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Population dynamics of major insect pests and its natural enemies in okra cv. Akola Bahar in relation to weather parameters

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Abstract
The present studies entitled "Population dynamics of major insect pests and its natural enemies in okra cv. Akola bahar in relation to weather parameters" were carried out to estimate the impacts of weather factors on population dynamics of some of major insect pests of okra during kharif season of year 2017-18. The highest population of aphids was in 39 MW (78 DAE); however, population range was 3.27 to 10.50 / leaf. The leafhopper number continuously increased up to 39 SMW with 11.48 leafhopper /leaf, thereafter population dropped slightly. Maximum whiteflies count was recorded at 39 SMW *i.e.* third week of September. The highest number of mites / sq.cm was in third week of September. Natural enemy's *viz*., coccinellids, and spiders remain good in number at initial stage and fluctuated depending upon availability food in the okra field. Evaporation rate had significant negative impact on aphid population build up. Leafhoppers and whiteflies increased with increasing morning relative humidity that means morning relative humidity had significant positive impact on leafhoppers and whiteflies. The spider mites and fruit damage due to shoot and fruit borer were not affected significantly by any of the weather parameter.

Keywords: Population, dynamics, okra, insect pests, weather parameters

Introduction
Okra (*Abelmoschus esculentus* L. Monech), commonly familiar with name as "Bhendi", is cultivated all over India. Tender fruits of okra are used as vegetable or in culinary preparations as sliced and dried pieces. It is also used for thickening gravies and soups, because of its high mucilage content. Okra is a rich source of vitamins, proteins, carbohydrates, minerals, iron, calcium, potassium and acids *viz.*, rhamnose (22%), galacturonic acid (27%) and amino acid (11%) and plays important role in human diet. Okra has good medicinal value against antispasmodic, demulcent, diaphoretic, diuretic, emollient, stimulant and vulnery properties.
India is the largest producer of okra in the world. In world it is grown in 11.48 lakh hectares with production of 78.96 lakh tonnes. In India, it is grown on an area 5.07 lakh hectares with production of 60.03 lakh tonnes with productivity 11.33 tonnes/hectares (Anonymous, 2016) [3]. In India, it is cultivated on an area of 5.01 hectare in India, production 59.72 MT (Anonymous, 2017) [4]. In Maharashtra, the grown area of 0.23 lakh ha, with production 2.41 lakh tonnes and productivity 10.47 tonnes/ha (Anonymous, 2015) [5] commonly it is cultivated in Kharif and summer season; however, productivity in state is less as compared to national average. The productivity of okra is low in India due to various reasons *viz.* unavailability of quality seed, irrigation method, fertilizers, insect pests and diseases. Among these, damage due to the insect pest is one of the major reasons for low productivity. Okra is attacked by a number of insect pests of which the shoot and fruit borer, *Earias vittella* (Fabricius) is a serious pest of okra crop. As high as 112 species of insects have been documented on okra (Ardhendu chakraborty, 2014) [6], of which, the sucking pests includes Aphids (Aphis gossypii), leafhopper, *Amrasca biguttula biguttula* (Ishida), whitefly, *Bemisia tabaci* (Gennadius) and Red spider mite, *Tetranychus cinnabarinus* (Boisduval) causes considerable damage to the crop. Among the pests of okra Leafhopper, a polyphagous pest which causes serious losses from last few years. It sucks cell sap mainly from ventral surface of the leaves and injects toxic saliva into plant tissues resulting into yellowing and upward curling of leaves (Singh *et al*., 2008) [20]. Whitefly (*B.tabaci*) not only causes direct damage by sucking cell sap from plant leaves but also indirect damage by transmitting yellow vein mosaic virus diseases (Singh *et al*. 2008) [20].

Due to scratching the leaf tissues by Red spider mites sap from leaves oozing out. Heavy webbing caused by the mite make it difficult to control.

Hence, the present study was carried, to work out the population dynamics of sucking pests with relation to abiotic factors to determine the seasonal incidence of okra between phonological stages of crop and their correction with weather parameters. Furthermore the trends of insect pests along with natural enemies associated with them and correlation between pest's population and weather parameters provide a prediction to know the most favorable condition for buildup of pests which is helpful in developing pest management strategies.

