae population (3.40%) decreased to 2.52, 1.76, 1.20, 0.30 and 0.48/leaf after 24 h, 48 h, 72 h, 1 week and 2 week of spray, respectively. In control (check) the Tetranychus urticae population remained established throughout the experimental period of 15 days.

It was observed that all the biopesticides as well as synthetic pesticide were effective to decrease Tetranychus urticae population on okra; but the pest population started marginally increasing when observed after two weeks of spray. According to the efficacy, the treatments ranking was Oberon (chemical control), neem extract, tobacco extract and tooh extract. Hence, apart from the overall treatments ranking, the biopesticides reduced the target pest, but less effective than the chemical control. The higher efficacy of Oberon @200 ml/acre was only important when the biopesticides were ineffective; but the botanical extracts showed good control of Tetranychus urticae population and chemical control of this pest can be minimized by inclusion of botanical extracts in the spray program.

Second spray

The statistical analysis of variance of the data on the effect of different control measure of red spider mite population indicated that statistically, the differences in the insect population after second spray of biopesticides against Tetranychus urticae (Koch) of okra were non-significant for pre-treatment (F=3.73; DF=12; P>0.05) and the population decreased significantly when observed 24 hours after treatment (F=14.08; DF=12; P<0.05), 48 hours of treatment (F=41.24; DF=12; P<0.05), 72 hours after treatment (F=74.35; DF=12; P<0.05); after one week of treatment (F=272.95; DF=12; P<0.05) and after two weeks of treatment (F=258.73; DF=12; P<0.05).

The results (Table-2) indicated that after 24 h, 48 h, 72 h, 1-week and 2-week of second spray the pre-treatment population of Tetranychus urticae in okra crop treated with neem extract (3.30/leaf) declined to 3.07, 2.85, 2.71, 1.11 and 1.17/leaf, respectively with highest efficacy among biopesticides (64.63%); followed by the okra crop sprayed with tobacco extract where the pre-treatment Tetranychus urticae population (3.67/leaf) declined to 3.34, 3.17, 3.07, 1.16 and 1.50/leaf after 24 h, 48 h, 72 h, 1-week and 2-week of spray, respectively showing efficacy of 59.11%. Likewise, the okra crop sprayed with tooh extract, the pre-treatment Tetranychus urticae population (3.00/leaf) reduced to 2.76, 2.68, 2.49, 1.27 and 1.28/leaf after 24 h, 48 h, 72 h, 1-week and 2-weeks of second spray, respectively showing efficacy of 57.25%. However, overall, the highest efficacy against Tetranychus urticae population (91.77%) was achieved in okra crop sprayed with synthetic pesticide (chemical control), where the pre-treatment Tetranychus urticae population (3.07%) decreased to 2.18, 1.46, 0.95, 0.21.
and 0.25/leaf after 24 h, 48 h, 72 h, 1 week and 2 week of spray, respectively. In control (check) the *Tetranychus urticae* population remained stabled during the observational period. It was observed that the population of red spider mite *Tetranychus urticae* was controlled more effectively by synthetic pesticide (Oberon @200 ml/acre) as compared to biopesticides. The pest population however, showed slight development in its population when monitored after two weeks of the second spray.

According to the pesticidal efficacy, the treatments ranking was chemical control (Oberon @200 ml/acre), neem extract, tobacco extract, tooh extract. Hence, apart from the overall treatments ranking, the biopesticides were effective to reduce the red spider mite population and up to the final observation after 15 days of second spray, the pest population was minor and was below the economic injury level.

**Table-1. Efficacy of biopesticides against red spider mite *Tetranychus urticae* (Koch) infestation on okra as compared to chemical control at different intervals after first spray.**

<table>
<thead>
<tr>
<th>Plant extracts</th>
<th>Pre-treatment</th>
<th>Post treatment observation/leaf after:</th>
<th>Pest Reduction /leaf</th>
<th>Efficacy %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>24-hrs</td>
<td>48-hrs</td>
<td>72-hrs</td>
</tr>
<tr>
<td>Neem extract</td>
<td>3.73 a</td>
<td>3.40 a</td>
<td>3.23 b</td>
<td>2.87 b</td>
</tr>
<tr>
<td>Tobacco extract</td>
<td>3.53 a</td>
<td>3.29 a</td>
<td>3.25 b</td>
<td>2.93 b</td>
</tr>
<tr>
<td>Tooheh extract</td>
<td>3.57 a</td>
<td>3.36 a</td>
<td>3.02 b</td>
<td>2.60 b</td>
</tr>
<tr>
<td>Oberon (chemical control)</td>
<td>3.40 a</td>
<td>2.52 a</td>
<td>1.76 a</td>
<td>1.20 a</td>
</tr>
<tr>
<td>Control check</td>
<td>3.40 a</td>
<td>3.43 a</td>
<td>3.47 b</td>
<td>3.54 c</td>
</tr>
<tr>
<td>S.E.±</td>
<td>0.3540</td>
<td>0.3303</td>
<td>0.3093</td>
<td>0.2820</td>
</tr>
<tr>
<td>LSD 0.05</td>
<td>0.8164</td>
<td>0.7616</td>
<td>0.7134</td>
<td>0.6504</td>
</tr>
<tr>
<td>LSD 0.01</td>
<td>1.1879</td>
<td>1.1082</td>
<td>1.0380</td>
<td>0.9464</td>
</tr>
<tr>
<td>P-Value</td>
<td>0.8714</td>
<td>0.1072</td>
<td>0.0037</td>
<td>0.0004</td>
</tr>
</tbody>
</table>

**Table-2. Efficacy of biopesticides against red spider mite *Tetranychus urticae* (Koch) infestation on okra as compared to chemical control at different intervals after second spray.**

<table>
<thead>
<tr>
<th>Plant extracts</th>
<th>Pre-treatment</th>
<th>Post treatment observation/leaf after:</th>
<th>Pest Reduction /leaf</th>
<th>Efficacy %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>24-hrs</td>
<td>48-hrs</td>
<td>72-hrs</td>
</tr>
<tr>
<td>Neem extract</td>
<td>3.30</td>
<td>3.07</td>
<td>2.85</td>
<td>2.71</td>
</tr>
<tr>
<td>Tobacco extract</td>
<td>3.67</td>
<td>3.34</td>
<td>3.17</td>
<td>3.07</td>
</tr>
<tr>
<td>Tooheh extract</td>
<td>3.00</td>
<td>2.76</td>
<td>2.68</td>
<td>2.49</td>
</tr>
<tr>
<td>Oberon (chemical control)</td>
<td>3.07</td>
<td>2.18</td>
<td>1.46</td>
<td>0.95</td>
</tr>
<tr>
<td>Control check</td>
<td>3.17</td>
<td>3.14</td>
<td>3.07</td>
<td>2.98</td>
</tr>
<tr>
<td>S.E.±</td>
<td>0.1932</td>
<td>0.1705</td>
<td>0.1525</td>
<td>0.1419</td>
</tr>
<tr>
<td>LSD 0.05</td>
<td>0.4456</td>
<td>0.3931</td>
<td>0.3518</td>
<td>0.3271</td>
</tr>
<tr>
<td>LSD 0.01</td>
<td>0.6483</td>
<td>0.5720</td>
<td>0.5118</td>
<td>0.4760</td>
</tr>
<tr>
<td>P-Value</td>
<td>0.0534</td>
<td>0.0011</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

**Overall average efficacy**

The average efficacy of various botanical pesticides against *Tetranychus urticae* population on okra in comparison with the chemical control (Oberon @200 ml/acre) for two sprays was worked out and thus data (Table-3) indicated that among the biopesticides, the highest average efficacy (63.29%) was observed in case of neem extract against *Tetranychus urticae* population which was in the range of 61.95 to 64.63 percent; followed by tobacco extract with 57.70 percent average efficacy which was in the range of 56.28 to 59.11 percent; while tooheh extract remained least in average efficacy (55.39%) which was in the range of 53.52 to
57.25 percent. However, the overall efficacy against *Tetranychus urticae* population was highest (88.80%) in case of chemical control where Oberon @200 ml/acre was applied and during two sprays the efficacy ranged between 85.82 to 91.77 percent. Generally, the efficacy of all the biopesticides as well as for Oberon @200 ml/acre was higher in the second spray as compared to the efficacy of the first spray of the pesticides. On the basis of overall average efficacy of pesticides, the ranking of the products stood as Oberon @200 ml/acre (chemical control), neem extract, tobacco extract and tooh extract.

Table-3. Overall average efficacy of biopesticides against red spider mite *Tetranychus urticae* (Koch) infestation on okra as compared to chemical control.

<table>
<thead>
<tr>
<th>Plant extracts</th>
<th>First spray</th>
<th>Second spray</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neem extract</td>
<td>61.95</td>
<td>64.63</td>
<td>63.29</td>
</tr>
<tr>
<td>Tobacco extract</td>
<td>56.28</td>
<td>59.11</td>
<td>57.70</td>
</tr>
<tr>
<td>Tooh extract</td>
<td>53.52</td>
<td>57.25</td>
<td>55.39</td>
</tr>
<tr>
<td>Oberon (chemical control)</td>
<td>85.82</td>
<td>91.77</td>
<td>88.80</td>
</tr>
</tbody>
</table>

**DISCUSSION**

Red spider mite *Tetranychus urticae* is extremely polyphagous and can feed on almost all the major vegetable plants (Raworth *et al.*, 2002). Though the synthetic pesticides are used to combat red spider mite and there are numerous miticide products in the market, but their widespread use is threat to human health cause of environmental pollution (Shivanna *et al.*, 2011). Biopesticides are natural control of crop insect pests and these naturally occurring substances control pests by non-toxic mechanisms; while synthetic pesticides may adversely affect the organisms such as birds, beneficial insects and mammals. Neem (*Azadirachta indica*), Tobacco (*Nicotiana tabacum*) and Tooh (*Citrullus colocynthus*) extracts have been found to be effective in controlling various insect pests of okra including red spider mite *Tetranychus urticae* (Koch). The field evaluation of *Azadirachta indica*, *Nicotiana tabacum* and *Citrullus colocynthus* extract of okra was carried out during the year 2014. The efficacy of these biopesticides were compared with chemical control (Oberon @200 ml/acre); while an untreated control plot was also kept to check the overall efficacy of pesticides against the target pest.

The results showed that the first, second spray and average efficacy of neem extract against red spider mite was 61.95, 64.63 and 63.29%, tobacco extract 56.28, 59.11 and 57.70, tooh extract 53.52, 57.25 and 55.39%; while the okra crop was sprayed with Oberon @200 ml/acre (chemical control) resulted in 1st, 2nd and average efficacy of 85.82, 91.77 and 88.80%, respectively. The biopesticides were moderately effective to *Tetranychus urticae* population on okra. The pest population started marginally increasing when observed after two weeks of spray after both the sprays. Hence, apart from the overall treatments ranking, the biopesticides effective controlled the target pest and kept well below the economic injury level. Hence, the chemical control of this pest can be minimized by inclusion of botanical extracts in the spray program. These results are further supported by many research workers, Adalbert *et al.* (2013) advocated that for achieving high results from biopesticides, users need to know a great deal about managing pests. Prasad and Devappa (2006) reported that the biopesticides were found to be effective in suppressing the larval population vegetable insect pests; while Jeyarani and Kennedy (2004) reported that biopesticides were effective in reducing larval population of diamondback moth on cauliflower; and Hemchandra and Singh (2006) reported the effect of some indigenous plant products against insect pests on okra including red mites. Vishwakarma *et al.* (2009) suggested the use of botanical extracts against sucking complex and mites instead of complete reliance on synthetic pesticides. Sultana *et al.* (2006) found that *Citrullus colocynthus* extract has also been found effective to control various insect pests of different major crops and vegetables.

