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Spatio-temporal Pattern of Okra Yellow Vein Mosaic Virus and its Vector in Relation to Epidemiological Factors

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Abstract

Spatio-temporal pattern of Okra yellow vein mosaic virus as well as its vector whitefly was investigated in relation to epidemiological factors (Maximum and minimum air temperature, relative humidity, rainfall and wind speed) was determined on commercially grown okra varieties i.e. Sabaz pari, Pahuja, Lush green and Pusa sawani. Data recorded on whitefly population and Okra yellow vein mosaic virus disease incidence was graphically plotted to visualize spatio-temporal pattern. Four okra varieties Sabz pari, Pahuja, Pusa sawani and Lush green was sown under RCBD design. Data obtained from vector population and disease incidence was analyzed through ANOVA and three-dimensional graphs to demonstrate spatial and temporal pattern of OYVMV and *B. tabaci* population in relation to environmental factors. Among four varieties/lines Pusa sawani showed significant correlation with the environmental factors.

Keywords: Okra; Spatial pattern; Temporal pattern; Correlation; Whitefly population; Plant extracts

Introduction

Okra (*Abelmoschus esculentus L.* Moench) belongs to genus *Abelmoschus* and its family is *Malvaceae*. It is also known as lady finger. It is an important growing crop of Indo-Pak sub-continent. Okra is a very good source of vitamins A, B, C and is also rich in minerals, protein and iodine [1]. Okra fruit contains 80% water. The approximate nutrient value for 100 g of fresh edible fruit is 20 cal energy; 2 g protein; 0.1 g fat; 2.7 g carbohydrates; 660 g vitamin A; 0.2 mg thiamin; 0.06 mg riboflavin; 1 mg niacin; 44 mg vitamin C; 81 mg Ca; 0.8 mg Fe; 20 mg K and 10 mg Na. Average production of Okra in worldwide is 12.035 million tons. (FAO, 2011). In Pakistan it is cultivated on an area of 13.900 h and a total production of about 113,200 thousand tons [2]. Okra crop is attacked by various pathogens, which cause various diseases. These pathogens include Viruses, bacteria, fungi, mycoplasmas, nematode and insects. Some important diseases are Damping off, Fusarium wilt, Powdery mildew, Cercospora leaf spot, Leaf curl virus and Bhindi Yellow Vein Mosaic virus. The total loss of vegetable on this regard is about to 20-30%, which may increase up to 80-90% [3].

This viral disease infects during all the stages of growth. It is transmitted by white fly. The most susceptible stage of is from 35 to 50 days. The initial symptoms on young leaf are a diffuse, mottled appearance. Clearing of small veins starts near the leaf margin at various points, about 15 to 20 days after infection. Afterward vein clearing develops into a vein chlorosis. In infected leaves interveinal chlorosis occurs due to fibrous deficiency and all leaves turn yellow. The infected fruits are covered with yellow or creamy color, fibrous, small and tough [4]. Spatial and temporal pattern of *B. tabaci* is needed to study to find out the relative abundance of *B. tabaci* in the crop, their landing rate as well as the ability of their virus transmission. Spatial and temporal study of this viral disease are used to describes the dynamics of virus spread along with the respect of primary inoculum and all the mechanism involved in spread of vector. Keeping in view the importance of environmental conditions on disease spread the present study was planned to correlate environmental conditions for okra yellow vein mosaic virus and its vector.

The objectives of this study is to study the spatial and temporal pattern of *B. tabaci* and Okra yellow vein mosaic virus disease incidence in relation to epidemiological factors.

