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Population dynamics of insect pests on Loofah, *Luffa cylindrica* Mill., (Cucurbitales: Cucurbitaceae), cultivars in Peshawar

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Abstract
Insect pests pose heavy threat to loofah crop worldwide. For efficient management of insect pests, detail study of its population dynamics is utmost important. The present study was carried out at the New Developmental Farm (NDF) of The University of Agriculture, Peshawar in 2014. Four loofah cultivars, i.e. Peshawar local, Chikni (India local), Agro (India hybrid) and Malik were sown separately in May, 2014 and replicated three times. Overall mean density of aphids was non-significantly higher (0.28 aphids leaf^{-1}) on Chikni and lower (0.21 aphids leaf^{-1}) each on Peshawar local and Agro. Overall mean density of the thrips was significantly higher (1.41 thrips/leaf) on Peshawar local and Malik (1.40 thrips/leaf) and lower (1.26 thrips/leaf) on Agro. Overall mean density of the fruit fly was significantly higher (1.08 flies/pest) on Malik and lower (0.83 flies/fruit) on Peshawar local and Chikni (0.84 flies/fruit). Overall mean percent infested fruits were highest of 84.15% for Peshawar Local and lowest of 55.11% for Agro. Mean yield of loofah fruit was significantly higher (19100 kg/ha) for Agro. On the basis of the above results cultivar Agro is recommended to the growers. Results of the present investigation may be utilized in developing a sustainable pest management strategy against insect pests of loofah in the agro-ecological system of Peshawar.

Keywords: Aphids, Fruit fly, Loofah cultivars, Population dynamics, Thrips

1. Introduction
Luffa cylindrica Mill., (Cucurbitales: Cucurbitaceae), is also known as vegetable sponge or sponge gourd [1]. In addition to being used as edible vegetable, *L. cylindrinca* finds wide applications such as packing medium, shoes mats, sound proof linings, bath sponges, utensil cleaning sponge [2], adsorbent for heavy metal in waste water [3] and immobilization matrix for plant, algae, bacteria and yeast. Additionally, the luffin, a ribosome- inactivating protein isolated from Luffa seed, has been shown to be effective against growth of parasites, protozoa, insects, fungi and HIV [4]. The total area under cultivation of Loofah in Pakistan during 2008-09 was 20982 hectares and total production was 20982 tons [5].
Despite large number of cultivars in the field, Loofah yield per unit in Pakistan is lower than international standard due to many factors like poor cultural practices, poor weed control, pest attack, etc. Amongst these pests and diseases are major causes of low yield [6].
Loofah is attacked by a number of insect pests throughout its vegetative and production phases including which squash bug, squash vine borers, cucumber beetles, red pumpkin beetle, ants, thrips, fruit flies [7] and aphids are important [8].
Aphids are insect crop pests that develop tight interactions with their host plants, due to the peculiarity of their food source: the plant phloem sap. As for all phloem feeders, nutritional adaptation is mediated by the presence of a bacterial endosymbiont (*Buchnera aphidicola* in aphids) that is harbored in unique cells, called bacteriocytes, and is required to integrate the nutritionally unbalanced food source [9].
Fruit flies are important pests of fruits, vegetables, and other ornamental plants [10]. Several biotic factors limit the production and productivity of cucurbits, of which the cucurbit fruit fly, *Bactrocera cucurbitae* (Coquillett) (Diptera: Tephritidae), has been the most prominent pest. The extent of yield-loss caused by the pest to cucurbitaceous vegetables ranges from 30–100%, depending upon cucurbit species and the season [11]. Maggots feed inside the fruits, but at times also feed on flowers and stems. Generally, the females prefer to lay eggs in soft, tender fruit tissues by piercing the tissue with the ovipositor. A watery fluid oozes from the puncture, which becomes slightly concave with seepage of fluid and transforms into a brown

resinous deposit. Sometimes pseudo-punctures (punctures without eggs) have also been observed on the skin of fruit. These punctures reduce the market value of the produce. The eggs are laid into unopened flowers, and the larvae successfully develop in the taproots, stems, and leaf stalks [12]. *B. cucurbitae*) is another destructive pest of cucurbits causing direct yield loss. Bitter gourd, melon, sponge gourd and ash gourd are the most preferred hosts of fruit fly [13].