Moreover, neem based products have also been very effective against insect pests of okra (Ahmad *et al.*, 2010). Sarode *et al.* (1995) found that neem seed kernel
extract was the most effective treatment for controlling the okra insect pests, particularly for combating the mite infestation. Rita et al. (2000) reported that tetranychid mites appeared and two weeks of June the population was 3.33 mites per leaf; and from July to September (1.02-3.48 mites per leaf) but increased to 7.55 and 7.98 mites per leaf in October and November, respectively. Singh and Kumar (2003) reported that Achook and NSKE (3%), was the most effective in controlling the okra insect pests including sucking insect pests and mites. Binage et al. (2004) found that among botanicals, 5% neem seed extract resulted in lowest infestation of okra insect pests. Efeito et al. (2005) reported that botanical extracts controlled the okra insect pests effectively and their efficacy was almost equal to the synthetic products. Similarly, Haq (2006) found that application of different neem products effectively controlled the sucking complex and mite on okra. Similarly, Rita et al. (2000) reported population dynamics of mites associated with okra cv. Punjab-7 (Hibiscus esculentus) and reported that predatory mite populations in okra sown in March and June 1998 were highest in the first fortnight of June (2.5 mites per leaf) and in the last two weeks of September (3.12 mites per leaf), respectively at Ludhiana, Punjab. Zafar et al. (2002) found that pesticides successfully controlled the insect pest population of vegetables. Singh and Kumar (2003) determined the efficacy of neem Azadirachta indica based pesticides against the okra fruit borers and sucking complex. Achook and NSKE (3%), was the most effective in controlling the okra jassid. Singh and Kumar (2003) conducted an experiment to determine the efficacy of neem Azadirachta indica based pesticides against the okra fruit borers and sucking complex. Achook and NSKE (3%), was the most effective in controlling the okra jassid. Kahanpara and Kapadia (2011) carried out studies and laboratory efficacy of biopesticides alone and in combination with insecticides revealed that the treatment of endosulfan 0.07% recorded significantly highest larval mortality (96.58%) and it was at par with Bt @ 1.0 kg/ha + endosulfan 0.035 % which recorded 95.60 % mortality. Solangi et al., (2013) reported that the average performance of three sprays was highest in case of (Neem oil + B.M) (81.28%), followed by neem oil (79.40%), neem powder (72.93%) and tabacco leaves (69.00%) respectively. The present study strongly suggests that the use of bio-pesticides may be helpfull to reduce the effect of pesticides in the environment. Marcic and Medo (2014) concluded that five acaricides, Challenger, Ortu, Vertimec, Delmite and Bioca were investigated for controlling phytophagous mite Tetranychus urticae Koch and their side effects on the predatory insects, mites and spiders at the El-Fayoum Governorate of cotton seedlings during the late season of 2007 and 2008. At the early seedling time, the application of the five tested compounds induced an average of 81.55%, 80.62%, 75.94%, 65.35% and 54.57% reduction in the population of spider mite during the 2007 season, and then changed to 79.72%, 77.92%, 72.54%, 60.05% and 47.97% reduction during the 2008 season.

REFERENCES


COMPARATIVE TOXICITY OF CRUDE EXTRACT OF PLANT AND SYNTHETIC INSECTICIDE AGAINST RICE WEEVIL *SITOPHILUS ORYZAE* L. (COLEOPTERA: CURCULINOIDAE)

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ABSTRACT

Comparative toxicity of Deltamethrin and Aloe gel was tested again *Sitophilus oryzae* L. by filter paper impregnation method after 24 and 48 hours of treatment. LC₅₀ of Deltamethrin and Aloe gel after 24 hours were 0.16% & 0.7% respectively whereas after 48 hours 0.14% & 0.87% respectively. The residual toxicity of Deltamethrin increased after 3rd day of treatment similarly high mortalities were observed by Aloe gel after 3rd day of treatment. Rice weevil is considered as an economically important pest of stored grain. The control and management of this pest with the use of insecticides has caused difficulties and adverse effects on human health and eco-system. The contamination of synthetics in stored grains could be implemented by replacing them with plant extracts.

Keywords: *Sitophilus oryzae*, grain protectant, Aloe gel, Deltamethrin, residual toxicity

INTRODUCTION

*Sitophilus oryzae*, rice weevil is one of the most destructive for stored grain product having cosmopolitan distribution. *S. oryzae* known as most serious harvest loses of grain storage throughout the world. It completely disturbs stored grain in warehouses, go downs and broad commodities. Rate of destruction depends upon the humidity and other environmental factors Tanveer et al., (2005). The rice weevil, *Sitophilus oryzae* (L.) has been reported as one of the severe pests of cereal grains and their products (Baloch, 1992) causing loss in weight and leading to quality deterioration and fungal growth in harvested cereals (Park et al., 2003). The main aim of our agriculture is to boost food production in order to keep pace with population growth. However, the production of food is valuable only if food grains are properly stored after harvest and saved from the predation by stored grain pests which caused heavy loss during the period when food grains remain in storage. Therefore, we need more storage capacity and post-harvest losses which are estimated to be 5% to 10% or much higher in certain circumstances.

To control these pests synthetic pesticides are commonly used. However, they produce some hazardous effect like bioaccumulation (Pourmirza and Tajbakhsh 2008), pollution (Gupta et al., 1991, residues Perveen et al., 2010, Tahir et al., 1992, Athanassious et al., 2004, resistance Zafar et al., 2008, Naqvi 1987), environmental toxicity (Tahir et al., 2008). To solve these problem entomologists have diverted their attention towards the phyto-deterrents which do not only kill the insect pests by toxic effect but also interfere with physiology. Plant products kill insects and have low mammalian toxicity, leave no toxic residues and do not pollute the environment (Arif and Naqvi, 2013, Haq et al., 2014 and Shikder and Shahjahan, 2011), worked on plant products and reported their less toxic effects enable them to use as safe and friendly pesticides against indiscriminate synthetic insecticides. Xie et al., (1995) evaluated the effects of bark extracts of *Melia toosendan* on three
stored-product beetles, the rusty grain beetle, *Cryptolettesferrugineus* (Stephens), the rice weevil, *Sitophilus oryzae* (L.), and the red flour beetle, *Triboliumcastaneum* (Herbst) through repellency, toxicity, and fecundity in the laboratory.

Insecticides and phytopesticides could be used effectively for the protection of stored grains, but comparatively synthetic insecticides are toxic and hazardous, caused environmental pollution, insect's resistance, high mammalian toxicity and increasing cost of application. This had led to search for safer and less expensive alternative chemicals such as plant extracts. In the present study phytopesticides was evaluated against the rice weevil as safe grain protectant that led to ecofriendly control of stored grain.

**MATERIALS AND METHODS**

The test insect which is used for experiment was *Sitophilus oryzae*. The initial culture of *S. oryzae* were obtained from the stock culture of Stored Grain Research Laboratory SARC, PARC, University Campus Karachi and reared under controlled condition at the laboratory of toxicology SARC Karachi in sterilized jar covered with muslin cloths tied with rubber bands. The culture was maintained at 28-32°C temperature and 65-70% relatively humidity. The newly emerged adult was utilized for toxicity assessment. Commercial grade insecticides i.e. deltamethrin was purchased from the local market. Plant extract used in the present study i.e. Aloe gel collected from Karachi University Campus. Different concentrations of insecticide Deltamethrin 1.25%, 0.625%, 0.3125%, 0.156% and 0.078% were prepared by dissolving 1% stock solution of each in distilled water. 50% gm fresh leaves of Aloe gel leaves were washed with distilled water and blended in 50% ethanol and left for 3-4 days in 250ml of 50% ethanol. Then filtered leaves extract (100%), different concentration were prepared i.e. 1%, 0.5%, 0.25%, 0.125% and 0.0625% and used for toxicity assessment.

The experiment was conducted on the newly emerged adults of *Sitophilus oryzae* by contact method / filter paper impregnation method. For this purpose seven sets of Petri dishes were taken washed and air dried and sterilized in oven. Whatman Filter paper of 7.0 cm diameter impregnated by the help of 1ml pipette with different concentrations of insecticide i.e. 1.25%, 0.625%, 0.3125%, 0.156% and 0.078% and plant extracts i.e. 1%, 0.5%, 0.25%, 0.125% and 0.0625% were placed in petri dishes along with control petri plates. Three replicates of each dose were placed. After air dried 10 insects of same age and size were released in each petri plates and kept at 30±2°C temperature and 65±5 related humidity. Mortalities were recorded after 24 and 48 hours of treatment. New insects experiment repeated for five days the mortality rate were 100% in control petri dishes. The mortality data was subjected to correct with Abbot Formula to develop the regression model to calculate the lethal concentrations. The data were statistically analyzed.

Whatman filter paper of 7.0cm diameter were placed in 7.0cm diameter petri plates and were impregnated with different doses i.e. 1.25%, 0.625%, 0.3125%, 0.156% and 0.078% for Deltamethrin and Aloe gel i.e. 1%, 0.5%, 0.25%, 0.125% and 0.0625% along with control and each batch. Air dried and 10 adult insects per petriplates were released and kept in the laboratory under controlled environmental conditions i.e. 30±2°C temperature and 65±5 related humidity. Mortalities were observed daily in each petriplates until end point mortality was reached. After 12-15 days mortality rate decreased and 0% was observed in each control petriplates. The results were statistically analyzed.

**RESULTS AND DISCUSSION**

Laboratory bioassays were carried out to determine the toxicity of crude extracts of leaves in water and ethanol (1:1) *Alovera sp.* were collected from Karachi university campus field. The synthetic insecticide deltamethrin were purchased from the local market and tested against rice weevil, *Sitophilus oryzae* L. at room temperature. The LC30s and LC90s were calculated for Aloe gel (*Y* = 56.29x + 9.78) are 0.70 and 1.43 after 24 hours followed by 0.87 and 1.62% after 48 hours (*Y* = 53.35x + 3.57) of treatments respectively (Fig.1). As compared to synthetic insecticide the LC30s and LC90s were calculated from the regression model developed for deltamethrin(Y = 33.86x + 44.65) are 0.16 and 1.34% after 24 hours followed by 0.14 and 0.87% after 48 hours (Y = 54.31x + 42.58) of treatments respectively (Fig.2) against test insect rice weevil (*Sitophilus oryzae*).
Residual toxicity of deltamethrin against *Sitophilus oryzae* was observed. After 1st day residual effect of deltamethrin showed 10%, 10%, 10%, 10%, 0% mortality. 2nd day % mortality were 40%, 30%, 30%, 30%, 30% observed. 3rd day % mortality gradually increased due to the residual effects 80%, 60%, 60%, 60%, 30% observed. 4th day % mortality 40%, 30%, 20%, 20%, 20% observed. 5th day % mortality 30%, 20%, 20%, 10%, 10% observed at 1%, 0.5%, 0.25%, 0.125% and 0.0625% respectively. Residual toxicity of *Aloe vera* gel extract against *Sitophilus oryzae* was observed. After 1st day residual effect of *Aloe vera* gel showed 40%, 40%, 30%, 20%, 20% mortality. 2nd day % mortality were 40%, 40%, 30%, 30%, 30% observed. 3rd day % mortality gradually increased due to the residual effects 70%, 60%, 60%, 50%, 40% observed. 4th day % mortality 50%, 30%, 20%, 20%, 20% observed. 5th day % mortality 30%, 20%, 20%, 10%, 10% observed at 1%, 0.5%, 0.25%, 0.125% and 0.0625% respectively.

An increased mortality of *S. oryzae* was observed with *Aloe vera* gel extract with the passage of exposure time. The highest % mortality was observed at 3rd day (1%) while minimum insects were found dead at 5th day (0.0625%). Haq et al. (2014) reported that all botanicals (Neem, Datura, Kino, Grape fruit, Shahtara, Dairokh) extracts were found to be significantly effective against Khapra beetle with good repellent effects. Arif and Naqvi (2013) reported the LC50 values of *Acouscalamus*, Neem formulation and Deltamethrin were found to be 0.099µl/cm², 6.945µl/cm² and 0.0347µl/cm² when tested against *C. analis*. Similarly in the present study the LC50 deltamethrin were 0.16% and 0.17% after 24 hours treatment whereas the LC50 of Aloe gel were 0.70% and 0.87% after 24 hours of treatment against *S. oryzae*, as the deltamethrin (Pyrethroid) caused mortalities at low doses as compared to high doses of plant extracts. Singh and Mall (1991) reported less evaporation of *S. oryzae* when wheat grain treated with neem oil, sadabahar, darekh and neem cake; Kumar et al. (2007) reported that *A. indica*, *M. azedarach* and *M. dioica* were found to be significant grain protectant when tested against *S. oryzae* are in favour of present findings against *S. oryzae* the Aloe gel is proved to be effective with residual toxicity against *S. oryzae* and it can be used as grain protectant against *S. oryzae*. As previously Uttam et al. (2002) used taramera and mustard for control of rice weevil. In the present study different plant extracts was used therefore the differences could not be compared. Chayengia et al (2010) reported mortalities of *S. oryzae* caused by plant extracts that matched the present findings as LC50 of A. gel caused 0.7% and 0.87% after 24 hours and 48 hours of treatment. It is reported that the extracts of different plants and found to be significantly effective against rice weevil and fecundity was significantly affected and reduced as compared to control and effect increased propudually with the concentration of the plant extracts. In the present study comparative toxic effects of deltamethrin and Aloe gel was treated against rice weevil and it was observed that Aloe gel has significant residual effects and after 3-days of exposure the high mortalities were observed so this plant extract can be used safely and economically and due to eco-friendly, easily available plant extracts can become the important comport for controlling the rice weevil and can be used as grain protectant.

