GENOTYPIC AND SEASONAL INFLUENCE ON THE POPULATION DYNAMICS OF OKRA SUCKING PESTS

Ashika Akhtar Shitel[1], A F M Saiful Islam[2], Khadeja-Tul Kobra[3], Md. Abdur Razzak Choudhury[1] and Md. Abdul Maleque[1*]

[1]Department of Entomology, Faculty of Agriculture, Sylhet Agricultural University, Sylhet 3100, Bangladesh. [2]Department of Crop Botany and Tea Production Technology, Faculty of Agriculture, Sylhet Agricultural University, Sylhet 3100, Bangladesh, [3]FAO Representation in Bangladesh, House No. 74; Road No. 18, Block-J, Banani, Dhaka, Bangladesh

ABSTARCT

The study was carried out to record the genotypic and seasonal influence on the population dynamics of okra sucking pests viz., Aphid (*Aphis gossypii*), whitefly (*Bemisia tabaci*), jassid (*Amrasca biguttula biguttula*) and red spider mite (*Tetranychus urticae*) during two cropping seasons (*rabi* 2019-2020 and *kharif* 2020) at Entomology Research Field, SAU campus, Sylhet, Bangladesh. In both seasons, four Japanese okra genotypes (JO3, JO5, JO7 and JO9) and two local okra varieties (BARI Dherosh-1 and BARI Dherosh-2) were used as treatments of the study. The genotype JO5 was found less susceptible to insect and mite pests in both seasons but its fruit bearing capacity was very low. The highest yield was found in BARI Dherosh-2 and JO7 in both seasons. Okra sucking pests were found more prevalent during *kharif* 2020 than those of the *rabi* 2019-2020. Red spider mites were absent during *rabi* 2019-2020. Aphid, whitefly, jassid and red spider mite showed significant negative relationship with rainfall during *kharif* 2020. To control the okra sucking pests, effective management techniques need to be adopted at the beginning of *kharif-1* (March - April) when the pest infestation first appears.

Keywords: Accession, seasonality, weather parameter, correlation coefficient.

INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) belonging to the family Malvaceae is an economically important vegetable crop all over the world (Gopalakrishnan 2007). In Bangladesh, total production of okra was 55,000 tons from about 11,331 ha of land during 2016-2017 (BBS 2018). Although okra is considered to be a self-pollinated crop, some insects can help in cross pollination. Okra can be grown on a wide range of soil types but sandy loam soil is optimum for its proper growth

*Corresponding author : maleq.entom@sau.ac.bd

and development. Well drainage system is inevitable because okra cannot withstand waterlogging conditions. Okra has Ayurvedic medicinal properties. Its leaves are used to produce a medicament for reducing inflammation. It is an excellent source of iodine for the control of goiter disease and low in calories with high dietary fiber content which is beneficiary to decrease cholesterol level (Chadha 2007). Due to the attack of various insect and mite pests okra plants show distorted and stunted growth and also reduces yield (Shannag *et al*. 2007). Bhatt *et al*. (2018) reported 17 species of insect pests belonging to different orders and families from the experimental field of okra. Among these, the order Hemiptera represented the highest number (07) of species. Leaf hoppers suck the cell sap from lower surface of the leaves and inject toxic substances resulting in curling of leaves which retard plant growth. Aphid (*Aphis gossypii)* (Hemiptera: Aphididae) is one of the major pests of okra which occupies the highest position among the pests of vegetables. Aphid directly damages okra by feeding cell sap which results in curling and deformation of young leaves and twigs while indirectly damages by secreting honeydew that is contaminated with the fruits and leaves and may allow the growth of black sooty mold which inhibits photosynthesis and reduces yield (Jacobson & Croft 1998, Andrews *et al*. 2004, Capinera 2004).

