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Overview on seasonal abundance of major insect pests and their natural enemies on okra: A review

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Abstract
The production and yield of this okra crop is quit often very much hampered, as high as 72 species of insect have been recorded on okra crop, of which, the sucking pests comprising of Aphids, leafhopper, whitefly, and mite, causes significant damage to the crop. The leafhopper suck the cell sap usually from lower surface of the leaves and inject toxic saliva into plant tissues, resulting in curling of leaves as a result the plant growth is retarded. The milky white minute flies; nymphs and adults suck the cell sap from the leaves. Whiteflies do acts as vector and transmit yellow vein mosaic viral diseased from disease plant to healthy plants. Aphids are considered as the major pest of okra. It is a polyphagous pest, attacking a wide range of plant belonging to 46 families. Aphids and leafhoppers are important pests in the early stage of the crop, which de-sap the plants, make them weak and reduce the yield. Failure to control them in the initial stages was reported to cause a yield loss to the tune of 54.04%. The fruit borers include shoot and fruit borers are the most horrendous pests causing serious turndown of the produce, in terms of quality as well as of quantity.

Keywords: seasonal abundance, major insect pests, natural enemies, okra

Introduction
Okra is suitable for cultivation as garden crop as well as on commercial large farms. It is a short time vegetable crop and grown for its immature edible pods, seeds, cherished for its tender and green fruits used for vegetable, soups or it is preserved by freezing and canning for off-season consumption (Vijaya *et al*., 2004) [8]. The roots and stems are used for clearing cane juice for preparation of jaggery. Though okra finds its origin in South Africa, India is the largest producer of okra with 73.25 per cent share in world production and 11.60 t/ha productivity meanwhile total area and production under okra was 513 thousand hectares and 6170 thousand tones, respectively (Indian Horticulture database, 2018-2019).
The Insect pests of okra eat a variety of other plant species, such as cotton and pulses. Because of the pest's effects on plant stand and fruit yield declines, thorough research has been undertaken to establish management strategies for this pest. Agronomical practices, natural enemies, synthetic insecticides, and host plant resistance have all been proposed to mitigate losses incurred by sucking pests but adopting all of these practices are not always feasible. One of the most effective ways of maintaining insect species below economic threshold in such conditions is to use tolerant or less-susceptible cultivars. However, an effective insect pest management program can reduce pest-related losses and ensure appropriate pest control. Pest management methods including insect-plant resistance do not entail any increased costs or implementation abilities. Host-plant resistance, on the other hand, is not a cure for all pest problems. It is most effective when used in combination with other pest-control initiatives. The usage and adoption of okra varieties with stand major attacking pests. Resistance is crucial because it lowers cultivation costs and stabilizes yields. As a result, genotypes widely found in the region were evaluated for pest tolerance to find the most resistant genotype suiting to the local agro-climatic conditions.

Seasonal abundance of Jassids
In India the infestation of leafhopper was started during third week and second week of March (12th SMWS and 11th SMWS) and reached to its peak in the first week of May and third week of April 2017 and 2018, respectively. The leafhopper population generally shows positive significant correlation with maximum and minimum temperature. Among the insect pests that cause economic damage on okra, *Amrasca biguttula biguttula* Ischida have been observed on the cultivated plot of okra during the June to October.

The diversity of insect pests and their predators in okra agroecosystem and reported a total of 17 insect pest species belonging to different orders and different families among which hemiptera had shown highest number of seven species which was further followed by Lepidoptera (6 species), Coleoptera (3 species) and Orthoptera (1 species). The predator population was also quite diverse in their occurrence with the observed species belonging to the orders as Coleoptera, Lepidoptera, Hemiptera and Dictyoptera.

Jassids first appeared in fourth week of July and their peak population was obtained in second and fourth week of September, respectively. They also found that whitefly density was positively correlated with maximum temperature as reported by Kumawat *et al*. In year 2020.

The most average incidence of 52.44±3.99 insects per plant of *A. biguttula biguttula* Ischida were recorded, during the 2009 season, (June to October) meanwhile the most average incidence of 54.44±4.51 infestation of *A. biguttula biguttula* Ischida, were recorded respectively, during the 2010 season, (June to October). Effects of agroclimatic factors on the growth of insect pests revealed that temperature, relative humidity and rainfall had shown direct effect on the population trend of all insect pests as recorded by Benchasri (2013) [1].