**REFERENCES**


Fig. 1 Regression model of aloe gel (AV) toxicity against *S. orzae* after 24 (A) and 48 (B) hours of treatment.

**AV-24**

\[ y = 56.298x + 9.7805 \]

\[ R^2 = 0.9429 \]

**AV-48**

\[ y = 53.359x + 3.5688 \]

\[ R^2 = 0.9146 \]
Fig. 2 Regression model of deltamethrin toxicity against *S. orzae* after 24 (A) and 48 (B) hours of treatment.
STUDIES ON THE IMPORTANCE OF COMMON CALOTROPIS PROCERA (ASCLEPIADACEAE) AND CLOSE ASSOCIATION OF POEKILOCERUS PICTUS (FABRICUS, 1775)

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ABSTRACT

Common Calotropis procera is studied with its medicinal properties and its association with Poekilocerus pictus, they are studied from agricultural crops, mixed vegetation of herbs, grasses along with field boundaries surrounding by different plantation and from water channels. The fear that this pest has chances to shift from Calotropis procera to the agricultural crops is discussed.

Key words: Calotropis procera, medicinal properties, pest, Poekilocerus pictus, Akk (Oak)

INTRODUCTION

The naturally occurring plant Calotropis procera served as food plant of Poekilocerus, whilst in some part of Africa it played minor medicinal role in treating complaints of the urogenital tract, particularly barrenness and complicated labour in women in Asia the inflated fruiting bodies somewhat resemble a human scrotum and it may be for the same reason that a preparation of is used against gnorrhoea in the eastern Sudan. Dalziet (1937) indicates various other ailments that may be treated with it, and mentions that it is used in curdling milk and for arrow poison. In southern India, the rind of the stems was sometime used for fiber and the silky seeds for suffering pillows Popov and Kevan (1979).

Damage to the plants, however, would not attract much attention but the facultative polyphagy manifested by the least two of the three poekilocerus species has the consequence that, in years of mass multiplication, when the supply of the natural food (e.g Calotropis) may become depleted by near total defoliation, the insects, in search of alternative food, may invade crop, causing more or less appreciable, but generally localized damage.

Poekilocerus pictus is commonly famous due to its bright coloration. Among such diversify group of insect Akk grasshopper is very common found in Pakistan, India and Afghanistan that was reported by (Shumakov 1963, Cejchan 1969 and Sheri 1976). P. pictus is largest in size and having and bright coloration. This species, through proportionately less stout compare to P. bufonius it is smaller than P. arabicus. Integument smooth, finely and shallowly punctured. The color of northern females is as that of males, but generally duller, with blue pattern. Adults from Madras and other parts of southern India are tend to be darker, their pattern bolder and purplish.

An extraordinary outbreak of this pest in Pakistan was reported by Ghouri (1975) he suggested that apart from C. procera this insect also caused serious damage to valued crops such as cotton, sugarcane, chili and cucurbits. During present survey, we have also reported their large number from precious crops i-e Cotton, Tomato, Rose, Wheat, Brinjal and Akk. Occurrences of this species in such greater No. confirmed its dominant status in Sindh as well.
MATERIAL AND METHODS

Collection of samples. The major sources of collection was *Calotropis procera* while few specimens were collected from crops i.e. cotton, sugarcane surrounding by grasses, mixed vegetation of herbs. Specimen were captured with traditional insect hand net (9.1 cm diameter and 52.2 cm length) but fair No. of specimens were captured by hand picking using large forceps, surveys were carried out during the year 2012-2013. For the preservation and killing the method given by Vickery and Kevan (1983) and Riffat and Wagan (2008) was adopted.

RESULTS & DISCUSSION

*Poekilocerus pictus* is having maximum frequently as a crop pest, such record originating from several localities in northern and southern India, Orissa, Uttar Pradesh, Punjab and Pakistan. In addition to many wild plants, a wide range of crops i.e. cotton, sugarcane, and other cultivated plants are said to be subject to attack by this pest (Khurana, 1975). These range from fruit trees like citrus, papaya, mango, and banana fruit, to industrial crops, i.e sugarcane, cotton, castor, bamboo and pines, various vegetables, including tomatoes, brinjal, chillis, okra, radishes and cucurbit, as well as some ornamental, such as canna lilies, palms, clerodendron and *Ficus carica* Linnaeus, and it was also major pest of *C. procera*.

An extraordinary outbreak in Jhang district Pakistan, in May-June 1973 was reported by Ghouri (1975) he suggested that 26 square kilometres of crops of various kinds were attacked in 07 villages of Punjab. About 101 hectares of cotton were fully destroyed and about 30 hectares of chilli and cucurbit were severally damaged, while sugarcane in the area was not attacked less. The causes of such greater outbreak of *Poekilocerus* have not been properly studied yet, but Ghouri (1975) recorded that 10 hectares of dense *Calotropis* were damaged by this pest during May and June and he also recommends that these months with huge rainfall had been highly favorable for oviposition and mass production of this pest.

REFERENCES


Figure 1. Showing the collection of *Poekilocerus pictus* from district Shikarpur during the year 2012-2013

Figure 2. Showing the Season abundance of different stages of *Poekilocerus pictus* from *Calotropis procera* during various month of the year 2012-2013
Plate. 1. View of different host-plants from where Poekilocerus pictus were collected

Plate. II Adult (a) male (b) female
OBSERVATION ON THE IMMATURE STAGES OF OEDIPODINAE (ACRIDIDAE: ORTHOPTERA) FROM DIFFERENT HABITATS SUKKUR AND KHAIROPUR DISTRICT

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ABSTRACT

Three selective habitats viz. Rocky, desert and cultivated field areas were selected and same sites were studied through sampling continuously for three seasons during 2013-2015 from Sukkur and Khairpur district. Immature stages of 08 species were recorded pertaining to sub-family Oedipodinae. Seasonal occurrence of nymphal stages of 05 species were found predominant than others while status of life stages Locusta migratoria found sporadic from study sites. Six species giving biennial generation in a year whereas Aiolopus species were polyvalentine giving three or more generation in a year. All the species under observation undergoes mandatory short or long diapause. Emergence of younger stages (I, II & III) varies species to species usually started from May to July. Advance stages were in maximum ratio from July to Early November except Aiolopus species nymphs were collected around the year except January to mid of February. In some unusual cases younger and advance stages of hoppers of Trilophidia annulata were recorded up to mid of December, they might be diapause eggs may hatched out, as temperature raised younger nymphs frequently die except few survive to transform into adult stage.

Key words: Biennial, Polyvalentine, Nymphs, Habitat, Diapause and Hoppers.

INTRODUCTION

Seasonal occurrence of grasshoppers can be placed in two main groups those which undergoes winter diapause of eggs and those which may pass their early stages in cold season as well. Majority of grasshoppers exhibit winter diapause. Hatching of eggs may occur at different time and temperature as well as rate of emergence of instars and maximum population density of adult also varies even in closely related species. Habitat preference of early stages either specialist type those species restrict in specific soil type or generalist type occur in wide range of soil types or may be intermediate. Identification of early stages of grasshoppers is not an easy task, particularly inc closely related species, younger stages are more identical to distinguished from each other. Grasshoppers select their habitat according to the temperature, humidity, food availability, structural qualities, oviposition sites, suitable hiding places and presence of competitor and predators (Joen, 1982). Early stages of grasshopper are more confined to their habitat than the adult because they do not have function wings like adults which are mobile and can easily shift their habitat for the search of host plant of their choice. Occurrence of species confirm through continuous collection and visits of same sites under study with regular interval can give complete series of all nymphal instar and adults (Parihar, 1987). In some species of grasshoppers life stages may show change in behavior regarding their choice of habitat as their younger nymphal stages remain confined to their original habitat from where they emerge from eggs. Whereas advance stages hoppers become mobile they may change their habitat regarding best choice of food for the
development or during their maturity their feeding habits are change accordingly (Popov, 1989). Nymphs of grasshoppers are mainly phytophagus and voracious feeder of many valuable crops through successive ecdisys rapidly transformed to adult which increase food consumption and may reach up to threshold level. Larik et al. (2014).

Unfortunately earlier only superficial or fragmentary attention paid towards habitat preference of grasshoppers particularly to nymphal stages. Basic parameters regarding the ecology of developmental stages of most of grasshoppers species are still limited or partially known (Mariottini et al. 2011). Keeping in view the it importance this study present experiment has been design to highlight the different habitats in relation with the occurrence of early stages grasshopper species.

MATERIALS AND METHODS

**Study area:** Study was carried out in three different habitats i-e Rocky (Kotdigi and Shadishaheed), Sandy (Salehpak and Choondiko-Nara) and Cultivated field (Goth Bahar Larik and Roshanabad).

**Sampling, Killing and Preservation**

Sampling locations of grasshoppers were specified during February to March 2013. Same location were used to study during entire period of study (three consecutive seasons from 2013-2015). Grasshopper Early stages were collected from three different habitats under study with different plant communities like cultivated field with various seasonal crops and sandy and rocky areas with wild vegetation grow with monsoon rain and some patches of cultivated field in vicinity. Sampling was carried out from spring to coldest month of December and January with an average of 08 samples per season. After collection specimens were brought in the laboratory for identification of species and developmental stage and sex. Sample belonging to sub-family Oedipodinae were considered for the study. Early stages were classified as younger nymphal stage (I, II and III) and Advanced nymphal stage (IV, V and VI). Data collected from all of habitats with equal ratio lumped together and percentage (Mean±SD) of species determined for each collecting time (Mariottini et al., 2011).

RESULTS

Early stages of 08 species of Oedipodinae were collected from selective habitat for the seasonal occurrence of species for three seasons from 2013-2015. Five species found dominant with more than 200 specimens of nymphs and adults were come in collection whereas two species of Sphingonouse were collected with lesser number from rocky areas. While early stages of Locusta migratoria found sporadic with fewer number of instars were came in collection for short duration of their occurrence. Early stages of Aiolopus i-e A.thalassius thalassinus and A. thalassius tamulus were found round the year are polyvolatine give three or more generation in a year. A.thalassius thalassinus occurs more frequently than A. thalassius tamulus. Emergence of instars were very closer therefore difficult to differentiate from each other easily. Younger stages (I, II, & III) collected around the year except January and mid of February. All the species under study except Aiolopus have biennial life cyclegive two generation of nymphs in a year. Maximum population of instars were recorded from May to September. Trilophidia annulata hatching were started from early May to August advances stages were maximum from June to October. Sometime diapause eggs hatched in winter. Surprisingly for the first time Trilophidia annulata instars came collection during mid of December during 2015 with younger as well as advanced stages. Acrotylus species i-e A. humbertinus & A. longipas subfasicutus emergence were recorded during Mid of July and young nymphs were maximum in August to September while advance stages dominant from August to Early November. Nymphs of Sphingonotus i-e S. rubescens rubescens & S.
Nymphal emergence also started with monsoon rain from July to September. Maximum population of younger stages were collected in July and Advanced stages up to October. Emerging of *Locusta migratoria* started in May. Generally maximum nymphs were recorded from May to August during 2013-2015. Mean percentage of instars were 69.57 ± 7.83 for *Aiolopus thalassinus thalassinus*, 53.77 ± 7.27 for *A. thalassinus tamulus* 67.53 ± 5.86 for *Trilophidia annulata*, 62.77 ± 3.47 for *Acrotylus humbertinus* and 51.48 ±7.02 for *A. longipas subfasicatus*. Mostly nympha stages of *Aiolopus* and *Trilophidia* were came in collection during December. They may be diapause eggs that may hatch out in rocky and sandy habitat which have warmer temperature during day. Dominant percentage of younger instars of species were 28.33 ± 3.18 for *Aiolopus thalassinus thalassinus* followed by 24.53± 3.14 for *Trilophidia annulata* and 24.06 ± 0.94 for *Acrotylus humbertinus*. Percentage of advance stages of instar remain maximum throughout the study it might be they become mobile and can be disperse for the search of food plant and at some extent adoptive to survive in higher temperature. Maximum percentage of advance stages (IV, V & VI) were 43.00 ± 2.75 for *Trilophidia annulata* followed by 41.24 ± 6.47 for *A.thalassinus thalassinus* and 39.39 ± 6.07 for *A.humbertinus*. Adult percentage was found 100% from August to November.Less frequently occurring species were *Sphingonotus*average population of younger stages were 13.15 ± 0.86 for *S. savignyi* and 13.13 ± 0.43 for *S. rubescens rubescens* and advanced stages were31.65 ± 1.82 for former and 23.15 ±3.84 for later species. *Locusta migratoria* found as sporadic pest with minimumpercentage of instars throughout three seasons 10.02 ± 3.90 for younger instar and 23.15 ± 3.84 for advance stages.