Keeping in view the importance of loofah as vegetable crop, and the damages caused to it by various insect pests, the present study aimed to determine population dynamics of insect pests of on four loofah cultivars.

2. Materials and Methods

2.1 Experimental layout

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Each replication consisted of four treatments. Each loofah cultivar, i.e. Peshawar local, Chikni (India local), Agro (India hybrid) and Malik was sown separately in each treatment. The loofah was sown in lines on ridges in May, 2014. A buffer zone of half meter was kept between the treatments for isolation. Size of the whole experimental field was 25 m x 14 m and size of each treatment was 5x4 m. Plant to plant and row to row distance was kept 6 cm and 65 cm, respectively. Standard agronomic practices were applied in the field throughout the loofah growing season. The field was left open for natural infestation of insect pests. Data was recorded on loofah leaves, stem and fruits from germination till maturity of the crops at weekly intervals.

2.2 Collection and recording of insect pests

The aphids, thrips and fruit fly data was recorded weekly between 07 to 11 am on three randomly selected leaves (top, middle and bottom) and flowers of each of the 10 selected plants in each of three rows per treatment. The two border rows were excluded from data recording. Progress of the aphids was determined by the aphids leaf^{-1} count method [14].

The collected leaves and flowers were separately placed into 500 ml plastic bottles containing 70% ethyl alcohol. The fruits were put in ethylene bags and labeled. The samples were transported to the laboratory where the leaves and flowers were washed to dislodge the insect pests. The infested fruits were cut with a sharp knife to count the number of fruit fly larvae inside each fruit. The insects were counted under a Stereo microscope at 40x magnification. The identified specimens were deposited in the Insect Museum, Department of Entomology.

2.3 Statistical analysis

The data recorded for each parameter was analyzed statistically by using Statistix 8.1 Software and means were separated by using Fisher Protected Least Significance Difference Test at 5% level of significance [15].

3. Results and Discussion

Density of the aphids fluctuated on the luffah cultivars, where it was higher on Peshawar local (0.27 aphids leaf^{-1}), Malik (0.13 aphids leaf^{-1}), Chikni (0.51 aphids leaf^{-1}), Chikni (0.41 aphids leaf^{-1}), Malik (0.55 aphids leaf^{-1}) and Peshawar Local (0.42 aphids leaf^{-1}) in week 1, 2, 3, 4, 5 and 6, respectively (Table 1). Overall mean density of the pest was non-significantly different on the four loofah cultivars, where it was higher (0.28 aphids leaf^{-1}) on Chikni and lower (0.21 aphids leaf^{-1}) each on Peshawar local and Agro.

Table 1: Mean density of aphids leaf^{-1} on four loofah cultivars during 2014.

Cultivar	Mean density of aphids leaf^{-1} in week							Overall mean
	1	2	3	4	5	6	7	
Peshawar Local	0.27 a-i	0.00 i	0.20 b-i	0.13 e-i	0.24 b-i	0.42 a-e	0.22 b-i	0.21a
Chikni	0.07 f-i	0.02 hi	0.51 a	0.41 abc	0.43 a-d	0.37 a-f	0.13 f-i	0.28 a
Agro	0.07 ghi	0.09 f-i	0.09 f-i	0.23 b-i	0.46 ab	0.36 a-g	0.19 c-i	0.21 a
Malik	0.20 b-i	0.13 d-i	0.29 a-h	0.21 b-i	0.55 a	0.29 a-i	0.10 ghi	0.25 a
LSD Value	0.15	0.06	0.27	0.25	0.42	0.36	0.16	ns

Means in columns followed by different letters are significantly different at 5% level of significance. ns = non-significant.