Materials and Methods

1) **Study areas:** The present studies entitled "Population dynamics of major insect pests and its natural enemies in okra cv. Akola bahar in relation to weather parameters*"* were carried out at the field of Department of Agricultural Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Kharif* 2017. The sucking pests like aphids, leafhoppers and whitefly constitute the major group of insect pest on okra at initial stage of crop growth, while in later stage shoot and fruit borer attack the crop which needs to be managed below the level of economic damage.
2) **Layout:** The field experiments were laid out in randomized block design (RBD) consisting of six treatments including control during *kharif* season 2017. Okra (Cultivar: Akola bahar) was raised in the plots size of Gross plot size 4.8 m x 2.7m and Net plot size: 3.6 m × 1.8 m with the spacing of 60 x 45 cm. Cultural practices like preparatory tillage, hoeing, weeding, thinning, gap filling, fertilizer applications, etc. were done as per the university recommendations.
3) **Observations:** The observations of major sucking pest's population were recorded at weekly interval on randomly selected five plants per plot. The population of aphid (Aphis gossypii), jassid (*Amrasca biguttula biguttula*), and whiteflies (*Bemisia tabaci*) was recorded by counting both nymphs and adults on three leaves i.e. top, middle and bottom of each five tagged plants with the help of a magnifying lens (10 x) and average population per three leaves were worked out at weekly interval. The incidence of shoot and fruit borer (*Earias vittella* Fab.) was recorded by counting infested plants and fruits on 10 random plants. The mite (nymph and adult) population, was observed on three leaves (top, middle and bottom) of each ten tagged plants by placing a card board sheet having a window of 2 cm2 on the ventral surface of the leaf. Counting was done with the help of a magnifying hand lens (10 x). At the time of every picking damaged fruits and healthy fruits were counted on number basis to workout percent infestation of shoot and fruit borer.
4) **Data analysis:** The data of sucking pest *viz*., aphids, leafhoppers, whiteflies, red spider mites was recorded weekly throughout season and transformed to square root values and per cent fruit damage data was transformed arc sine values and subjected to statically analysis (Gomez and Gomez, 1984) [9]. The mean predator data per five plants was also analysed statically after transformation.

Results

A. Seasonal incidence of major sucking pests: A separate untreated plot of okra was sown for recording seasonal incidence of major sucking pests. Sucking pest's *viz.*, aphids, leafhoppers, whiteflies, spider mites were recorded mentioned as in methodology.

- ***Aphis gossypii*:** Incidence of aphids initiated during early crop growth *i.e.* 16 days after crop emergence (29 MW) and continued till crop harvest. The highest population of aphids was in 37 MW (71 DAE) (11.98 aphids/ 3 leaves); however, population range was 3.27 to 11.98/ leaf was found throughout the observation period.
- ***Amrasca biguttula biguttula*:** Our recorded observation data revealed that leafhopper were observed in early crop growth (29 MW); however, leafhopper number continuously increased up to 37 MW 13.98 leafhopper / 3 leaves, there after population dropped slightly. There number varies from 1.78 to 13.98 leafhopper/ 3 leaves during observation period.
- ***Bemicia tabaci*:** Similarly, In B. tabaci population range was 2.56 to 7.67 / 3 leaves. Maximum population was recorded at 37 SMW i.e. first week of September, where incidence was noticed 7.67 whiteflies/ 3 leaves. However, whiteflies numbers not exceed > 10 whiteflies/3 leaves throughout the observation period.
- ***Tetranychus urticae* Koch:** Unlike to major sucking insect pests, spider mites its incidence observed in 31 MW i.e. first week of August. The highest number of mites / sq.cm where in third week of September (38 MW) (14.87 mites/sq.cm); however, range of spider mites was 1.45 in 31 MW to 14.87 mites / sq.cm at 38 SMW (Fig 1).