**DISCUSSION**

Present study design to focus on the seasonal variation occurs in the life stages of band wing grasshoppers of sub-family Oedipodinae for the thee season from 2013-2015. Grasshopper belonging to this family are geophilous (found on open grounds)and phytophilous (found on vegetation, grasses, herbs, forbs and shrubs) Riffat, Wagan and Soomro et al. (2015). Species of grasshoppers in temperate region are usually undergoes univolatine cycle with longer embryonic diapause that may extended up to week, months or yearlong Uvarov, 1966 and Peshwani, 1961. Most of recorded species under study give Biennial generation per year with some exception i-e *A. thalassinus thalassinus*, *A. thalassinus tamulus* and *T. annulata*under goes triennial and polyvolatine life cycle. In accordance with Riffat, 2008 usually grasshoppers species under goes embryonic diapause may be extended for longer period of 9-10 month or more when there is no rainfall. Embryonic diapause found mandatory in all species was influenced by temperature, rainfall and moisture. Longer diapause recorded for *Locusta migratoria* up to 10-11 month long during 2013 might be due to low rain fall rate. In contrasting with Azim and Reshi et al. (2008) abundant population of nymphs recorded from April whereas, presently author collected maximum population of early stages from April to October. Maximum number eggs hatchingwere recorded during 2015 after monsoon rain during July to August. Outbreak of younger stages of *Sphingonotus* were always recorded during the month of July just after monsoon rain. While Khan and Aziz, 1973 collected from first fortnight of June. There was third generation of nymphal instars of *T. annulata* collected for the first time from Late October to mid of December. Present study show same trend in Oedipodinae species as *Oedalus senegalensis* reported to under goes Univolatine Life cycle in south colder region of Gellabiya site with onset early rain fall in April cause hatching of eggs earlier and second generation of nymphs appear from August to October Elamin et al 2014, Soomro et al. (2014). Most of species show similar trend regarding emergence of
instars affected by onset of rain fall particularly in sandy and rocky sites. Emergence as well as rate of post embryonic developmental period varies at different temperature and moisture (Fisher et al. 1996).

Table. I  
Showing mean percentage of seasonal occurrence of various immature stages of Oedipodinae during 2013-2015.

<table>
<thead>
<tr>
<th>Species</th>
<th>Younger Stages (I, II, III) (Mean ± SD)</th>
<th>Advance Stages (IV, V, VI) (Mean ± SD)</th>
<th>Total Percentage (Mean ± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aiolopus thalassinus thalassinus</td>
<td>28.33 ± 3.18</td>
<td>41.24 ± 6.47</td>
<td>69.57 ± 7.83</td>
</tr>
<tr>
<td>A. thalassinustumulus</td>
<td>19.46 ± 2.23</td>
<td>34.31 ± 5.04</td>
<td>53.77 ± 7.27</td>
</tr>
<tr>
<td>Acrotylus humbertinus</td>
<td>24.06 ± 0.94</td>
<td>38.71 ± 2.53</td>
<td>62.77 ± 3.47</td>
</tr>
<tr>
<td>A. longipas subfasicutus</td>
<td>20.09 ± 1.32</td>
<td>39.39 ± 6.07</td>
<td>59.48 ± 7.02</td>
</tr>
<tr>
<td>Trilophidia annulata</td>
<td>24.53 ± 3.14</td>
<td>43.00 ± 2.75</td>
<td>67.53 ± 5.86</td>
</tr>
<tr>
<td>Sphingonotus rubescens rubescens</td>
<td>13.15 ± 0.43</td>
<td>29.71 ± 2.41</td>
<td>42.87 ± 2.61</td>
</tr>
<tr>
<td>S. savignyi</td>
<td>13.13 ± 0.86</td>
<td>31.65 ± 1.82</td>
<td>44.78 ± 0.98</td>
</tr>
<tr>
<td>Locusta migratoria</td>
<td>10.02 ± 3.90</td>
<td>23.15 ± 3.84</td>
<td>33.17 ± 2.75</td>
</tr>
</tbody>
</table>

Table-II  
Showing occurrence of life stages of Oedipodinae species collected from three different Habitats during 2013-2015.

<table>
<thead>
<tr>
<th>Species</th>
<th>Cultivated Sites</th>
<th>Sandy Sites</th>
<th>Rocky Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aiolopus thalassinus thalassinus</td>
<td>D</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>A. thalassinustumulus</td>
<td>D</td>
<td>A</td>
<td>P</td>
</tr>
<tr>
<td>Acrotylus humbertinus</td>
<td>P</td>
<td>D</td>
<td>A</td>
</tr>
<tr>
<td>A. longipas subfasicutus</td>
<td>P</td>
<td>P</td>
<td>A</td>
</tr>
<tr>
<td>Trilophidia annulata</td>
<td>D</td>
<td>A</td>
<td>P</td>
</tr>
<tr>
<td>Sphingonotus rubescens rubescens</td>
<td>A</td>
<td>P</td>
<td>D</td>
</tr>
<tr>
<td>S. savignyi</td>
<td>A</td>
<td>P</td>
<td>D</td>
</tr>
<tr>
<td>Locusta migratoria</td>
<td>A</td>
<td>P</td>
<td>P</td>
</tr>
</tbody>
</table>

Note:  D = Dominant ,  P = Present &  A = Absent
REFERENCE:


Map-I Showing different habitats of seasonal occurrence of life stages.
ABUNDANCE OF COCCINELLID PREDATORS ON INSECT PESTS OF COTTON, GOSSYPIUM HIRSUTUM (L)

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ABSTRACT

Cotton is the cash crop of Pakistan. In parallel, cotton crop is always threatened by the insect pests that severely affect its quality and overall production. Previous literature is evident that in cotton agro ecosystem, the coccinellid as effective predator has immense potential to keep population of different pests below the threshold level while helps to reduce indiscriminate use of pesticides that may cause environmental and health problems. Therefore, considering the potential of coccinellids, the study was undertaken to evaluate the abundance of coccinellid predators on insect pests of cotton at Entomology section, ARI, Tandojam – Sindh during, 2013 on standard variety of cotton NIAB-78. The results about population of A. gossypii was recorded at the end of study, where the population of A. devastans, B. tabaci and T. tabaci fluctuated throughout the cotton season and E. insulana appeared during the month of July and continued till harvesting. Among the predator’s population of C. septempunctata and C. undecimpunctata was recorded at the start of season and M. sexmaculatus only at sowing and harvesting of crop whereas; B. sutoralis was recorded throughout the cotton season and S. punctis only in the months of July and August. The results of this studies suggest that the population of coccinellid predators along with other potential predators, if properly managed can reduce the economic, environmental and health losses.

Keywords: Natural enemies, pest population, IPM, cotton.

INTRODUCTION

Cotton, Gossypium hirsutum L. Malvaceae is the most important fiber cash crop in the world in general and Pakistan in particular. Besides its use in textile, seeds are used in many important products such as hulls, lint, oil and food for animals (Ozyigit et al. 2007). Hence, it is the main component of foreign exchange earnings for Pakistan since its creation and contributed 6.9 percent of value added in agriculture and 1.4 percent of GDP. Moreover, it provides raw material to local textile industry for the manufacturing of many value added products. The area under cotton slightly increased in 2012-13 to 7,114 acres from 7,071 acres in 2011-12; however, production was reduced to 13,031 bales from 13,595 in the same period (Anon, 2014; FAO, 2014).

Quality and quantity of cotton is worsening by different insect pests and diseases that attack cotton at various developing stages. It is estimated that about 20-30% cotton crop is lost every year due to insect pests (Masood et al. 2011; Shahid et al. 2013). The cotton insect pest complex in Pakistan is diverse and comprised of sucking pests i.e. Jassid (Anerasca devastans Dist.), Thrips (Thrips tabaci Lind), Whitefly (Bemisia tabaci Gennadius) and Aphids (Aphis gossypii Glov); leaf worm (Spodoptera spp.) and bollworms such as pink (Pectinophora gossypiella Saunders), Spotted (Earias vitella Boisduval), Spiny (E. insulana Fabricius) and American (Helicoverpa armigera Hubner) (Chamberlain et al. 1996). To minimize the damage of pests, farmers mostly used pesticides to control them, however, extensive use of pesticides have enormous disadvantages that includes development of resistance among pests, emergence of secondary pests, destruction of beneficial insects, environmental pollution and health problems (Masood et al. 2011; Shahid et al. 2013).

Biological control that focused on the use of predators, parasitoids and other bio-agents holds key importance in pests control in the integrated management system as they are entomophagous arthropods of insect pest and enhance pollination ( Isaacs et al. 2008). Large number of predators and parasitoids are reported feeding on insect pests of cotton and Coccinellids are considered as potential predators of aphids in particular and other soft bodied insects in general and thus have immense biocontrol potential (Pervez and Omkar, 2003;
Srivastava, 2003). Coccinellids, commonly known as Ladybird beetles are the most active predators of most insect pests such as aphids, adelges, leafhoppers, lepidoperous, borers, scale insects, white flies and mites during their various developing stages. Accordingly, they played a significant role in regulating the population of these economic pests in various cropping systems because both adults and larvae of beetles feed on their prey (Irshad, 2001). More than 3,500 species of ladybird beetles have been reported around the world (Irshad, 2001) and 71 species in Pakistan (Mustafa et al. 1996). In cotton agro ecosystem, the coccinellids known as an important group of predators that played important role to keep population of different pests below threshold level (Dhaka and Pareek, 2007). Therefore, considering the potential of coccinellids as effective predators of cotton pests, this study was conducted to determine the abundance of these coccinellid predators in cotton along with cotton insect pests.

**MATERIALS AND METHODS**

A field experiment was conducted to determine the abundance of coccinellid predators on different insect pests of cotton during the year, 2013 at experimental field of Entomology section, Agriculture Research Institute, Tandojam - Sindh. A standard variety of cotton NIAB-78 was used in the experiment. To observe the population of cotton insect pests and coccinellid predators, cotton field was divided into five sample plots of 20 square feet and each plot was treated as replicate. Ten plants from each replicate were randomly selected to observe the population and whole plant was observed for the data collection. The first observations on coccinellids and their prey (insect pests of cotton) were started from germination and continued twice a week till the harvesting of crop (first picking of the crop). Moreover, to confirm the coccinellid predators, their adults and grubs were brought into the laboratory for their identification.

The data obtained was analyzed through Analysis of Variance (ANOVA) to find significant difference between different cotton pests and their coccinellid predators. Correlation was used to find the relationship between population of cotton pests and their coccinellid predators. All analysis was done using SAS 9.1.

**RESULTS AND DISCUSSION**

According to results, *Aphis gossypii* population was recorded at the end of study period with mean population of 2.98±1.38 / plant, whereas minimum and maximum population was recorded at 7.46 / plant and 18.60 / plant. *Thrips tabaci* population fluctuated throughout the study period. The minimum and maximum population of *T. tabaci* was recorded at 1.06 / plant and 284.60 / plant with mean population of 52.09±18.23 / plant. *Bemisia tabaci* population showed a gradual increased with the cotton season with minimum and maximum population of 3.26 / plant and 31.28 / plant. Mean population of *B. tabaci* was recorded as 9.66±1.61 / plant. *Ammasca devastans* population appeared at the start of the season but fluctuated throughout the study with mean population of 4.04±0.88 whereas; the minimum and maximum population of jassids was recorded as 0.26 / plant and 14.06 / plant. Population of *Earias insulana* appeared with the start of fruiting bodies at the start of July and continued afterwards. The minimum, maximum and mean population of *E. insulana* was recorded as 0.14 / plant, 0.38 / plant and 0.17 ± 0.03 / plant (Table-1). Previous studies also suggested the fluctuation in the population of different insect pests of cotton throughout its growth period. It is reported that population of *A. gossypii* remained on cotton throughout its growth period (Nizamani et al. 2002; Hanumantharaya et al. 2008; Godhani et al. 2009; Ashfaq et al., 2011). However, in this study population of *A. gossypii* was only recorded during the harvesting period of cotton. Moreover, population of *B. tabaci*, *T. tabaci* and *A. devastans* appeared at the start of the cotton season but showed a regular fluctuation over the entire growth period of cotton. Studies of Nizamani et al. (2002); Abro et al. (2004); Hanumantharaya et al. (2008); Solangi et al. (2008) and Godhani et al. (2009) also showed the fluctuating pattern in the population of above mentioned pests. Results of the study also showed that population of *E. insulana* was first recorded in the month of July and then continued throughout the cotton season. Tomar et al. (2000) and Selvaraj and Ramesh (2013) reported the appearance of *E. insulana* throughout the cotton growth with peak population observed during flowering and fruiting time.