Aphids are important pests of cultivated crops in Pakistan. They not only reduce the yield of crops but also serve as vectors of disease. There are about 92 species of aphids in Pakistan. In Pakistan, aphids have mostly been controlled by insecticides applications. However, due to adverse effects of insecticides, total reliance on them cannot be made. Alternative control strategy should be devised against the 30 aphid species. Forty two aphid predators were identified, which showed a large complex of natural enemies existing in the aphid environment [8].

The results in table 2 shows that mean density of thrips was significantly higher on Peshawar local (1.44 thrips flower^{-1}), Peshawar local (1.76 thrips flower^{-1}), Peshawar local (1.56 thrips flower^{-1}), Malik (0.94 thrips flower^{-1}), Chikni (0.78 thrips flower^{-1}), Malik (2.17 thrips flower^{-1}), Malik (2.48 thrips flower^{-1}), Malik (2.12 thrips flower^{-1}), Peshawar local (1.44 thrips flower^{-1}) in week 1, 2, 3, 4, 5, 6, 7, 8, 9, respectively. Overall mean density of the pest was significantly higher (1.41 thrips flower^{-1}) on Peshawar local and Malik (1.40 thrips flower^{-1}) and lower (1.26 thrips flower^{-1}) on Agro.

Table 2: Mean density of thrips flower^{-1} of four loofah cultivars during 2014.

Cultivar	Mean density of thrips flower^{-1} in week									Overall mean
	1	2	3	4	5	6	7	8	9	
Peshawar Local	1.44 i-e	1.76 i-e	1.56 Ef	0.62 mn	0.65 lmn	0.97 h-m	2.12 bc	2.09	1.44a	1.41a
Chikni	0.89 j-k	0.99 k-n	1.56 Ef	0.87 j-n	0.78 k-n	1.32 fgh	1.92 bcd	2.04	1.22b	1.32ab
Agro	0.94 j-k	0.71 k-n	1.33 Fg	0.70 k-n	0.69 k-n	1.77 cde	2.15 ab	2.05	1.00c	1.26b
Malik	1.02 i-e	0.71 k-n	1.41 Ef	0.94 i-m	0.55 n	2.17 Ab	2.48 a	2.12	1.12b	1.40a
LSD Value	1.08	1.04	1.46	0.78	0.67	1.56	2.17	ns	0.30	0.22

Means in columns followed by different letters are significantly different at 5% level of significance. ns = non-significant.

Biology and control of *Thrips flavus* Schroeder, an important pest of cucurbits, was carried out under field conditions in southern Taiwan in 1979-80. Both larvae and adults suck the plant sap within shoots and flowers, causing the stunting of shoots and retarding terminal growth; which results in the yellowing of leaves, wilting of flowers and scarring of fruit. Wax gourd (*Benincasa hispida*) was found to be the most susceptible cucurbit to attack, followed by nodose wax gourd, watermelon, cucumber, pumpkin, vegetable sponge (*Luffa cylindrica*), muskmelon, balsam pear (*Momordica charantia*) and calabash gourd (*Lagenaria siceraria*). The thrips was present throughout the year, its populations increasing during the dry season (October-December and January-March) and decreasing during the wet season (July-August). When the effectiveness of sprays of 9 insecticides applied 4 times at 7-day intervals was evaluated for the control of the thrips on watermelon in field-plot tests, treatments with deltamethrin (Decis) and carbofuran (Furadan) were the best [16].

The results in table 3 shows that mean density of fruit fly was significantly higher on Malik (0.13 flies fruit^{-1}), Peshawar local (0.77 flies fruit^{-1}), Chikni (0.90 flies fruit^{-1}), Chikni (1.57 flies fruit^{-1}), Agro (1.37 flies fruit^{-1}), Malik (1.70 flies fruit^{-1}), Peshawar local (1.63 flies fruit^{-1}) in week 1, 2, 3, 4, 5, 6 and 7, respectively. Overall mean density of the pest was significantly higher (1.08 flies fruit^{-1}) on Malik and lower (0.83 flies fruit^{-1}) on Peshawar local and Chikni (0.84 flies fruit^{-1}).