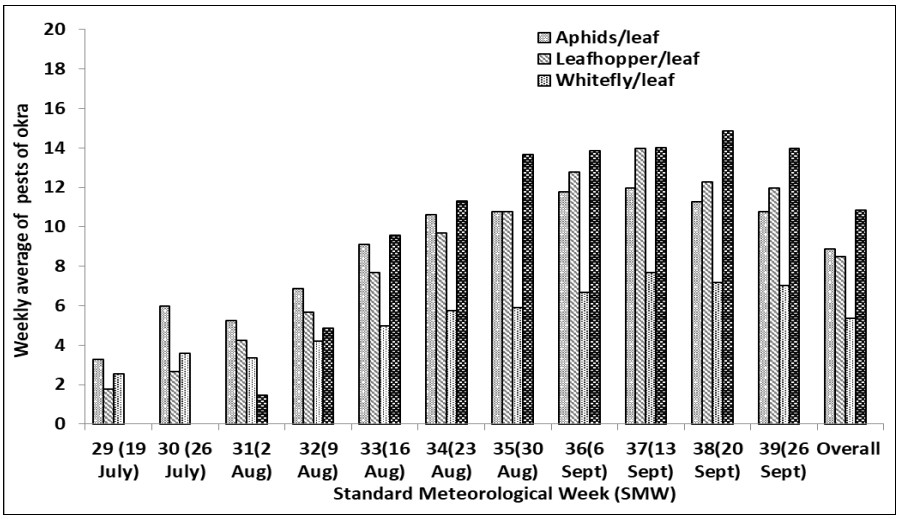

Fig 1: Seasonal population dynamics of major pests of okra Agro-ecosystem during Kharif, 2017

B. Percent fruit damage by fruit & shoot borer: Our recorded data revealed that highest fruit damage recorded at 39 SMW (35.68 percent) damage followed by 38 SMW (34.67 %). Overall data stated that average 31.43 percent fruit damage done during observation period. Shoot & fruit borer damage found in the range between 24.79 to 35.68 percent fruit damage (Fig 2).

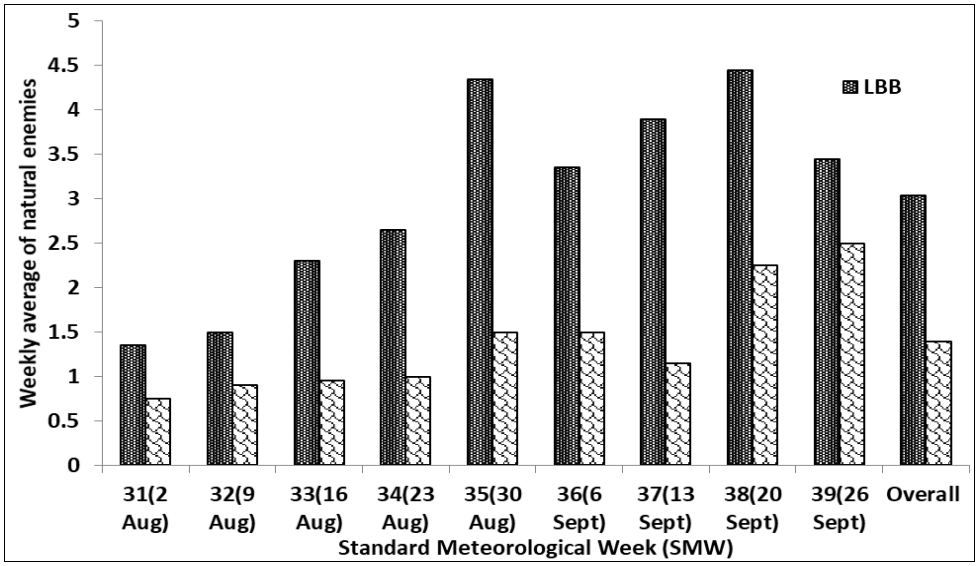

Fig 2: Seasonal population dynamics of predatory fauna found in okra Agro-ecosystem during Kharif, 2017