Okra is mostly consumed as fresh vegetable in Bangladesh. But the indiscriminate use of toxic pesticides in controlling okra pests and diseases causes human health hazards and environmental pollution. It is essential to manage the pest population with environmentally suitable measures to prevent the infestation of the pests. In this context, scientists are trying to develop environmentally safe non-chemical methods for the pest management of vegetables including okra. Host plant resistance is a self-perpetuating and cost effective method of pest management which could be used as alternative to chemical method. Only tolerant varieties can reduce the adverse effects of pesticides in agro-ecosystem. Nonetheless, so far only two okra varieties viz., BARI Dherosh-1 and BARI Dherosh-2 have been released by Bangladesh Agricultural Research Institute, Joydebpur, Gazipur. However, the number of okra varieties released so far is very few which cannot meet the huge demand of Bangladesh. In Sylhet Agricultural University, continuous efforts are underway to develop pest tolerant okra varieties through evaluating some promising Japanese okra genotypes. A total of 10 Japanese okra genotypes together with BARI Dherosh-1 as the local check variety have recently been evaluated by Tanni *et al*.

(2019) who preliminary reported four promising Japanese genotypes with respect to high yield performance and tolerance against some insect and mite pests of okra. They conducted the experiment only during *kharif* 2018. Against this backdrop, their preliminary results need to be validated across the seasons.

In addition to genotypic influence on pest abundance, seasonal variation plays a vital role in the occurrence of different insect pests. In recent years, several authors have reported that weather parameters viz., temperature, rainfall, relative humidity, sunshine hour, etc. are directly or indirectly influence the population dynamics of okra pests (Ashraf *et al*. 2017, Kumar and Singh 2020, Pazhanisamy e*t al*. 2020, Singh *et al*. 2020). As such, the present piece of investigation was carried out to determine the effects of genotype and season on the occurrence of different pest complex of okra. Information on the relationships of okra pest complex with genotypes and weather parameters are essential to design effective pest management techniques. Considering the limitations of the previous preliminary results reported by Tanni *et al*. (2019), the study was conducted to select the most suitable Japanese okra genotype(s) with respect to yield potential and tolerance to sucking pests of okra. Yield and yield attributing characteristics of six okra genotypes and relationships of okra sucking pests with weather parameters on BARI Dherosh-2 were investigated in this study.

MATERIALS AND METHODS

The present investigation was carried out at the Entomology Research Field, Sylhet Agricultural University (SAU), Sylhet, Bangladesh during *rabi* (03 October 2019 to 20 February 2020) and *kharif* (01 March to 31 July 2020) seasons. The location of experiment is lying between 24°54’38’’ North latitude and 91°54’05’’ East longitude. Elevation of this site is 25.6 m. According to Bangladesh Agro-Meteorological Information Systems (BAMIS 2020), the experimental site was situated in the sub-tropical climatic zone, characterized by high temperature, high humidity and heavy rainfall with occasional stormy wind during *kharif* season (*Kharif-1*: Mid-March to Mid-June; *kharif-2*: Mid-June to Mid-October) and less rainfall with moderately low temperature during *rabi* season (Mid-October to Mid-March). The soil of the experimental field is sandy loam in texture with pH of 5.27, as determined by SRDI (2018). Four okra (*Abelmoschus esculentus*) genotypes

(JO3, JO5, JO7, JO9) and two varieties (BARI Dherosh-1 and BARI Dherosh-2) were used as the plant material. BARI Dherosh-2 was used as the check variety. The experiment was laid out in a 2-factor Randomized Complete Block Design (RCBD) with three replications. In this experiment, seasons (*Rabi* 2019-2020; *Kharif* 2020) were used as Factor A and genotype (JO3, JO5, JO7, JO9) plus varieties (BARI Dherosh-1 and BARI Dherosh-2) was used as Factor B. The experiment had 18 plots in total where 6 unit plots were accommodated in each block. Each plot size was 2.5 × 2.0 m^2. Neighboring plots were 1.0 m apart and adjacent blocks were 1.5 m apart (Fig. 1). Okra seeds were sown in line keeping 0.50 m apart between plants and 0.40 m apart between rows. In this experiment, each unit plot had 4 rows with 5 plants per row so each unit plot accommodated 20 plants in total (Fig. 1). Three okra plants were randomly selected from each plot and three leaves (Top, middle and bottom) were randomly selected from each plant to collect data on the number of sucking pests. The population of aphid *(Aphis gossypii)*, whitefly *(Bemisia tabaci)*, jassid *(Amrasca biguttula biguttula)* and red spider mite (*Tetranychus urticae*) were recorded through visual counting of both nymphs and adults infesting leaves. A magnifying glass was used to count the pests. Three okra plants from each plot were selected at random to collect data on various yield attributing characteristics viz., plant height, fruit length by using meter scale; number of fruits per plant by visual count; fruit girth by measuring tape and individual fruit weight by digital weighing machine. Fruit yields from all harvests of each plot were recorded separately. At the end of the seasons fruits harvested separately and all yield data were expressed in t ha^{-1}. The data on different parameters were statistically analyzed using R software (R ver. 4.1.0, R Core Team 2021). Because all the okra genotypes and varieties had similar incidence patterns of okra pests, correlation coefficient values of okra sucking pests with weather parameters on BARI Dherosh-2 were explored using Microsoft Excel in Office 2010.