Materials and Methods

The experiment was conducted in the research area of department of Plant Pathology, University of Agriculture Faisalabad. Four different okra varities viz; Sabz pari, Pahuja, Pusa sawani and Lush green were sown in 10th July 2015. Seed of four okra varieties were taken from Vegetable section of Ayub Agriculture Research Institute, Faisalabad for raising disease screening nursery. Each replication consists of four entries with row to row distance 60 cm and plant to plant distance 20 cm. All the agronomic practices were followed to maintain the okra nursery in good condition. Thus okra germplasm was subjected to natural viral inoculum, invasion and buildup of white fly (*B. tabaci*) Population density. The disease on each entry was assessed by following the diseases rating scale (Table 1).

Conformation of the disease

Virus infected plants were collected from the field area. A slanting cut was made on both sides of the stem of infected plant. Wedge-grafting was performed as described by the Pullaiah et al., [5]. The grafted portion were wrapped tightly with Para film and covered with polythene bags. The plants were irrigated and the polythene sheet removed after the grafting was set properly. Non-inoculated served as

Rating scale		Severity range %
0	Immune	0
1	Highly resistant	1-10
2	Moderately resistant	11-25
3	Tolerant	26-50
4	Moderately susceptible	51-60
5	Susceptible	61-70

Table 1: Showing the diseases rating scale.

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control. The graft Inoculated plants showing the symptoms of OYVMV which indicates the presence of Okra yellow vein mosaic virus.

Spatial and temporal data

Environmental data consisting of maximum and minimum temperature, rainfall, relative humidity and wind speed were recorded on weekly basis from second week of August 2015 to the end of the July 2015 and the weekly average was collected from metrological station run by University of Agriculture, Faisalabad. The environmental factors (Maximum and minimum temperature, rainfall, relative humidity and wind speed) were correlated with disease incidence (OYVMV) and whitefly population data. To study the temporal pattern, data were taken on weekly basis. In case of spatial study, distances of infected plants were measured with the help of measuring tape from the hot spot.

Statistical analysis

The data on the whitefly population and percent plant infection were subjected to statistical analysis using RCBD factorial design. To determine the relation of environment with white fly population and percent plant infection data were subjected to the correlation and regression analysis [6].

Results and Discussion

Among all four varieties no any variety shows immunity against OYVMV disease incidence and whitefly population. Response of these varieties towards OYVMV disease shows variability on the basis of their comparison to each other. Sabaz Pari shows moderately resistance response to the disease with 27.38% plant infection. Pahuja variety showed tolerant response with 27.38% plant infection. Lush green variety was fall in moderately susceptible category with 52.47% plant infection. Suceptibility was observed in Pusa Sawani cultivar with maximum plant infection about 64.22%. Dhankar et al., [7] performed an experiment in which he screened 51 hybrids of okra and their 20 parents for resistance against okra yellow vein mosaic virus under field condition. Observation was made at 35, 50 and 65 days after sowing. Only one parent and 11 hybrids were fall in resistance category against yellow vein mosaic virus. P-7 was moderately susceptible while the rest fall in the category of susceptible and highly susceptible. Raghpathi et al., screened 12 okra varieties against yellow vein mosaic virus. The results show that 2 varieties Bo-1 and HRB-55 were proved highly resistance cultivar. Seven cultivars were resistant and Bo-2 was susceptible. MDU-1 and Pusa Sawani were highly susceptible. Ahmad and Patil [8] screened nineteen okra germplasm, susceptible control Pusa Sawani also included. These germplasm were screened for their resistance toward OYVMV during summer season. The variety Arka Anamika recorded the lowest disease incidence (0.80%) and highest yield (23 t/ha) while Pusa Sawani the susceptible control recorded highest disease incidence (74.99%) and lowest yield (7.90 t/ha). None of them show complete immunity against disease. Arka Anamika, H-8 and H-10 were resistant, while Soumya F_1 and Reshma were moderately resistant. Among all those 19 okra genotypes, 13 genotypes were susceptible. Srivastava et al. [9] deliberate the reaction of 12 okra varieties against YVMV in the field at three spots. Varsha Uppar and HRB 55 were free of the disease at Karnal and Hy 6 at Andhra Perdesh. Arka Anamika revealed moderate resistance at karnal. The virus was not detected in any variety at Nashik. Singh [10] noted that hot weather with slight or no rainfall was encouraging for disease development of OYVMV and also for multiplication of *Bemisia tabaci*. Low temperature high relative humidity and rainfall were detrimental to whitefly population. Sangar [11] assessed eight okra varieties for resistance to YVMV in the rainy and summer season. He observed that disease incidence was much higher during the rainy season at that relative humidity was also high. Among eight varieties Arka Anamika was highly resistant, Arka Abhey resistant, Parbhani Kranti and V-6 were moderately resistant towards OYVMV. All other varieties were susceptible or highly susceptible. Bhagat et al. [12] found the rate of dissemination of okra yellow vein mosaic virus in okra cultivars. Pusa Sawani (highly susceptible) Vaishali, Vadhu (susceptible) and Parabhani Kranti (resistance) during rainy season.