C. Association of major sucking pests with weather parameters: Aphid population was noticed negative non-significant correlation with maximum temperature (r = - 0.207) and minimum temperature (r = - 0.410). Evaporation rate (r = - 0.611) had significant negative impact on aphid population build up; however, morning relative humidity established non significant but positive impact on aphid incidence. Similarly, morning relative humidity affected leafhoppers population and established significant positive association; however, the evaporation rate played a non-significant but negative role. Whiteflies were increased with increasing morning relative humidity that means morning relative humidity had significant positive impact on whiteflies. Whiteflies decreased with increasing evaporation rate non-significantly and negatively expressing non-significant negative weak correlation impact on whitefly development. The spider mites and fruit damage due to shoot and fruit borer were not affected significantly by any of the weather parameters (Table 1).

Table 1: Correlation of major sucking pests and weather parameters in okra

Parameters	Aphids /leaf	Leafhoppers/leaf	Whiteflies /leaf	Mites /leaf	Fruit Damage (%)
Temp max. (ºC)	-0.207	-0.107	-0.107	0.011	-0.080
Temp min. (ºC)	-0.410	-0.390	-0.381	0.219	-0.308
BSH (hrs)	0.173	0.232	0.223	-0.103	-0.231
RH Mor. (%)	0.589	0.609*	0.623*	0.437	0.731
RH Evn. (%)	0.457	0.383	0.395	0.454	0.282
Evap. (mm)	-0.611*	-0.572	-0.575	-0.457	-0.517
RF (mm)	-0.116	-0.200	-0.166	0.096	-0.092
N=	11	11	11	9	6

N=11, r =0.602 (5%), 0.735 (1%); N = 9, r = 0.666 (5%), 0.798 (1%); N=6, r = 0.811 (5%), 0.917 (1%) *Significant (5%), **highly significant (1%).

D. Seasonal incidence of major natural enemies found in okra agro-ecosystem: Beneficial insects play a key role in natural pest control and pollination. Beneficial insects such as lady bird beetles and spider have also been recorded in the present study though there presence was very small numbers during the season. In okra agro-ecosystem the predators of major insect pests of okra were mainly ladybird beetles and spiders. The predator's *viz*., lady bird beetle grubs and adult spiders were recorded on per five plants in each plot.

LBB: Lady bird beetles were noticed from 31th SMW i.e. first week of August with 1.35 per five plants. The abundance of lady bird beetle continuously increased up to 38th MW to 4.45 per five plants thereafter decreased. Our recorded observation revealed that infestation of sucking pest and occurrence of predatory fauna coincides with each other (Fig 3).

Spiders: Similarly, spider existence was also initiated in 31st MW with 0.75 spiders per five plants. The highest spiders were noted in 39th SMW (2.50 / 5 plants). However, range of spider was 0.75 in 31 SMW to 2.50 spiders/ 5 plants (Fig 3).