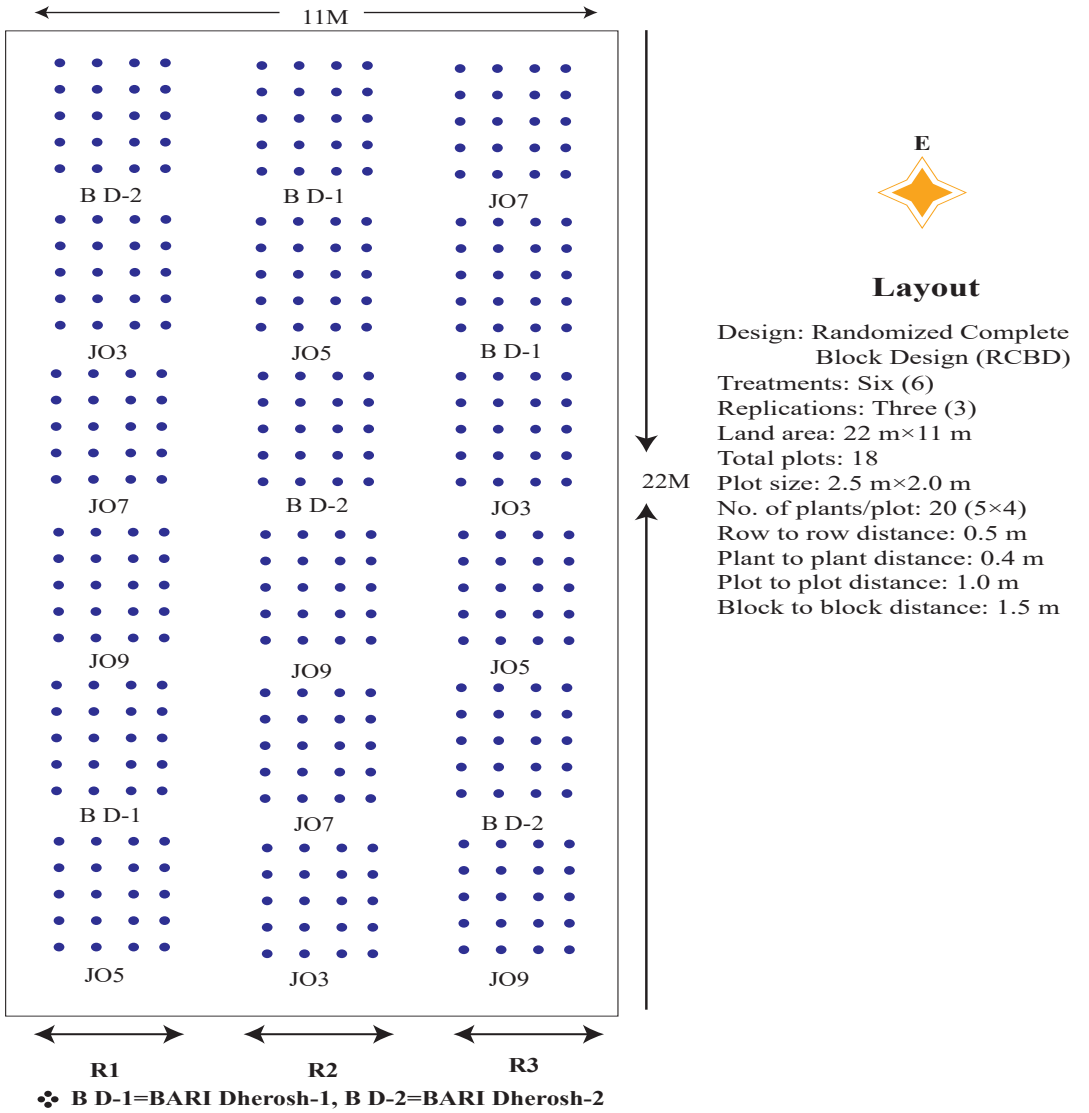


Fig. 1. Layout of the experiment at Sylhet Agricultural University (SAU) campus, Sylhet

RESULTS AND DISCUSSION

Genotypic and seasonal influence on okra sucking pests and their interaction: The influence of okra genotype and season on aphid, whitefly, jassid and red spider mite are shown in Table 1. Aphid, whitefly and jassid were more abundant during *kharif* 2020 compared to those of the *rabi* 2019-2020. BARI Dherosh-2 showed highest

and JO5 showed lowest infestation of sucking pests during the experimental period. Some physical characteristics of plant like leaf hair, tissue hardness and so on are often responsible for lower pest infestation. For example, Tanni *et al*. (2019) found that the incidence of insect and mite pests on different okra genotypes were low due to the presence of higher number of leaf hair (trichomes). Abang *et al.* (2016) found that two accessions (VI041210 and VI033824) with higher trichome density were less susceptible to aphid infestation. Moreover, Sandhi *et al*. (2017) reported that high hair density, broad leaves, moderate levels of total sugars, reducing sugars, total phenols, tannins and silica exhibit moderate level of resistance in different okra genotype against insects.

Table 1. Genotypic and seasonal influence on okra sucking pests during *rabi* 2019-2020 and *kharif* 2020

Treatments	Number/three leaves			