Correlation of environmental factors with yellow vein mosaic virus disease

Correlation of weekly maximum and minimum temperature, relative humidity, rain fall and wind speed with OYVMV disease incidence was determined at variety level. A significant correlation was found between maximum temperature and disease incidence on three varities/lines i.e. Sabaz pari, Pahuja, and Pusa sawani while non-significant correlation with one variety named Lush green. Minimum temperature had highly significant correlation with disease incidence on variety named Pusa sawani and had significant correlation with variety Lush green. It had non-significant correlation with two varieties/lines Sabaz pari and Pahuja. Relative humidity showed highly significant relationship with disease incidence on two varieties/lines Pahuja and Lush green while sows significant correlation with other two varieties/lines Sabaz pari, Pusa sawani. Rainfall and wind speed showed non-significant relationship with disease incidence on four okra varieties/lines i.e. Sabaz pari, Pahuja, Lush green and Pusa sawani (Table 2).

Correlation of environmental conditions with whitefly population

A significant correlation was found between maximum temperature and whitefly population on all four varities/lines. Similarly minimum air temperature had non-significant correlation with whitefly population on all the varities/lines i.e. Sabaz pari, Pahuja, Lush green and Pusa sawani. Relative humidity had significant relationship with whitefly population on all four varities/lines i.e. Sabaz pari, Pahuja, Lush green and Pusa sawani. Rain fall had non-significant correlation with whitefly population on four varities/lines i.e. Sabaz pari, Pahuja, Lush green and Pusa sawani. Wind speed had significant correlation with whitefly population on one variety i.e Sabaz pari and shows non-significant correlation with other three varities/lines i.e. Pahuja, Lush green and Pusa sawani as shown in Table 3.

Relationship of spatial pattern with OYVMV disease incidence and whitefly population

According to the spatial study of OYVMV disease incidence and

Variety	Max Temp.	Min Temp.	RH	RF	WS
Sabaz pari	0.937**	0.612	-0.869*	-0.446	0.775
	0.006	0.197	0.025	0.375	0.070
Pahuja	0.797*	0.774	-0.941**	-0.579	0.589
	0.050	0.071	0.005	0.229	0.219
Lush gren	0.763	0.809*	-0.921**	-0.523	0.510
	0.078	0.050	0.009	0.287	0.302
Pusa sawani	0.783*	0.921**	-0.893*	-0.199	0.266
	0.050	0.009	0.017	0.705	0.610

Upper values indicated Pearson's correlation coefficient; Lower values indicated level of significance at 5% probability.
* = Significant (P<0.05); ** = Highly significant (P<0.01)

Table 2: Correlation of environmental conditions with OYVMV disease incidence recorded on four varieties/lines during 2015.