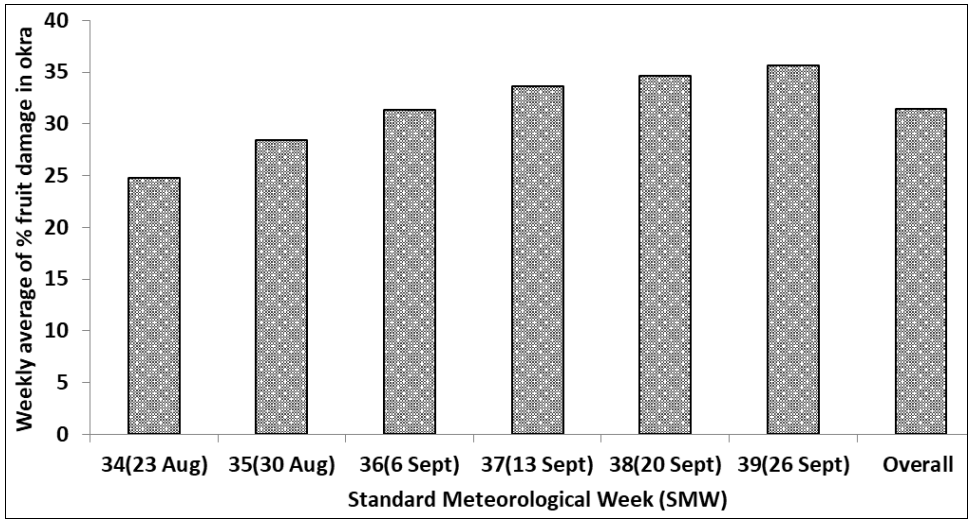

Fig 3: Weekly means percent fruit damage by fruit & shoot borer in okra

Discussion

Our observation stated that maximum *Aphis gossypii* recorded at 37 SMW. Present study results in line with the results of (Siddartha *et al*. 2017) [19] which stated that aphis gossypii incidence commenced from second week of July and attained its peak on 31st SMW (last week of July). Similar observation recorded by (Chundawat *et al*. 2011) [7] which stated that aphis gossypii infestation started from the second week of August and touching the peak during fourth week of August. Similarly leafhopper, whiteflies reached at this peak in 37 MW with 13.97 and 7.67 /leaf, which are in agreement with findings of (Khating *et al*. 2016 and Saroj *et al*. 2017) [11, 17] that leafhopper population started since the vegetative stage and continued till harvesting stage of the crop and was noticed for the first time during 32nd SW and continued up to 41st SMW till the harvest of the crop. Similar observation of *Tetranychus sp* was recorded by (Nath *et al*. 2011) [15] which stated that highest peak i.e. 37.89 and 40.83 per inch sq. of *Tetranychus* sp in 40th and 39th MW respectively during 2005 and 2006 season.

Our recorded data revealed that maximum fruit damage recorded at 39 SMW damage followed by 38 SMW. The results are corroborating with the earlier findings of (Akhila *et al.* 2019) [1] which reported that peak incidence of shoot & fruit borer observed in the 42nd standard week.

Aphid population was noticed negative non-significant correlation with maximum temperature and minimum temperature. Present findings are in line with the findings of (Konar *et al*., 2013) [12] stated that aphid population is non-significant negatively correlated with maximum and minimum temperature. However, our results disagreement with the results of (Selvaraj *et al*., 2010) [18] which stated that aphid had significant positive association with maximum temperature. In present findings, leafhopper and whitefly incidence was positively significant with morning relative humidity which in agreement with the previous reports (Akhila *et al* 2019, Selvaraj *et al*., 2010, Netam *et al*., 2007, Anitha KR *et al* 2008, & Yadav *et al*., 2009) [1, 18, 16. 2, 21]. Our data revealed that positive correlation between temperature and red spider mite population in okra. In present study red spider mites and fruit damage were not affected by maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, Sunshine and rainfall. Similar results observed by (Siddartha *et al.* 2017) [19]. However, Our results disagreement with the results of (Gulati 2004, Mohanasundaram *et al.* 2011 & Nath *et al*. 2011) [10, 13, 14] who reported negative effect of minimum temperature on the red spider mite and fruit damage.

Our data stated that in okra agro-ecosystem predatory fauna active throughout the cropping season. Our results are line with observation recorded by (Gaikwad *et al.* 2020) [8] which stated that the population of coccinellids (grub and adult) peak was observed in 40th MW after that, the number gradually declined but sustained till harvest of the crop. Similar observation of spider was noticed by (Gaikwad *et al.* 2020) [8] which stated that occurrence of spider noticed first at 31st SMW and occurred till harvesting of crop. The peak activity (1.20/plant) was observed during 40th SMW.

Conclusion

Most of the sucking pest's *viz*., aphids, leafhoppers and whiteflies started from early crop growth and their population steadily increased; whereas, fruit damage commenced during fruiting stage of crop. Evaporation rate exerted significant negative impact on aphid population build up; however, morning relative humidity affected leafhoppers population and established significant positive association. Whiteflies increases with increasing morning relative humidity that means morning relative humidity had significant positive impact on whiteflies. The spider mites and fruit damage due to shoot and fruit borer were not affected significantly by any of the weather parameter.

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