	Aphid	Whitefly	Jassid	Red spider mite
Factor A: Season				
Rabi (2019-2020)	1.86b	1.33b	0.75b	0.00b
Kharif (2020)	6.01a	6.68a	6.01a	2.20a
Factor B: Genotype				
JO3	4.27b	4.20bc	3.33bc	1.12c
JO5	2.40c	1.97d	1.55d	0.38d
JO7	2.97c	3.75c	2.97c	0.62d
JO9	3.07c	4.13bc	3.87ab	1.25bc
BARI Dherosh-1	5.08ab	4.65ab	4.15ab	1.50ab
BARI Dherosh-2	5.82a	5.32a	4.40a	1.73a
MSD (Season)	0.40	0.34	0.31	0.13
MSD(Genotype)	1.04	0.87	0.82	0.34
CV (%)	14.66	12.13	13.49	17.25

Footnote: *Means followed by the same letter are not significantly different (P>0.05) based on ANOVA (Analysis of variance) and HSD (Honestly Significant Difference) test. MSD = Mean Squared Deviation, CV = Coefficient of variation*

Interactions of season and genotype on aphid, whitefly, jassid and red spider mite are shown in Table 2. The lowest number of aphid, whitefly and jassid per three leaves were recorded in JO5 during *rabi* 2019-2020 and the highest number of aphid,

whitefly and jassid per three leaves were found in BARI Dherosh-2 during *kharif* 2020. Red spider mites were totally absent during *rabi* 2019-2020. It happened possibly due to adverse weather effects on the population dynamics of these pests. The results are in agreement with the findings of Kumar *et al*. (2017) who reported that the jassid population disappeared after the month of November. Nutrition deficiency may be another reason of absence or lower incidence of okra pests during *rabi* 2019-2020.