Khan *et al.* (2015) [3] studied population densities of insect pest and their natural enemies on okra and reported that densities of insect pests as well as their natural enemies peaked in June-July. They recorded highest density of *Amrasca biguttula biguttula* (47.03 adults/leaf) on 7th July, *Cerotoma trifurcate* (0.14 adults /leaf) on 14thJuly and *Dysdercus koenigii* (1.03 adults/leaf) on 21st July. Highest density of *Coccinella septempunctat* (0.58/ leaf) was on 21st July, *Dictyna sp.* (0.36/leaf) on 21stJuly and *Solenopsis invicta* (2.25/leaf) on 16th June. The present work might help in devising IPM against insect pests of okra especially using its natural enemies in Peshawar.

Chauhan *et al.* (2016) [2] observed that okra jassids first appeared (5.33 jassids/plant) in the third week of February and its peak (27.27 jassids/plant) was obtained in third week of March. On the other hand, peak population of white fly (18.07 whitefly/plant) was observed in third week of March and second week of April. They found that white fly population was positively correlated with maximum temperature (r= 0.748**) and had non-significant correlation with minimum temperature (r = 0.165).

Seasonal abundance of Aphids

Singh *et al.* (2013) [7] studied effect of abiotic factors on population of aphid and natural enemy and found that aphid population showed negative correlation with minimum and mean temperature, rainfall and maximum and minimum relative humidity, where as coccinellids population showed positive correlation with maximum temperature and negative correlated with temperature (maximum, minimum and mean), rainfall and relative humidity (maximum and minimum).

Al Eryan *et al.* (2001) revealed from Alexandria (Egypt) that *A. gossypol* activity started in July on okra and reached its peak in late August (1343.38 aphids/plant).

Khan *et al.* (2015) [3] studied population densities of insect pest and their natural enemies on okra and reported that densities of insect pests as well as their natural enemies peaked in June-July. They recorded highest density of *Aphis gossypii* (3.56 adults/leaf) on 23rd June, *Cerotoma trifurcate* (0.14 adults /leaf) on 14th July and *Dysdercus koenigii* (1.03 adults/leaf) on 21st July. Highest density of *Coccinella septempunctat* (0.58/leaf) was on 21st July, *Dictyna sp.* (0.36/leaf) on 21st July and *Solenopsis invicta* (2.25/leaf) on 16th June. The present work might help in devising IPM against insect pests of okra especially using its natural enemies in Peshawar.

Seasonal abundance of White flies

In India the whitefly infestation started generally in fourth week of March (13thSMWS) and related its peak in the 18th SMWS during both the years. The whitefly population shows positive significant correlation with maximum and minimum temperature.

Kumawat *et al*. (2000) [5] reported that white flies first appeared in fourth week of July and their peak population was obtained in second and fourth week of September, respectively. They also found that whitefly density was positively correlated with maximum temperature.

Safdar *et al*. (2005) [6] noticed that minimum temperature and relative humidity had significant correlation with whitefly population on okra; the whitefly population decreased with increase in relative humidity and increased with increase in minimum temperature.

Benchasri (2013) [1] reported that among the insect pests that cause economic damage on okra, *Bemisia tabaci* Gennadius have been observed on the cultivated plot of okra during the June to October, 2009 and 2010 season. The most average incidence of 14.07±1.64 insects per plant of *B. tabaci* Gennadius were recorded, during the 2009 season, (June to October) meanwhile the most average incidence of 17.10±1.24 infestation of *B. tabaci* Gennadius were recorded respectively, during the 2010 season, (June to October). Effects of agroclimatic factors on the growth of insect pests revealed that temperature, relative humidity and rainfall had shown direct effect on the population trend of all insect pests.

Lal and Singh (2019) [4] studied the population of sucking pests whitefly, *Bemisia tabaci* (Gennadius) on okra during two seasons. Whitefly infestation started in fourth week of March (13th SMWS) and related its peak in the 18th SMWS during both the years. The whitefly population shown positive significant correlation with (r=0.65), (r=0.55) maximum temperature (r=0.60) minimum temperature during 2017 and 2018 and while whitefly populations was observed negative significant correlation (r= -0.55, r= -0.53) with rainfall during both the year.

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