Table 3: Mean density of fruit flies fruit^{-1} on four loofah cultivars during 2014.

Cultivar	Mean density of fruit flies fruit^{-1} in week							Overall mean
	1	2	3	4	5	6	7	
Peshawar Local	0.13 j	0.77 e-i	0.87 d-i	1.30 a-d	1.20 a-e	1.70 a	1.57 abc	1.08 a
Chikni	0.10 j	0.53 g-j	0.90 d-h	1.33 a-d	1.37 a-d	1.67 ab	1.17 b-e	1.01 ab
Agro	0.07 j	0.37 ij	0.57 f-j	1.57 abc	1.27 a-e	1.07 c-f	1.00 d-g	0.84 b
Malik	0.07 j	0.37 ij	0.43 hij	0.93 d-h	1.03 d-g	1.37 a-d	1.63 ab	0.83 b
Means	0.09	0.51	0.69	1.28	1.22	1.45	1.34	0.07

Means in columns followed by different letters are significantly different at 5% level of significance. ns = non-significant.

Fruit fly density was recorded at six locations in District Srinagar and District Budgam of the Jammu and Kashmir, India. Various cucurbit crops, such as cucumber, bottle gourd, ridge gourd and bitter gourd, were selected for the study. With regard to locations, mean fruit fly population was highest (6.09, 4.55, 3.87, and 3.60 flies/trap/week) at Batamaloo and Chadoora (4.73, 3.93, 2.73, and 2.73 flies/trap/week) on cucumber, bottle gourd, ridge gourd, and bitter gourd, respectively. The population of fruit flies was significantly correlated with the minimum and maximum temperature. The maximum species diversity of fruit flies was 0.511, recorded in Chadoora. *Bactrocera cucurbitae* (Coquillett) (Diptera: Tephritidae) was the most predominant species in both Srinagar and Budgam, followed by *B. dorsalis* (Hendel) and *B. tau* (Walker), while *B. scutellaris* (Bezzi) was found only in Chadoora [17].

Occurrence and distribution of the Pumpkin or cucurbit Fruit Fly, *Dacus ciliatus* Loew as re-appearing pest on Cucurbitaceae in addition to its biology. *D. ciliatus* was found in ten Egyptian governorates from 2002 till 2004, causing serious damage for gourd, marrow, cucumber, cantaloupe, melon and luffa [18].

Table 4 shows percent infested fruits for the four loofah cultivars by the fruit flies. The results show that percent infested fruits remained highest for Peshawar local in all the 8 weeks, where it was 80.00%, 78.18%, 82.00%, 85.00%, 86.86%, 88.57%, 87.00%, 87.00%, in week 1, 2, 3, 4, 5, 6, 7, 8, respectively. Overall mean percent infested fruits were highest of 84.15% for Peshawar Local and lowest of 55.11% for Agro.

Table 4: Mean percent infested fruits of four loofah cultivars during 2014.

Cultivar	Percent infested fruits in week								Overall Mean
	1	2	3	4	5	6	7	8	
Peshawar Local	80.00%	78.18%	82.00%	85.00%	86.86%	88.57%	87.00%	88.00%	84.15 %
Chikni	75.00%	76.25%	73.33%	75.00%	76.25%	78.33%	73.33%	73.45%	75.11%
Agro	57.50%	55.00%	53.08%	55.93%	53.33%	53.53%	56.47%	56.00%	55.11%
Malik	66.67%	61.11%	68.89%	63.45%	64.85%	68.46%	68.89%	65.88%	66.03 %
LSD Value	9.79	10.14	6.32	3.59	9.32	7.22	7.17	6.33	10.12