Table 2. Interactions of season and genotype and variety with okra sucking pests during *rabi* 2019-2020 and *kharif* 2020

Treatments (Season × Genotype)	Aphid	Number/three leaves			
		Whitefly	Jassid	Red spider mite	
Rabi (2019-2020)	JO3	2.03ghi	1.20de	0.80e	0.00e
	JO5	0.77i	0.47e	0.17e	0.00e
	JO7	1.07hi	0.93e	0.60e	0.00e
	JO9	1.40hi	1.27de	0.83e	0.00e
	BARI Dherosh-1	2.77fgh	1.60de	1.00e	0.00e
	BARI Dherosh-2	3.13efg	2.50cd	1.10e	0.00e
Kharif (2020)	JO3	6.50bc	7.20ab	5.87bc	2.23c
	JO5	4.03def	3.47c	2.93d	0.77d
	JO7	4.87cd	6.57b	5.33c	1.23d
	JO9	4.73de	7.00ab	6.90ab	2.50bc
	BARI Dherosh-1	7.40ab	7.70ab	7.30a	3.00ab
	BARI Dherosh-2	8.50a	8.13a	7.70a	3.47a
MSD (Interaction)		1.71	1.44	1.35	0.56
CV (%)		14.65	12.14	13.50	17.25

Footnote: *Means followed by the same letter are not significantly different (P>0.05) based on ANOVA (Analysis of variance) and HSD (Honestly Significant Difference) test. MSD = Mean Squared Deviation, CV = Coefficient of variation*

Yield and yield attributing characteristics of okra genotypes and their interaction with season: Yield and yield attributing characteristics of six okra genotypes are shown in Table 3. JO5 gave the highest plant height (125.57 cm), fruit length (9.53 cm), fruit girth (6.12 cm) and individual fruit (15.78g) weight but

highest number of fruits per plant (12.05) and fruit yield (7.68 t ha^{-1}) was recorded in BARI Dherosh-2. The yield of JO7 (7.50 t ha^{-1}) was closely followed by the yield BARI Dherosh-2.

Table 3. Yield and yield attributes of okra genotypes and varieties during *rabi* 2019-2020 and *kharif* 2020

Treatments	Plant height (cm)	No. of fruits per plant	Fruit length (cm)	Fruit girth (cm)	Individual fruit weight (g)	Fruit yield (t ha^{-1})
Factor A: Season						
Rabi (2019-2020)	49.11b	3.21b	4.12b	4.13b	6.51b	1.23b
Kharif (2020)	150.42a	14.08a	11.11a	6.12a	19.69a	9.70a
Factor B: Genotype						
JO3	74.83d	8.85b	5.90c	4.30d	10.47c	5.48b
JO5	125.57a	4.42d	9.53a	6.12a	15.78a	2.58c
JO7	87.82c	11.47a	7.70b	5.07bc	13.03b	7.50a
JO9	83.18cd	9.33b	6.25c	4.50cd	11.62c	6.10b
BARI Dherosh-1	116.90ab	5.75c	7.92b	5.32b	13.55b	3.45c
BARI Dherosh-2	110.27b	12.05a	8.37b	5.43b	14.17b	7.68a
MSD (Season)	3.51	0.43	0.31	0.25	0.46	0.45
MSD(Genotype)	9.14	1.12	0.81	0.65	1.20	1.17
CV (%)	5.09	7.23	5.90	7.09	5.10	11.87

Footnote: *Means followed by the same letter are not significantly different (P>0.05) based on ANOVA (Analysis of variance) and HSD (Honestly Significant Difference) test. MSD = Mean Squared Deviation, CV = Coefficient of variation*

Interactions of seasons with yield and yield attributing characteristics of six okra genotypes are given in Table 4. In *rabi* 2019-2020 yield and yield attributing characteristics of okra genotypes were quite low than that of the *kharif* 2020. Even though JO5 had the highest plant height, fruit length, fruit girth and individual fruit weight, its yield performance was the lowest. The reason may be the lowest number of fruits per plant in JO5, which ultimately resulted in lowest yield. On the other hand, the genotype BARI Dherosh-2 had moderate plant height, fruit length, fruit girth and individual fruit weight but gave higher yield due to its inherent higher

yield potential. Though okra is not a *rabi* crop, okra plant's growth and development was not satisfactory during *rabi* 2019-2020 compared to *kharif* 2020.