**Table 1: Per plant population of insect pests of cotton during, 2013.**

<table>
<thead>
<tr>
<th>Insect Pests</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean Population</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Aphis gossypii</em></td>
<td>7.46</td>
<td>18.60</td>
<td>2.98±1.38</td>
</tr>
<tr>
<td><em>Thrips tabaci</em></td>
<td>1.06</td>
<td>284.60</td>
<td>52.09±18.23</td>
</tr>
<tr>
<td><em>Bemisia tabaci</em></td>
<td>3.26</td>
<td>31.28</td>
<td>9.66±1.61</td>
</tr>
<tr>
<td><em>Ammasca devastans</em></td>
<td>0.26</td>
<td>14.06</td>
<td>4.04±0.88</td>
</tr>
<tr>
<td><em>Earias insulana</em></td>
<td>0.14</td>
<td>0.38</td>
<td>0.17±0.03</td>
</tr>
</tbody>
</table>

* Means followed by the same letters are not statistically different (p < 0.001)
was recorded at 0.04 / plant & 0.02 / plant, and 0.08 / plant for the two species respectively. Population of *Menochillus sexmaculatus* (Figure 1C) was recorded at the start and end of cotton season with minimum and maximum population of 0.02 /plant and 0.22 / plant, respectively. Mean population of *Menochillus sexmaculatus* was recorded at 0.04 / plant. Among coccinellid predators, population of *Brumus suturalis* (Figure 1D) only was recorded throughout the study period with mean population of 0.16 / plant, whereas its minimum and maximum population was recorded at 0.06 / plant and 0.74 / plant. The population of *Stethorus punctis* (Figure 1E) was only recorded during the months of July and August with minimum and maximum population of 0.16 / plant and 1.34 / plants, whereas its mean population was recorded at 0.33 / plant.

![Adults of different predators](image)

**Figure 1:** Adults of different predators. A= *Coccinella septempunctata*, B= *Coccinella undecimpunctata*, C= *Menochillus sexmaculatus*, D= *Brumus suturalis*, E= *Stethorus punctis*.

<table>
<thead>
<tr>
<th>Predators</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean Population</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Coccinella septempunctata</em></td>
<td>0.04</td>
<td>0.08</td>
<td>0.01&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td><em>Coccinella undecimpunctata</em></td>
<td>0.02</td>
<td>0.08</td>
<td>0.01&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td><em>Menochillus sexmaculatus</em></td>
<td>0.02</td>
<td>0.22</td>
<td>0.04&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td><em>Brumus suturalis</em></td>
<td>0.06</td>
<td>0.74</td>
<td>0.16&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td><em>Stethorus punctis</em></td>
<td>0.16</td>
<td>1.34</td>
<td>0.33&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

* Means followed by the same letters are not statistically different (p < 0.001)

**Table 2:** Per Plant population of Coccinellid predators on cotton during, 2013.

In this study, population of *C. septempunctata* and *C. undecimpunctata* was only observed at the start of the cotton season, whereas *M. sexmaculatus* was recorded at the start and late season. Previous studies showed the regular fluctuation in the population of these predators throughout the cotton season (Godhani *et al.* 2009; Ashfaq *et al.* 2011). Lohar (2001) reported the significant role of coccinellid predators’ especially *C. septempunctata*, *C. undecimpunctata*, *M. sexmaculatus*, *B. suturalis* and other in the management of cotton pests and showed their population fluctuation along with cotton pests. In this study, we have observed the population of *B. suturalis* throughout the cotton growth and *S. punctis* population during the months of July and August.

Correlation results showed that among population of *M. sexmaculatus* was significantly and positively correlated with the populations of *A. gossypii* (r = 0.47) and *B. tabaci* (r = 0.79). *Brumus suturalis* abundance was also significantly and positively correlated with *B. tabaci* (r = 0.67), whereas its relationship with *A. gossypii* (r = -0.51) and *T. tabaci* (r = -0.82) was significant but negatively correlated. In other words, increasing population of *B.*

<table>
<thead>
<tr>
<th></th>
<th><em>Coccinella septempunctata</em></th>
<th><em>Coccinella undecimpunctata</em></th>
<th><em>Menochillus sexmaculatus</em></th>
<th><em>Brumus suturalis</em></th>
<th><em>Stethorus punctis</em></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>A. gossypii</em></td>
<td>-0.11</td>
<td>-0.12</td>
<td>0.47&lt;sup&gt;*&lt;/sup&gt;</td>
<td>-0.51&lt;sup&gt;*&lt;/sup&gt;</td>
<td>0.19</td>
</tr>
<tr>
<td><em>Thrips tabaci</em></td>
<td>0.65</td>
<td>0.65</td>
<td>-0.5</td>
<td>-0.82&lt;sup&gt;*&lt;/sup&gt;</td>
<td>-0.49</td>
</tr>
<tr>
<td><em>Bemisia tabaci</em></td>
<td>-0.74</td>
<td>-0.74</td>
<td>0.79&lt;sup&gt;*&lt;/sup&gt;</td>
<td>0.67&lt;sup&gt;+&lt;/sup&gt;</td>
<td>0.57</td>
</tr>
<tr>
<td><em>Amrasca devastans</em></td>
<td>0.24</td>
<td>0.24</td>
<td>-0.18</td>
<td>0.24</td>
<td>-0.42</td>
</tr>
<tr>
<td><em>Earias insulana</em></td>
<td>0.12</td>
<td>0.12</td>
<td>-0.49</td>
<td>0.43</td>
<td>-0.18</td>
</tr>
</tbody>
</table>

*Significant at P < 0.05
suturalis resulted in the decline of the populations of A. gossypii and T. tabaci.

CONCLUSION

In conclusion population of T. tabaci, B. tabaci and A. devastans was recorded throughout the cotton growth, however, A. gossypii and E. insulana population was recorded at the end of season and with the emergence of flowering bodies respectively. Among coccinellid predators, population B. suturalis was recorded throughout the study and S. punctis during the months of July and August. Population of remaining predators was only observed either at the start or end of the cotton season. The results of the study suggested that population of predators especially coccinellids should be preserved with proper application of chemicals and other control measures to ensure their effective role in the management of cotton pests’ particularly sucking complex.

REFERENCES


Authors’ Contributions: Arfan Ahmed Gilal and Jam Ghulam Mustafa Sahito, Design and carried out the experiments. Fahad Nazir Khoso and Muhammad Shahid Arain wrote the article. Jam Ghulam Murtaza Sahito, and Muhammad Javed Sheikh performed statistical analysis and proof reading.
INVESTIGATIONS ON VARIETAL RESISTANCE OF GRAM AGAINST HELICOVERPA ARMIGERA HB. UNDER FIELD CONDITIONS

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To determine varietals resistance of gram against Helicoverpa armigera, the studies were conducted on Gram varieties such as; DG-89, DG-92, NCSO-520, Sanyasi, NCSO-525, NCSO 521, Rabat, Chola Kabli and Black Gram during 2012-2013 at experiment field of pulse section Agriculture Research Institute Tandojam. The experiment was designed in Randomized Complete Block Design (RCBD) with nine treatments and three replications were sown under field condition. The study indicated that the population of H. armigera on chola kabli was overall maximum population (2.17±0.59) per plant followed by DG-92 (1.55±0.28) and 2nd variety was black gram was found the most resistant variety the overall minimum population (1.03±0.30) per plant. Result revealed that variety Chola kabli was found the most susceptible variety to H. armigera followed by DG-92. The Black gram was found the most resistant variety against H. armigera. The ANOVA results for population of H. armigera per plant in all nine varieties showed that treatment were statistically highly significant with (f=16.65) value indicating variance among treatments.

Key Words: Varietal Resistance, Gram, H. armigera, Field Condition.

INTRODUCTION

Gram, Cicer arietinum L. is a major pulse crop grown in Pakistan. Being rich in protein it is susceptible to a number of insect pests, which attack on roots, foliage and pods. Gram is the third most important food legume grown in 1 million ha with 9 million ton production (FAO, 2002). Gram Pod borer, Helicoverpa armigera Huber is a worldwide pest of great economic importance on this crop. This pest is the major constraint in chickpea production causing severe losses upto 100% inspite of several rounds of insecticidal applications. Sometimes in serious cases, there may be a complete crop failure. It is a highly polyphagous pest, feeding on a wide range of food, oil and fiber crops. Due to its wider host range, multiple generations, migratory behaviour, high fecundity and existing insecticidal resistance; it has become a difficult pest to tackle. Amongst its major hosts are grain legumes such as chickpea that has been reported to suffer million rupees worth of damage. It selectively feeds upon growing points and reproductive parts of the host resulting in significant yield loss. In chickpea, it feeds on buds, flowers and young pods of the growing crop, the crop often fails to recover and yields extremely poor. The pest status of this species has increased steadily over the last50 years due to agro-ecosystem diversification by the introduction of winter host crops such as chickpea (Knights et al. 1980).
Many workers tested various chickpea cultivars for their resistance/tolerance (Khan et al. 2009). To avoid ill effects of chemical abuse, eco-friendly pest management is mainly concentrating on the maximum utilization of natural resources by integrating different non-chemical pest management portions and the adoption of need based chemical application. Traditionally, farmers have been using several practices to prevent the hazards of pests. During the current years, it is well recognized that certain strains of chickpea are attacked less by insect pests than the others, because of natural resistance they possessed. Therefore, development, selection and use of high yielding and insect pest’s tolerant cultivars are an urgent need of the day. Total dependence on chemicals for insect control has give rise to insect resistance problems. This situation prompts the workers to divert their efforts to Integrated Pest Management (IPM) which includes the use of resistant varieties means of biological Cultural and chemical control of H. armigera (Lal et al., 1986). Evaluated eight chickpea genotypes against CPB and observed that its larval population ranged from 1 to 50 larvae per plant, pod damage from 8 to 90% with grain yield from 23 to 1920 g per plot. The genotype, C-727 was found to be relatively resistant against CPB among the eight tested genotypes. Shafique et al. (2009) screened 13 advanced strains of Kabuli chickpea including a check and reported that pod damage ranged from 13.3 to 22.7% with grain yield from 274 to 855 g per plot on most and least susceptible strains, respectively. Efforts were carried out in the present study to screen advanced Kabuli chickpea genotypes against pod borer in a trial under natural field conditions keeping in view the importance of resistance in plants against insect pests in IPM. Therefore, screening out the resistance cultivars to this pest would provide an effective approach in integrated pest management to minimize the extent of losses due to this pest.

**MATERIALS AND METHODS**

The study was carried out during the year 2012-2013. The experiment was conducted to find out the most resistance variety of grams against gram pod borer at the experimental fields of Pulse Section, Agriculture Research Tandojam. Nine commercial gram varieties namely viz., DG – 89, DG – 92, NCSO – 520, Sanyasi, NCSO – 525, NCSO – 521, Rabat, Chola kabli and black gram were sown on October 8, 2012 in a randomized complete block design with three replications. The plot size was 9.8×4.6 m having six rows and with row-to-row and plant-to-plant distance of 20 cm, respectively. The sowing of gram seeds was done on ridges and first two irrigation were given frequently after emergence of seed. Normal agronomic practices were carried out throughout the growing season of the crop and no practices were sprayed in and around the experimental field. The observations on the infestation of American bollworm were recorded at weekly interval. For this purpose, five plants from each replication were randomly selected. The observation was recorded at morning hours (8-10 am) and ultimate care was taken to examine the population of insect pests. The observations were started in the end of December, 2012 and taken till third week of March, 2013. The data were statistically analyzed by analysis of variance (ANOVA) and highly significance of pest population means differences were also compared by (LSD) test.
RESULTS