Host plant resistance is an important component of the *B. cucurbitae* owing to difficulties associated with its chemical and biological control. Twenty nine ridge gourd varieties/genotypes were evaluated to screen the susceptible and resistant varieties/genotypes against the fruit flies. The results imparted that the percentage of fruit fly infestation and larval population per fruit on tested varieties/genotypes of ridge gourd varied significantly. Pooled data showed that the AHRG-49, AHRG-33, AHRG-42, AHRG-30, AHRG-23, AHRG-58, AHRG-50, AHRG-28, AHRG-42, AHRG-52 and AHRG-59 were categorized as susceptible varieties/genotypes with fruit infestation (70.85%, 68.13%, 57.97%, 55.93%, 70.17%, 55.00%, 53.25%, 65.75%, 57.82%, 68.68% and 65.83%, respectively) and larval population per fruit (22.27, 28.92, 25.93, 22.73, 22.63, 24.28, 22.27, 23.42, 24.12, 21.97, 24.93 and 24.13, respectively). whereas, the varieties/genotypes AHRG-29, AHRG-57, and Pusa Nasdar had fruit infestation (17.92%, 16.22%, and 18.50%, respectively) and larval population per plant (16.60, 13.45, and 14.55, respectively) and declared as resistant varieties/genotypes to fruit fly. The AHRG-47, AHRG-31, AHRG-48 and AHRG-61 with fruit infestation (78.02%, 80.13%, 80.10%, and 79.42%, respectively) were highly susceptible varieties/genotypes to fruit fly in pooled data of both the seasons viz., 2011 and 2012. Lower values of host plant susceptibility indices based on fruit infestation (HPSI) were recorded on resistant varieties/genotypes, AHRG-29, AHRG-57 and Pusa Nasdar (36.12%, 32.69% and 37.29%, respectively) could be used as a source of resistance for developing ridge gourd varieties/genotypes resistant to fruit fly [19].

B. cucurbitae has been found a serious insect pest of cucurbits vegetables and fruits in different parts of the world. Damage

caused of other species, lesser pumpkin fly, *Dacus ciliatus* Loew was in India and Africa. The infestation of other species, like lesser pumpkin beetle and *Dacus ciliatus* was reported on few cucurbits. Fruit fly was recorded throughout the year and highest no of fruit fly were recorded in August (14.14/trap/week). The collected fruit flies were significantly positively correlated with a biotic factor of the environment. Highest emergence of 494.64/kg of *B. cucurbitae* was recorded on bitter gourd [20].

B. cucurbitae is a major pest of cucurbitaceous vegetables including cucumber (*Cucumis sativus)*, ridge gourd (*Luffa acutangula*), bitter gourd (*Momordica charantia*) and pickling cucumber (*C. sativus*) and fruits in many parts of the world. Crop loss is often >60% [21]. *D. ciliates*, a serious pest of cucurbits in Saudi Arabia [22], is distributed in Africa, Atlantic Islands and oriental Asia [23]. In India, this species generally infests a large number of melons and wild cucurbits to a relatively lesser extent though, in patches serious damage is reported [24]. *D. ciliatus* is relatively smaller than *B. cucurbitae*, orange in color, with facial spots. Costal band is apically expanded to form a small apical spot and a basal oblique spot. Abdomen has two black spots especially in females.

4. Conclusion and Recommendations

Aphids, thrips and fruit fly were the insect pests recorded on the four loofah cultivars. Insect pests infestation remained almost constant on the four loofah cultivars. Aphids density was higher on Peshawar local and Malik and lower on Agro. Thrips density was higher on Peshawar Local and Malik, while lower on Agro and Chikni. Fruit fly density was higher on Peshawar local and Chikni and lower on Agro and Malik. Fruit fly infested fruits were higher for Peshawar local and lower for Agro. Because of low insect pest infestation cultivar Agro is recommended to the farmers.

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