Table 4. Interaction of season with yield and yield attributing characteristics of okra genotypes and varieties

Treatments (Season × Genotype)		Plant height (cm)	No. of fruits per plant	Fruit length (cm)	Fruit girth (cm)	Individual fruit weight (g)	Fruit yield (t ha^{-1})
Rabi (2019-2020)	JO3	38.07g	2.77fg	3.40e	3.60h	5.40f	1.00d
	JO5	64.10e	1.33g	5.00d	4.73efg	7.60e	0.37d
	JO7	45.40fg	4.80e	4.03de	4.17fgh	6.60ef	1.97d
	JO9	41.43fg	3.27ef	3.50e	3.67gh	5.73ef	1.27d
	BARI Dherosh-1	55.67ef	2.10fg	4.27de	4.23fgh	6.73ef	0.77d
	BARI Dherosh-2	49.97efg	4.97e	4.50de	4.37efgh	7.00ef	2.03d
Kharif (2020)	JO3	111.60d	14.93b	8.40c	5.00def	15.53d	9.97b
	JO5	187.03a	7.50d	14.07a	7.50a	23.97a	4.80c
	JO7	130.23c	18.13a	11.37b	5.97bcd	19.47bc	13.03a
	JO9	124.93cd	15.40b	9.00c	5.33cde	17.50cd	10.93b
	BARI Dherosh-1	178.13ab	9.40c	11.57b	6.40bc	20.37b	6.13c
	BARI Dherosh-2	170.57b	19.13a	12.23b	6.50ab	21.33b	13.33a
MSD (Interaction)		15.14	1.85	1.33	1.08	2.00	1.92
CV (%)		5.11	7.22	5.88	7.09	5.12	11.86

Footnote: Means followed by the same letter are not significantly different (P>0.05) based on ANOVA (Analysis of variance) and HSD (Honestly Significant Difference) test. MSD = Mean Squared Deviation, CV = Coefficient of variation

Seasonal distribution of okra sucking pests during rabi 2019-2020 and their correlation with weather parameters: Seasonal distribution patterns of aphid, whitefly and jassid during *rabi* 2019-2020 are shown in Fig. 2. Aphid (*Aphis gossypii*), whitefly (*Bemisia tabaci*) and jassid (*Amrasca biguttula biguttula*) infestation was the highest in November on all okra genotypes. Afterwards, the infestation started to go down in the subsequent two months but in February, it increased again.