The study was carried out during the Rabi season of 2012-2013 to examine the relative resistance of different gram varieties to *H. armigera*. The population of *H. armigera* was recorded and compared on nine varieties i.e. DG-89, DG-92, NCSO-520, Sanyasi, NCSO-525, NCSO 521, Rabat, Chola Kabli and Black Gram. The resistance of varieties to insect pests was measured on the basis of their population buildup throughout the growing season of gram. American bollworm (*H. armigera*) a major insect pest of gram and farmer spent million of rupees to protect their gram from this most injurious insect pest and this pest has been found activity damaging the gram immature and mature stage up to the final picking. The result (Table 1) indicated that statically the difference in population of *H. armigera* on different gram varieties was non significant (P> 0.05) however, The population of *H. armigera* was found relatively greater (2.17/plant) on variety kabli, while its population was 1.55, 1.24, and 1.21/plant on gram varieties DG-92, Rabat, NCSO-520, respectively. The population of *H. armigera* was slightly lower i.e. 1.21, 1.19, 1.14,11.08/plant on gram varieties Sanyasi, DG-89, NCSO-525 and NCS-521, respectively. Commercial gram variety black gram was found to be relatively less infested (1.03/plant). Considerable research has been reported world over on the aspects under investigation. Rajput *et al.* (2003) reported that the eight chickpea genotype against the infestation of *Helicoverpa* species under the field condition. *Helicoverpa* species was most serious insect pests causing severe damage to the crop. In order to identify resistance against the infestation of the pest, Wakil *et al.* (2005) evaluated the resistance of nine chickpea genotypes (6153, 93127, 90261, CM-88, CM-98, CM-2000, CM-2100/96, CM-4068/97 and Punjab-2000) were evaluated under the natural infestation in Rawalpindi (Pakistan) against *Helicoverpa armigera* (Hub.). None of

DISCUSSION

American bollworm is most injurious insect pests of gram and billion of rupees are spent annually on insecticidal treatments for their control. Due to excessive use of insecticides, not only the farmers’ net revenues are reduced, but this practice is also a threat to the environment. However, development of gram varieties resistant to these harmful insects could be the most effective, safe and economical solution of the problem. The present study was carried out to examine the relative resistance of different gram varieties against American bollworms *H. armigera*. It was noted that population of *H. armigera* was found relatively greater (2.17/plant) on variety kabli, while its population was 1.55, 1.24, 1.21, 1.21, 1.19, 1.14 and 1.08/plant on varieties DG-92, Rabat, NCSO-520, Sanyasi, DG-89, NCSO-521 and NCSO-525, respectively. Commercial variety black gram was found to be relatively less infested (1.03/plant). Considerable research has been reported world over on the aspects under investigation. Rajput *et al.* (2003) reported that the eight chickpea genotype against the infestation of *Helicoverpa* species under the field condition. *Helicoverpa* species was most serious insect pests causing severe damage to the crop. In order to identify resistance against the infestation of the pest, Wakil *et al.* (2005) evaluated the resistance of nine chickpea genotypes (6153, 93127, 90261, CM-88, CM-98, CM-2000, CM-2100/96, CM-4068/97 and Punjab-2000) were evaluated under the natural infestation in Rawalpindi (Pakistan) against *Helicoverpa armigera* (Hub.). None of
the genotypes could exhibit complete resistance to the pest or could evade the pest infestation. Gowda et al. (2005) evaluated a series of half-diallel crosses involving early, medium and late maturity desi and kabuli type chickpea (Cicer arietinum Linn.) genotypes with stable resistance to *H. armigera* pod borer along with the parents at two locations in India to understand the inheritance of pod borer resistance and grain yield. Inheritance of resistance to pod borer and grain yield was different in desi and kabuli types. Sharma et al. (2005) observed that the standardized a cage technique to screen chickpeas for resistance to *Helicoverpa armigera* (Hubner). Leaf feeding by the larvae was significantly lower on ICC 506 than on ICC 37 when the seedlings were infested with 20 connotes per 5 plants at 15 days after seedling emergence or 10 neonates per three plants at the flowering stage. Narayananamma et al. (2007) studied host plant resistance is one of the important components for minimizing the damage by the pod borer, *Helicoverpa armigera*. To develop cultivars with stable resistance to insect pests, Shafique et al. (2008) screened thirteen Kabuli advanced recombinants including check were screened against chickpea pod borer (CPB) infestation in field trial to identify advanced Kabuli chickpea recombinants resistant to CPB. Comparison of resistance among the recombinants against CPB showed that none was completely resistant against this pest. Sreelatha et al. (2008) evaluated Half-diallel cross progenies of desi (45F1s and 45F2s) and kabuli (28F1s and 28F2s) chickpeas (Cicer arietinum) along with their parents (10 desi and 8 kabuli) with varying levels of pod borer resistance (PBR) evaluated in replicated field trials under unprotected conditions. Shafique et al. (2009). Evaluated that the advance desi chickpea. (Cicer arietinum L.) Genotypes developed at Nuclear Institute for Agriculture and Biology, Faisalabad was evaluated along with check variety for resistance against chickpea pod borer (CPB), *Helicoverpa armigera* (Hubner) infestation in a field trial. Nadeem et al. (2010) conducted a trial to evaluate the comparative varietals resistance in thirteen advanced desi chickpea genotypes against chickpea pod borer (CPB), *Helicoverpa armigera* (Hubner). Sarwar et al. (2011) evaluated the use of crop varieties resistant or tolerant to insect pests stress is an imperative approach in non-chemical crop protection. Similarly in present study was sown nine genotype of gram compare with 16 genotypes of gram (Cicer arietinum L. were utilized for field assessment against gram pod borer (*Helicoverpa armigera* Hubner) to evaluate their genotypic differences.

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Table No. 1. Mean population of gram pod borer on gram varieties.

<table>
<thead>
<tr>
<th>Date of Observation:</th>
<th>Varieties</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DG-89</td>
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<tr>
<td>26-12-2012</td>
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</tr>
<tr>
<td>03/1/2013</td>
<td>0.87</td>
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<tr>
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</tr>
<tr>
<td>Mean±S.D</td>
<td>1.19±0.30</td>
</tr>
</tbody>
</table>
ABSTRACT

A laboratory experiments was conducted on “Biology of Angoumois grain moth, S. cerealella (Olivier), on wheat in laboratory conditions” at Department of Entomology, SAU, Tandojam. The adult moths and Srarsabz variety of wheat were obtained from Agriculture Research Institute (ARI) Tandojam for culture development. The results on the biology of S. cerealella indicated that mean egg incubation period was shorter in the month of August (4.8 ± 0.58 days). The longer incubation period was observed in the month of January due to fall in temperature 24.37ºC and relative humidity. The eggs hatching percentage was significantly lowest due to lower temperature and relative humidity %. The emergence of male was 40% and female 52.0 % in the month of August. The highest population of eggs, larvae, pupae and adults inside per 10 grains were recorded 6.50, 2.75, 2.0 and 2.75 respectively at temp. 29±2ºC to 34±2ºC and relative humidity of 70±5 to 76±5. Whereas the minimum populations were recorded 0.75, 0.75, 0.25 and 0.50 respectively at temp.24.15±2ºC and relative humidity 62.15±5.

KEYWORDS:  
Sitotroga cerealella, Biology, Wheat

INTRODUCTION

Wheat, Triticum aestivum (L), is locally called kank in Sindhi, ganum in Pashto and gandum in Urdu. In Pakistan it is cultivated since last centuries in different provinces according to their climatic conditions. Wheat is most important food crop. Besides, being a major source of food for human beings it is used as feed for livestock and as industrial raw materials. There are so many bye-products of wheat like meal, pastries etc., which have been used in our daily life. In Pakistan, the largest cropped area is devoted to the cultivation of wheat, and the quantity produced is more than that of any other crop (Shah, 1998). When the wheat is stored in godowns, many insect pests attack the grains and reduce the quality and quantity. Almost all the insect pests of stored grains have a remarkably high rate of multiplication and within one season, they may destroy 10-15% of the grains and contaminate the rest with undesirable odors and flavors. Wheat is damaged by many insect pests like beetle,
weevil and other lepidopterous moth. The common examples are Angoumois grain moths, Mediterranean flour moth, rice moth etc. (Atwal, 1994; Lohar, 2001). Among others, the Angoumois grain moth, *Sitotroga cerealella* (Oliver) is one of the major storage pest of cereals and no antibiotic resistance in wheat against this insect has been identified to date (Shukle and WU, 2003). Similarly (Mvumi *et al.* 2002) observed that *S. cerealella* (Oliver) is an important pest of stored grains, whose biology has been well-researched, but little is known about its population dynamics under field conditions. This study examined the importance of the moth in relation to other storage insect pest on maize and sorghum. Earlier Khatak *et al.* (1996) studies, the susceptibility of 8 wheat cultivars to *S. cerealella* under controlled laboratory conditions. The results were evaluated on the basis of percent weight loss, percent damage, and progeny development period and grain size. There criteria revealed that none of the cultivars was completely immune to the attack of this pest. There is a great importance of Integrated Pest Management strategy. Keeping in view the importance of work present studies were planned to determine the Biology of Angoumois grain moth *Sitotroga cerealella* (Oliver) on wheat in laboratory conditions. Hopefully, this research work will be helpful to the agricultural scientist for the control of Angoumois grain moth through different strategies in Pakistan.

**MATERIALS AND METHODS**

A laboratory study was carried out to determine the Biology of grain moth, *Sitotroga cerealella* (Oliver) on wheat in the Department of Entomology, Faculty of Crop Protection, Sindh Agriculture University, Tando Jam during 2004-05. Seeds of Sarsabz variety of wheat were brought from wheat section, Agriculture Research Institute (ARI) Tandojam. The grains were boiled for 15 min, and then dried on clean cloth on sunlight for 8 hrs. A grain sample of about 200 gm of boiled wheat were kept in separate plastic jars and replicated 12 times. Newly emerged adults Angoumois grain moths *Sitotroga cerealella* (Oliver) were brought from IPM Laboratory (ARI) Tandojam. Five pairs of moths (Male and Female) were released in each plastic jars. The head of jars was covered with muslin cloth bended with rubber strips. The observations were recorded 1st August and continued till 30th January for observations on egg development time, hatching rate and sex ratio were observed, the data continued from egg to the emergence of adult. For this purpose, 25 eggs were kept in each Petri dish and replicated 05 times the incubation period of eggs, larval and pupal duration were observed. The sex ratio of male and female adults was also calculated.

**RESULTS**

The results indicated in Table 1 that egg incubation period was shorter in the month of August (4.8 ± 5.8 days) as compared to September (5.0 ± 0.54 days), October (6.2 ±0.37 days) November (7.0 ± 0.44 days), December (7.6 ± 0.51 days) and January (8.4 ± 0.51 days). The largest incubation period was observed in the month of January due to fall in temperature (24.37°C) and relative humidity. Similarly the egg hatching percent was also higher in the month of August with a temperature of 31.79) relative humidity 72.73%. It was followed by September (79.2 ± 4.28) October (75.2 ± 3.45) November (72.0 ± 4.57) December (61.6 ± 5.47) and January (53.6 ± 4.12). The results thus indicated that
there was significantly lowest hatching percentage of egg in January due to lower temperature and relative humidity %. The results in Table 2 showed that adult emergence of male and females of *S.cerealella* was more in the month of August followed by rest of months. The emergence of males was 40% and females 52.0% in the month of August.

In September it was 38.0 percent and 49.0, October (38.0 percent and 48.0%). November (38.0 and 52.0%), December (34.0 and 46.0%) and January (28.0% and 39%) respectively. This is clear from the results that adults emergence was faster in August due to higher temperature and relative humidity percent.

**DISCUSSION**

During present studies it was observed that the Angoumois grain moth *S. cerealella* (Oliver) larvae attack and feed whole kernels of wheat grains, this damage may result in weight losses of kernel as much as of percent for wheat. Badly infested grain has an unpleasant smell.

Similarly many authors have reported that Angoumois grain moth, *Sitotroga cerealella* (Oliver) is one of the major storage pests of cereals. Shukle and Wu, (2003) reported that *Angoumois* grain moth, *Sitotroga cerealella* (Oliver) was found infesting wheat kernels. Similarly Khatak et al (1996) has reported 8 wheat cultivars to *S. Cerealella* under controlled laboratory conditions. The results were evaluated on the basis of percent weight loss, percent damage and progeny development period and grain size. There criteria revealed that none of the cultivars was completely immune to the attack of this pest.

During present study it was noted that *Angoumois* grain moth, *Sitotroga cerealella* (Oliver) is correlated with the temperature and humidity. Similarly many researches have reported the effect of varied temperatures (25, 30 or 35°C) and relative humidities (RH, 40, 50, 60, 70 or 80%) on the incubation, developmental period, percentage of hatching and moth emergence of *Sitotroga cerealella* were studied in the laboratory on rice cv. CR 1014.

The developmental period for the pest was in the range 24, 4-41.5 days. The developmental activity was quickest at 30°C + 80% RH and slowest at 35 °C + 50% RH. It is concluded that storing rice grain at high temperature but low humidity will curb the infestation by the pest. (Shazali, 1997; Maity et al., 1999).