Variety	Max Temp	Min Temp	RH	RF	WS
Sabaz pari	0.861*	0.507	-0.874*	-0.500	0.870*
	0.028	0.305	0.023	0.312	0.024
Pahuja	0.792*	0.666	-0.848*	-0.717	0.711
	0.050	0.149	0.033	0.109	0.113
Lush green	0.896*	0.775	-0.882*	-0.565	0.660
	0.016	0.070	0.020	0.242	0.154
Pusa sawani	0.889*	0.745	-0.852*	-0.557	0.644
	0.018	0.089	0.031	0.251	0.167

Upper values indicated Pearson's correlation coefficient; Lower values indicated level of significance at 5% probability.
* = Significant (P<0.05); ** = Highly significant (P<0.01)

Table 3: Correlation of environmental factors with whitefly population recorded on four varities/lines during 2015.

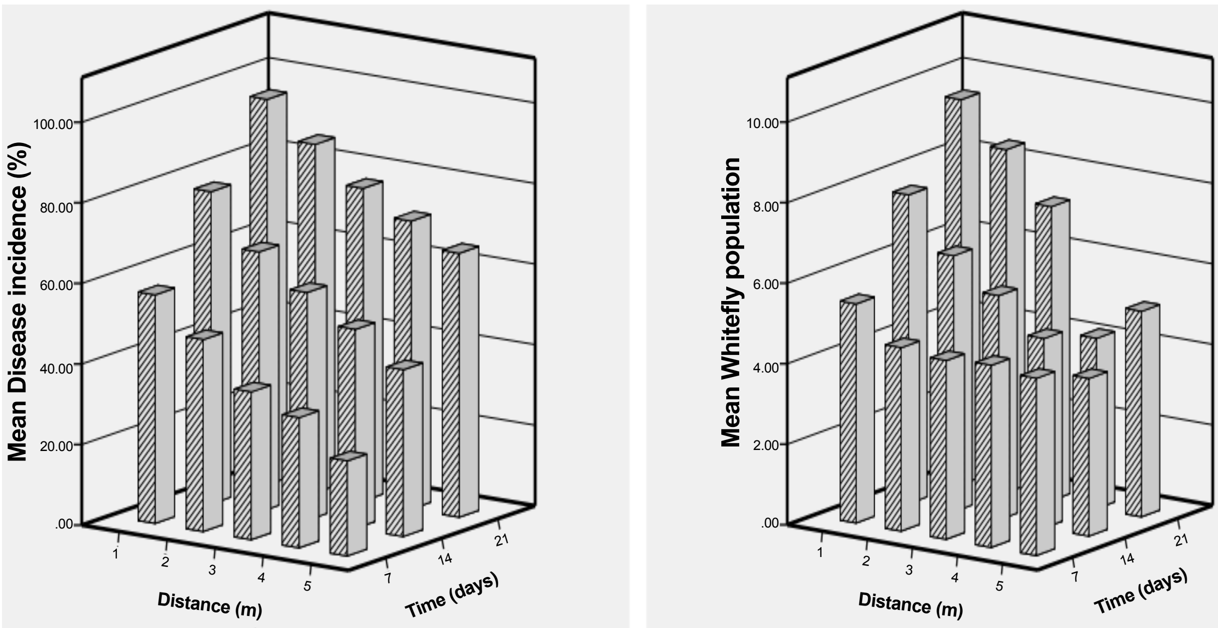

Figure 1: Relationship of Spatial pattern with OYVMV disease incidence and whitefly population.

whitefly population, the disease incidence decreases with increase in distance and time with respect to infected foci. In case of whitefly population, it increases with increase in time while distance shows minor effect (Figure 1).

Conclusion

It was concluded that among all environmental factors, two variables includes wind speed and rainfall shows non-significant correlation with OYVMV disease incidence and whitefly population. There were observed that with increase in minimum temperature the disease incidence and whitefly population increased. Similarly with decrease in relative humidity, the disease incidence and whitefly population increased. Spatial study of OYVMV and whitefly shows that with increase in time and distance, the disease incidence and whitefly population also increased. These findings could be used to make out disease predicting model.

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