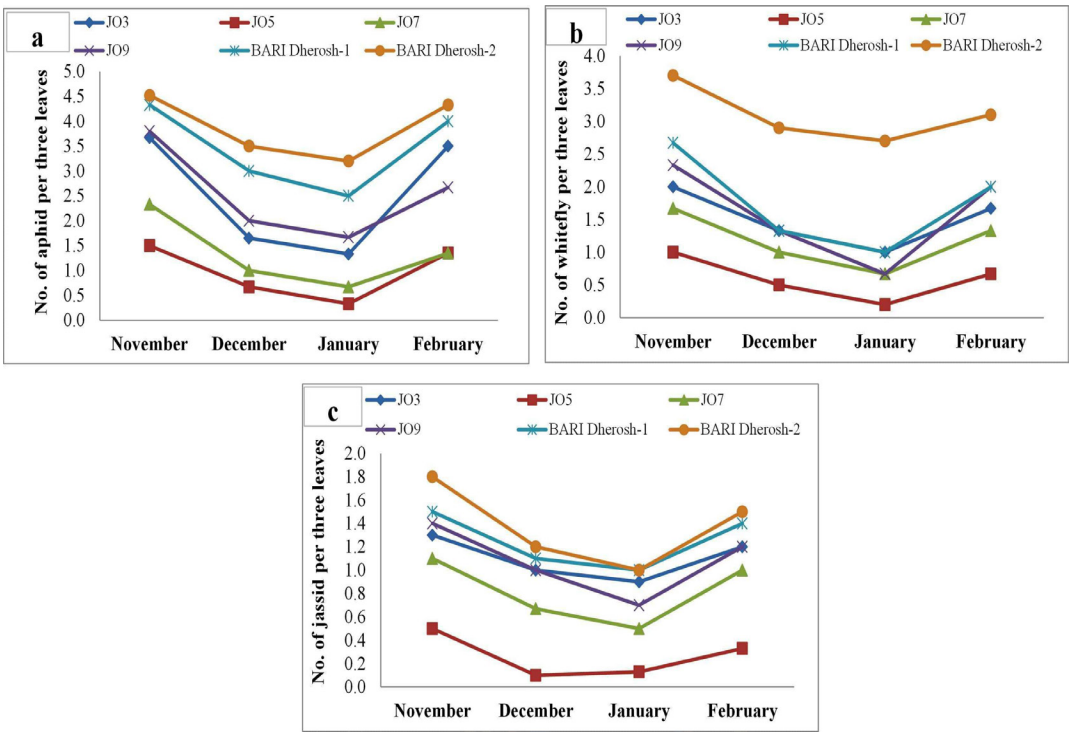


Fig. 2. Seasonal distributions of aphid (a), whitefly (b) and jassid (c) on okra genotypes and varieties during *rabi* 2019-2020 (note varied Y-axis range)

Correlation coefficient values of okra sucking pests with weathers parameters on BARI Dherosh-2 during *Rabi* 2019-2020 are presented in Table 5. The correlation coefficient values indicated that the infestation of aphid was significant with the maximum temperature (r = 0.99), infestation of whitefly was significant with the maximum temperature (r = 0.97) and minimum temperature (r = 0.98) and infestation of jassid was significant with the maximum temperature (r = 0.99). In agreement with the present results, Gogoi & Dutta (2000) found that meteorological parameters played an important role in the population buildup of cotton jassid. High temperature (30-36˚C), evening relative humidity (below 80%) and low rainfall period coupled with bright sunshine hours favored the development of cotton jassid population. Aziz *et al.* (2011) found that there was significant effect of maximum, minimum and average temperatures on the development of pest population on okra.

Table 5. Correlation coefficient values of okra sucking pests with weather parameters on BARI Dherosh-2 variety during *rabi* 2019-2020

Month	Dates of observation	Temperature (°C)		Average relative humidity (%)	Total rainfall (mm)	Sunshine (hour)	Mean number/three leaves		
		Max	Min				Aphid	Whitefly	Jassid
November	15/11/2019	30.10	19.80	71.00	10.00	7.42	4.52	3.70	1.80
December	15/12/2019	26.20	14.90	66.00	0.00	6.54	3.50	2.90	1.20
January	15/1/2020	24.70	13.70	69.00	18.30	5.13	3.20	2.70	1.00
February	15/2/2020	28.10	15.10	54.00	3.30	6.32	4.43	3.10	1.50
Correlation coefficient of aphid		0.99**	0.91	-0.05	-0.24	0.88	-	-	-
Correlation coefficient of whitefly		0.97*	0.98*	0.18	-0.13	0.89	-	-	-
Correlation coefficient of jassid		0.99**	0.91	-0.06	-0.25	0.88	-	-	-

**Significant at 5% level, ** Significant at 1% level.*

Seasonal distribution of okra sucking pests during kharif* 2020 *and their correlation with weather parameters: Seasonal distribution patterns of aphid, whitefly, jassid and red spider mite during *kharif* 2020 are shown in Fig. 3. The incidence of aphid (*Aphis gossypii*), whitefly (*Bemisia tabaci*), jassid (*Amrasca biguttula biguttula*) and red spider mite (*Tetranychus urticae*) was highest on all okra genotypes initially in April but the occurrence gradually went down in the subsequent months and reached at the least in July.