**CONCLUSION**

It is concluded that the temperature ranges of 29°C to 34°C proved best for multiplication of *S. cerealella* on wheat grain, whereas, minimum temperature ranges of 24°C to 29°C displayed slow multiplication.
Contribution of Co-authors

ASLAM BUKERO, IMTIAZ AHMED NIZAMANI AND LUBNA BASIR RAJPUT belong to the department of Entomology, SAU Tandojam are in the supervisory committee of the Master’s student. NAEEM AHMED QURESHI has done the statistical analysis for the research. MUHAMMAD JAVED SHEIKH asked his friend to allow student to conduct the field experiment on his agricultural field and JAM GHULAM MURTZA SAHITO has helped in the technical report writing of this paper.

REFERENCES


Table 1. Monthly egg development period of Angoumois grain moth, *S. cerealella* on sarsabz variety of wheat (Mean ± S.E) (n=25).

<table>
<thead>
<tr>
<th>Months</th>
<th>Temperature (Maximum)</th>
<th>Relative Humidity %</th>
<th>Incubation period</th>
<th>No. of eggs hatched</th>
<th>Hatching (%)</th>
<th>No. of eggs unhatched</th>
<th>Unhatching (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>August-04</td>
<td>31.79±2</td>
<td>72.73±5</td>
<td>4.8 ± 0.58</td>
<td>20.0 ± 0.70</td>
<td>80.0 ± 2.83</td>
<td>5.0 ± 0.70</td>
<td>20.0 ± 2.83</td>
</tr>
<tr>
<td>September-04</td>
<td>31.64±2</td>
<td>71.05±5</td>
<td>5.0 ± 0.54</td>
<td>19.8 ± 1.07</td>
<td>79.2 ± 4.28</td>
<td>5.2 ± 1.07</td>
<td>20.8 ± 4.28</td>
</tr>
<tr>
<td>October-04</td>
<td>29.68±2</td>
<td>66.09±5</td>
<td>6.2 ± 0.37</td>
<td>18.8 ± 0.86</td>
<td>75.2 ± 3.45</td>
<td>6.2 ± 0.86</td>
<td>24.8 ± 3.45</td>
</tr>
<tr>
<td>November-04</td>
<td>28.56±2</td>
<td>65.83±5</td>
<td>7.0 ± 0.44</td>
<td>18.0 ± 1.14</td>
<td>72.0 ± 4.57</td>
<td>7.0 ± 1.14</td>
<td>28.0 ± 4.57</td>
</tr>
<tr>
<td>December-04</td>
<td>26.13±2</td>
<td>65.30±5</td>
<td>7.6 ± 0.51</td>
<td>15.4 ± 1.36</td>
<td>61.6 ± 5.47</td>
<td>9.6 ± 1.36</td>
<td>38.34 ± 5.47</td>
</tr>
<tr>
<td>January-05</td>
<td>24.37±2</td>
<td>63.13±5</td>
<td>8.4 ± 0.51</td>
<td>13.4 ± 1.03</td>
<td>53.6 ± 4.12</td>
<td>11.6 ± 1.03</td>
<td>46.4 ± 4.12</td>
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</table>
Table 2. Duration (days ±SE); Adult emergence; mortality (%) and sex ratio (Mean ± S.E) in male and female adults of Angoumois grain moth, *S. cerealella* on sarsabz variety of wheat (n=20).

<table>
<thead>
<tr>
<th>Months</th>
<th>Temperature (Maximum)</th>
<th>Relative Humidity %</th>
<th>Adult Duration (days)</th>
<th>Adult emergence</th>
<th>Mortality (%) (Male + Female)</th>
<th>Sex ratio</th>
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</thead>
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<tr>
<td>August-04</td>
<td>31.79±2</td>
<td>72.73±5</td>
<td>2.6 ± 0.40</td>
<td>7.6 ± 0.51</td>
<td>38.0 ± 2.55</td>
<td>10.0 ± 1.58</td>
</tr>
<tr>
<td>September-04</td>
<td>31.64±2</td>
<td>71.05±5</td>
<td>2.8 ± 0.37</td>
<td>7.6 ± 0.51</td>
<td>38.0 ± 2.55</td>
<td>9.8 ± 0.66</td>
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<tr>
<td>October-04</td>
<td>29.68±2</td>
<td>66.09±5</td>
<td>2.8 ± 0.37</td>
<td>8.0 ± 0.31</td>
<td>40.0 ± 1.58</td>
<td>9.6 ± 0.51</td>
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<tr>
<td>November-04</td>
<td>28.56±2</td>
<td>65.83±5</td>
<td>3.2 ± 0.37</td>
<td>7.2 ± 0.58</td>
<td>38.0 ± 2.55</td>
<td>10.20 ± 0.73</td>
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<tr>
<td>December-04</td>
<td>26.13±2</td>
<td>65.30±5</td>
<td>5.2 ± 0.58</td>
<td>6.8 ± 0.37</td>
<td>34.6 ± 1.87</td>
<td>9.2 ± 0.37</td>
</tr>
<tr>
<td>January-05</td>
<td>24.37±2</td>
<td>63.13±5</td>
<td>7.2 ± 0.37</td>
<td>5.6 ± 0.40</td>
<td>28.0 ± 2.0</td>
<td>7.8 ± 0.58</td>
</tr>
</tbody>
</table>
BIODIVERSITY OF INSECT PESTS AND PREDATORS OF WINTER CROPS

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4Information Technology Centre
Sindh Agriculture University Tandojam
3Department of Zoology, University of Sindh Jamshoro, Pakistan.
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ABSTRACT

The assessment of insect pests and predators diversify on some winter crops was carried out during the year 2014-2015. The population of four insect pests (thrips, aphid, whitefly, spiders) and two predators (predatory beetles and predatory mites) was assessed. On carrot, increasing tendency of thrips and peak population was 3.0/plant (6 March) averaging 1.66/plant; while whitefly was in the range of 0.07 and 1.40/plant reaching peak (1.40/plant) on 20th Feb. averaging 0.66/plant. Aphid population was in the range of 0-1.02/plant reaching at peak (1.02/plant) on 6th March, averaging 0.66/plant; while spider population found scattered in the range of 0-0.42/plant, reaching at peak level on 27th Feb, averaging 0.11/plant. Predatory beetles and mites showed no consistency; population of beetles were in the range of 0-0.35 averaging 0.08/plant and mites 0-0.30/plant averaging 0.06/plant. On spinach, thrips population was in the range of 0-2.62/plant, reaching peak on 13th March, averaging 1.19/plant; while whitefly was in the range of 0.15-1.07/plant reaching its peak on 20th Feb averaging 0.67/plant; and aphid population was in the range of 0.07-0.20/plant reaching peak level on 6th Feb, averaging 0.11/plant.

Key Words: Biodiversity, Insect Pests, Predators, Winter Crops

INTRODUCTION

Various insects and mites damage winter vegetables at all stages of growth. Occasionally new pests are noticed, which are different to the pests seen in the past. Common and new insect pests are a concern for the farming community, as they could threaten the agricultural and horticultural crops (Sorensen, 1988 and Burt et al. 2014). Carrots, Daucus carota L. are mainly attacked by several species of leafhopper (Kenneth et al. 2001). The six-spotted leafhopper is the principal carrier of aster yellows, a virus disease of carrots. Leafhopper control is essential for this area if quality carrots are expected (Stevenson and Chapat, 1998 and Webb, 2008).

In spinach, green peach aphid is one of the major insect pests that feed by sucking juice from the spinach plant. Aphid populations seldom reach sufficient levels to reduce spinach yield. The principal concern surfaces when aphids are detected in the processed spinach product in the can (Holloway et al. 2003). Beneficial activity, however, is more limited during much of the cool season in which spinach is grown (Sweeden and McLeod, 1997, (MacNab et al. 1983).

Aphids, followed by thrips and other insect pests such as the white fly can cause serious
damage to fennel plants and the herb is susceptible to such pests, the fennel is also susceptible to being affected by root rot especially if the soil is too moist or water logged (Banerji, 2000). There is a number of insect pests that attack fennel crop which included thrips, aphid, whitefly etc (El-Bardai et al. 2001).

A number of natural enemies such as lacewings and ladybugs will give some biological control. (Burt et al. 2014). Adults are 1/3 to 1/2 inch long. White eggs are deposited on foliage or on the body of the host (in the picture below, the tachinid fly is approaching the larvae of an elm leaf beetle). Larvae are internal parasites, feeding within the body of the host; sucking its body fluids to the point the pest dies (Banerji, 2000). Keeping in view the importance of vegetable and medicinal plants such as carrot, radish, spinach, fennel and economic significance of different insect pests of these crops, the present study was carried out to evaluate the population of these insect pests and their predators.

**MATERIAL AND METHODS**

The experimental was conducted during the year 2014-2015 to evaluate the population buildup of insect pests of carrot, spinach, radish and fennel crops as well as their predators during their growth periods.

**Experimental design**

The experiment was planned in Randomized Completely Block Design (RCBD), using insects and predators as treatments and observation dates as replicates. The treatment size was 13.5 m². The seedbed prepared for carrot, radish and fennel was comprised of ridges; while for sowing of spinach flat bed was prepared.

**Agronomic practices**

1. **Carrot**

The land was plowed up first with disc plow, followed by disc harrow; later on land was leveled and planked. Hence, a good seedbed was prepared for sowing carrot crop. DAP at the rate of 2 bags ha⁻¹ and 2 bags of urea ha⁻¹ were applied before preparation of ridges. The ridges were prepared at the distance of 45 cm, seed was broadcasted, mixed in soil and irrigated immediately. The sowing was completed on 14-10-2014.

2. **Spinach**

For spinach, the land was prepared as per agronomical recommendations and flat beds were prepared. DAP at the rate of 2 bags ha⁻¹ and 2 bags of urea ha⁻¹ were applied before sowing of seed. The sowing was done on 13-10-2014.

3. **Radish**

The land preparation for radish cultivation followed the way similar to that of carrots. After getting a good seedbed, the ridges were prepared and the seeds were sown using dibbling method. Before preparation of ridges, the DAP and urea were applied as per the recommended dosage. The sowing was done on 15-10-2014.

4. **Fennel**

In order to prepare land for fennel planting, deep plowing was practiced to remove the hard pan of the soil, followed by operation with disc harrow and leveling. After planking the soil, the ridges were prepared
and fennel seed was sown using dibbling method. Before preparation of ridges, the DAP and urea were applied as per the recommended dosage for fennel crop. The sowing was done on 14-11-2014.

**Collection of data on insect infestation**

**Sucking Insects (Thrips, Aphid, Whitefly)**

The observations started 45 days after planting and weekly data on each of the insect pest infestation were maintained. Observations on sucking complex such as, Whitefly, Thrips and Jassids were recorded on the basis of five randomly selected plants per treatment. The average infestation was managed on per plant basis.

**Spider mites**

The population count on the spider infestation on carrot, spinach, radish and fennel crops was started after 15 days after germination and was taken once a week. Five plants per treatment were selected at random and observations were recorded accordingly.

**Predators**

The population buildup of predators (predatory beetles and predatory mites) were also counted on carrot, spinach, radish and fennel crops with first observation after 15 days of germination and were taken once in a week. Five plants per treatment were selected at random and observations were recorded on total number of predators on all selected plants and then average was worked out.

**RESULTS**

**Carrot**

The population on different insect pests of carrot and predators observed for 15 weeks (Table-1) indicate that the tendency of thrips population followed a gradual increase and peak population of the insect was recorded on last observation (6th March, 2015) showing an average population of 1.66/plant. Thrips population during first six weeks was <1/plant, which increased to >1 upto 9th week, >2 upto 12 weeks and later >3/plant during last three weeks of crop. The population of insect was in the range of 0.15 and 3.0/plant. The trend of whitefly population showed a little change over thrips population which was in the range of 0.07 and 1.40/plant reaching its peak population of 1.40/plant on 20th February 2015 averaging 0.66/plant. Whitefly population remained <1/plant upto first 11 weeks, increased to >1 during 12-14 weeks and again declined to <1/plant in the last week of observation.