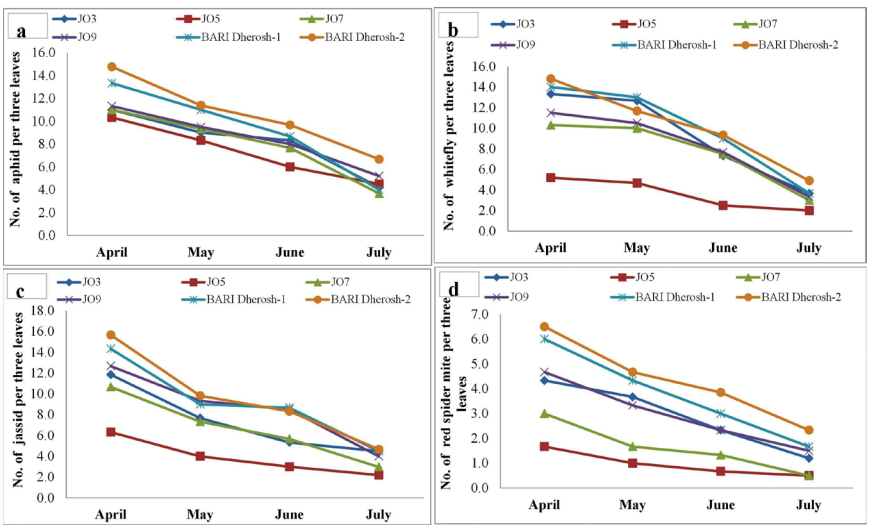


Fig. 3. Seasonal distribution patterns of aphid (a), whitefly (b), jassid (c) and red spider mite (d) on okra genotypes and varieties during *kharif* 2020 (note varied Y-axis range)

Correlation coefficient values of okra sucking pests with weathers parameters on BARI Dherosh-2 during *kharif* 2020 are presented in Table 6. The correlations indicated that the infestation of aphid was significant with minimum temperature (r = - 0.96), rainfall (r = - 0.98) and sunshine hour (r = 0.98), infestation of whitefly was significant with rainfall (r = - 0.96) and sunshine hour (r = - 0.95), infestation of jassid was significant with minimum temperature (r = - 0.95), relative humidity (r = - 0.96), rainfall (r = - 0.99) and sunshine hour (r = 0.99) and infestation of red spider mite was significant with minimum temperature (r = - 0.96), rainfall (r = - 0.99) and sunshine hour (r = 0.98). Ghuge *et al*. (2020) found that aphids showed significantly negative correlation with rainfall during *Kharif* 2018. Prasad *et al*. (2008) reported that rainfall was found to exert significant negative influence on whiteflies population. Aziz *et al*. (2011) found that rainfall and relative humidity had adverse effect on the population growth of aphid and other various insect pests of okra.

Table 6. Correlation coefficient values of okra sucking pests with weather parameters on BARI Dherosh-2 during *kharif* 2020

Month	Dates of observation	Temperature (◦C)		Average relative humidity (%)	Total rainfall (mm)	Sunshine (hour)	Mean populations/three leaves			
		Max	Min				Aphid	Whitefly	Jassid	Red spider mite
April	15/4/2020	32.80	21.20	57.00	246.30	6.70	14.77	14.80	15.67	6.50
May	15/5/2020	31.60	23.00	75.00	641.20	4.38	11.39	11.67	9.83	4.67
June	15/6/2020	32.10	25.30	83.00	665.70	3.08	9.67	9.33	8.33	3.85
July	15/7/2020	31.90	25.80	85.00	968.50	2.20	6.67	4.90	4.67	2.33
Correlation coefficient of aphid		0.64	-0.96*	-0.94	-0.98*	0.98*	-	-	-	-
Correlation coefficient of whitefly		0.55	-0.93	-0.89	-0.96*	-0.95*	-	-	-	-
Correlation coefficient of jassid		0.73	-0.95*	-0.96*	-0.99**	0.99*	-	-	-	-
Correlation coefficient of red spider mite		0.66	-0.96*	-0.95	-0.99*	0.98*	-	-	-	-

**Significant at 5% level, ** Significant at 1% level*

CONCLUSION

From the study it was found that the genotype JO5 had overall lowest incidence of okra sucking pests but it produced the lowest fruit yield due to lowest fruits per plant during the *rabi* 2019-2020 and *kharif* 2020 seasons. BARI Dherosh-2 produced the highest yield but it was susceptible to various sucking pests of okra. The genotype JO7 had moderate incidence of pests and produced higher fruit yield across the seasons. Okra pests were found more prevalent during *kharif* 2020 than the *rabi* 2019-2020. Red spider mites were found absent during *rabi* 2019-2020. Okra sucking pests showed significant relationships with weather parameters during the *rabi* 2019-2020 and *kharif* 2020 seasons. It is clearly evident from the results that both the genotype and season have significant influence on the population dynamics of okra sucking pests.

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