Aphid population was found in the range of 0 and 1.02/plant reaching its peak population of 1.02/plant on 6th March, averaging 0.22/plant. The insect population remained <1/plant upto 14 weeks and increased to >1 in the last week of observation. The spider population scattered over the period in the range of 0 to 0.42/plant, reaching its peak population on 27th February, averaging 0.11/plant. The insect population remained <1/plant throughout the observation period of 15 weeks. The population of predatory beetles ranged between 0-0.35 averaging 0.08/plant; while the population of predatory mites was in the range of 0-0.30/plant averaging 0.06/plant. The predatory population remained <1/plant during the study period of 15 weeks on carrot.
Table -1. Insect pests and predators population per leaf on carrot

<table>
<thead>
<tr>
<th>Obs. Date</th>
<th>Insect pests</th>
<th>Predators</th>
<th>Predatory mites</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Thrips</td>
<td>Whitefly</td>
<td>Aphid</td>
</tr>
<tr>
<td>28.11.14</td>
<td>0.15</td>
<td>0.07</td>
<td>0</td>
</tr>
<tr>
<td>05.12.14</td>
<td>0.60</td>
<td>0.27</td>
<td>0.05</td>
</tr>
<tr>
<td>12.12.14</td>
<td>0.57</td>
<td>0.27</td>
<td>0</td>
</tr>
<tr>
<td>19.12.14</td>
<td>0.67</td>
<td>0.17</td>
<td>0.07</td>
</tr>
<tr>
<td>26.12.14</td>
<td>0.70</td>
<td>0.15</td>
<td>0.02</td>
</tr>
<tr>
<td>02.01.15</td>
<td>0.80</td>
<td>0.57</td>
<td>0.07</td>
</tr>
<tr>
<td>09.01.15</td>
<td>1.02</td>
<td>0.62</td>
<td>0.32</td>
</tr>
<tr>
<td>16.01.15</td>
<td>1.17</td>
<td>0.65</td>
<td>0.10</td>
</tr>
<tr>
<td>23.01.15</td>
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<td>0.90</td>
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</tr>
<tr>
<td>30.01.15</td>
<td>2.12</td>
<td>0.70</td>
<td>0.52</td>
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<td>06.02.15</td>
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</tr>
<tr>
<td>13.02.15</td>
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<tr>
<td>20.02.15</td>
<td>3.37</td>
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<td>0.20</td>
</tr>
<tr>
<td>27.02.15</td>
<td>3.60</td>
<td>1.25</td>
<td>0.32</td>
</tr>
<tr>
<td>06.03.15</td>
<td>3.80</td>
<td>0.80</td>
<td>1.02</td>
</tr>
<tr>
<td>Total</td>
<td>24.96</td>
<td>9.89</td>
<td>3.33</td>
</tr>
<tr>
<td>Average</td>
<td>1.66 a</td>
<td>0.66 b</td>
<td>0.22</td>
</tr>
</tbody>
</table>

Table -2. Insect pests and predators population per leaf on spinach

<table>
<thead>
<tr>
<th>Obs. Date</th>
<th>Insect pests</th>
<th>Predators</th>
<th>Predatory mites</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Thrips</td>
<td>Whitefly</td>
<td>Aphid</td>
</tr>
<tr>
<td>28.11.14</td>
<td>0.32</td>
<td>0.17</td>
<td>0.10</td>
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<td>06.03.15</td>
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<td>2.62</td>
<td>1.00</td>
<td>0.10</td>
</tr>
<tr>
<td>Total</td>
<td>19.05</td>
<td>10.70</td>
<td>1.82</td>
</tr>
<tr>
<td>Average</td>
<td>1.19 a</td>
<td>0.67 b</td>
<td>0.11</td>
</tr>
</tbody>
</table>
Biodiversity of Insect Pest and Predators of Winter Crops

Table-3  Insect pests and predators population per leaf on radish

<table>
<thead>
<tr>
<th>Obs. Date</th>
<th>Insect pests</th>
<th>Predators</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Thrips</td>
<td>Aphid</td>
</tr>
<tr>
<td>30.11.14</td>
<td>0.70</td>
<td>0.50</td>
</tr>
<tr>
<td>07.12.14</td>
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<td>0.73</td>
</tr>
<tr>
<td>14.12.14</td>
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<td>0.43</td>
</tr>
<tr>
<td>21.12.14</td>
<td>2.03</td>
<td>0.80</td>
</tr>
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<td>2.23</td>
<td>0.55</td>
</tr>
<tr>
<td>04.01.15</td>
<td>3.25</td>
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</tr>
<tr>
<td>11.01.15</td>
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<td>3.45</td>
</tr>
<tr>
<td>18.01.15</td>
<td>1.78</td>
<td>3.15</td>
</tr>
<tr>
<td>25.01.15</td>
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<tr>
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<td>173.52</td>
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<tr>
<td>Average</td>
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<td>11.57</td>
</tr>
</tbody>
</table>

Table-4  Insect pests and predators population per leaf on fennel

<table>
<thead>
<tr>
<th>Obs. Date</th>
<th>Insect pests</th>
<th>Predators</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Thrips</td>
<td>Aphid</td>
</tr>
<tr>
<td>28.12.14</td>
<td>0.62</td>
<td>2.10</td>
</tr>
<tr>
<td>04.01.15</td>
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<tr>
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<td>1.00</td>
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</tr>
<tr>
<td>22.02.15</td>
<td>1.37</td>
<td>16.32</td>
</tr>
<tr>
<td>01.03.15</td>
<td>1.67</td>
<td>12.72</td>
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<tr>
<td>Total</td>
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<tr>
<td>Average</td>
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<td>13.86 a</td>
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</tbody>
</table>

Spinach

The analysis of variance (Table-2) indicated that there was significant difference in the population on different insect pests and predators on spinach (F=40.9630; DF=4, 79; P<0.01) as well as between observation dates (F=2.0919; DF=15, 79; P<0.0227). Population of different spinach insect pests and predators recorded for 16 weeks (Table-23) showed that the trend of thrips population followed a gradual increase and peak population of the insect was recorded in the last week (13th March) indicating an average population of 1.19/plant. Thrips population during first six weeks was
<1/plant, which increased to >1 upto 14th week, >2 during last two weeks of crop. The population of insect was in the range of 0.30 and 2.62/plant. The whitefly population on spinach was in the range of 0.15 and 1.07/plant reaching its peak population on 20th February averaging 0.67/plant. The insect population remained <1/plant upto first 12 weeks, increased to >1 during rest of the crop period. Aphid population was found in the range of 0.07 and 0.20/plant reaching its peak population on 6th February, averaging 0.11/plant. The insect population remained <1/plant upto throughout the observation period. However, no significant population fluctuation was noted during the study period of 16 weeks. Predatory beetles showed consistency on spinach and remained in the spinach field for whole crop period in the range of 0.05 to 0.20/plant, reaching its peak population on 16th January, averaging 0.11/plant. The predator population remained <1/plant throughout the observation period of 16 weeks. The population of predatory mites also showed consistency during 16 weeks study period on spinach. The population of predatory mites ranged between 0.07 and 0.20/plant, averaging 0.11/plant.

**Radish**

The analysis of variance (Table-3) indicated a significant difference in the population of different insect pests and predators on radish (F=9.1609; DF=5, 89; P<0.01), while non-significant between observation dates (F=0.9278; DF=14, 89; P=0.1342). High coefficient of variation (256.77%) inversely impacted the significance of differences. Population of different insect pests and predators recorded on radish crop for 15 weeks (Table-3) showed no linear trend and thrips population was quite uneven during the period of 15 weeks of study. However, the thrips population reached its peak infestation (3.25/plant) on 4th January, while the minimum population (0.5/plant on 15th February, having an average infestation of 1.39/plant. Thrips population reached >3/plant after 6th week of study and later decreased. The whitefly population on radish was in the range of 0.25 and 0.95/plant reaching its peak population on 4th January averaging 0.53/plant. The insect population remained <1/plant throughout the crop growth period of radish. The spider population on radish was in the range of 0 and 0.13/plant reaching its peak population on 7th December averaging 0.06/plant. The insect population remained <1/plant throughout the growth period of radish. No consistency and no linear trend of population buildup was found in case of predatory beetles and predatory mites on radish. Predatory beetle population was in the range of 0-0.25/plant reaching its peak population on 25th January, averaging 0.10/plant. The predator population remained <1/plant throughout the study period. The population of predatory mites ranged between 0.0 and 0.18/plant, averaging 0.04/plant, indicating the predator population remained scattered and <1/plant throughout the growth period of radish.

**Fennel**

The analysis of variance (Table-4) showed that the differences in the population of different insect pests and predators on fennel was significant (F=53.1601; DF=5, 59; P<0.01), while non-significant between observation dates (F=1.1244; DF=9, 59; P=0.3659). The coefficient of variation was relatively higher (92.16%) inversely affected the significance of differences between observation dates. Population of different
DISCUSSION

Winter crops like carrot, spinach, radish, fennel etc. are always left unsprayed against insect pests and in result the production level of these crops is far less in the country as compared to advanced agricultural countries of the world. Various insect pests and predators damage winter vegetables at all stages of growth. The present study was the study on the assessment of insect pests and predators diversify on some winter crops (carrot, spinach, radish, and fennel). The results showed that on carrot increasing tendency of thrips and peak population was 3.0/plant (6th March) averaging 1.66/plant; while whitefly was in the range of 0.07 and 1.40/plant reaching peak (1.40/plant) on 20th Feb. averaging 0.66/plant. Aphid population was in the range of 0-1.02/plant reaching at peak (1.02/plant) on 6th March, averaging 0.22/plant; while spider population found scattered in the range of 0-0.42/plant, reaching at peak level on 27th Feb, averaging 0.11/plant. Predatory beetles and mites showed no consistency; population of beetles was in the range of 0-0.35 averaging 0.08/plant and mites 0-0.30/plant averaging 0.06/plant. In a similar investigation Stevenson and Chaput (1998); Webb (2008) have reported infestation of sucking complex and spiders on the carrot leaves. Similar results have also been reported by Stevenson and Chaput (1998). Furthermore, Brunke et al. (2014) described the beetles predating carrot insect pests. Present study indicated that on spinach thrips population was in the range of 0.30-2.62/plant, reaching peak on 13th March, averaging 1.19/plant; while whitefly was in the range of 0.15-1.07/plant reaching its peak on 20th Feb averaging 0.67/plant; and aphid population was in the range of 0.07-
0.20/plant reaching peak level on 6th Feb, averaging 0.11/plant. Predatory beetles showed consistency, were in the range of 0.05-0.20/plant, reaching peak level on 16th Jan, averaging 0.11/plant; while predatory mites were in the range of 0.07-0.20/plant, averaging 0.11/plant. These results are further supported by Mound and Kuo (1996) who have reported thrips infestation on spinach. Nuessly and Webb (2014) studied the insect pests of leafy vegetables including spinach and concluded that damage to leafy vegetables results from holes chewed in leaves by caterpillars and beetles, leaf mining by fly larvae and disease transmission and head contamination by piercing sucking insects. Major pests of these crops are beet and southern armyworms, cutworms, cabbage loopers, dipterous leaf-miners, aphids, cucumber beetles and wireworms. Less common pests of leafy vegetables include seed corn maggot, seed corn beetle and corn earworm. In another study, Palumbo (2000) reported aphid and thrip population dynamics in spinach. Aslam et al. (2004) reported aphid, Lipaphis erysimi Kalt. on leafy vegetables. It was further noted that on radish, thrips population was in the range of 0.50-39.25/plant, reaching peak infestation (3.25/plant) on 4th Jan, averaging 1.39/plant; while aphid population was in the range of 0.50-39.25/plant reaching peak level on 1st March, averaging 11.57/plant. Whitefly on radish was in the range of 0.25-0.95/plant reaching peak level on 4th Jan averaging 0.53/plant; while spider population was in the range of 0-0.13/plant reaching peak level on 7th Dec. averaging 0.06/plant. Predatory beetle was in the range of 0-0.25/plant reaching peak population on 25th Jan, averaging 0.10/plant; while predatory mites were in the range of 0-0.18/plant, averaging 0.04/plant. These results reported by Eastman et al. (1995) who concluded that infestation radish leaves were attacked by thrips and aphids severely. Buntin and Beshear (1995) studied thrips abundance in radish and concluded that among thrips Limothrips cerealium and Frankliniella fusca were the 2 dominant species comprising >89% of the adult thrips collected in both crops. Alumbo (1997) concluded that like aphids, thrips can disperse onto radish crops at anytime. The results showed that thrips on fennel reached peak level (2.37/plant) on 18th Jan, averaging 1.20/plant; and aphid was in the range of 2.10-19.57/plant getting peak level on 1st Feb, averaging 13.86/plant; while whitefly was in the range of 0.08-0.77/plant reaching peak on 18th Jan averaging 0.41/plant; and spider population was in the range of 0-0.25/plant reaching peak on 25th Jan averaging 0.14/plant. However, predatory beetle population was in the range of 0-0.22/plant reaching peak level on 8th Feb, averaging 0.06/plant; while predatory mites ranged between 0-0.10/plant, averaging 0.01/plant, indicating almost absence of this predator from the field. These results are further supported by Banerji (2000), who reported that aphids followed by thrips and other insect pests such as the white fly can cause serious damage to fennel plants and the herb is susceptible to such pests; the fennel is also susceptible to being affected by root rot especially if the soil is too moist or water logged. There is a number of insect pests that attack fennel crop which included thrips, aphid, whitefly etc (El-Bardai et al. 2001).
REFERENCES


