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Incidence of Okra Yellow Vein Mosaic Disease in Relation to Insect Vector and Environmental Factors

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Abstract Okra (*Abelmoschus esculentus* L.) is an important vegetable crop around the world. It is a rich source of proteins carbohydrates and vitamins. Production of okra is under threat due to certain biotic and abiotic factors. Among them okra yellow vein mosaic disease is one of the most devastating viral diseases. An extensive survey for incidence of OYVMD was carried out in Sargodha, Khushab, Mianwali and Bhakkar districts of Sargodha division. The incidence was in the range of 51% to 88% with the maximum incidence in Bhakkar (88%) and least incidence in Khushab with 51%. Environmental factors had great impact on disease incidence and whitefly population. Maximum, minimum temperatutres and relative humidity was significantly correlated with disease incidence and whitely population in overall Sargodha division. Maximum temperature and relative humidity favored the disease development and increased the whitefly population. The disease incidence and whitefly population increased as the temperature and relative humidity level increased. Minimum temperature had no effect on the disease development and whitefly population.

Keywords OYVMD, Environment, Whitefly, Symptomology, Disease severity.

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Introduction

Okra (*Abelmoschus esculentus* L.) commonly known as lady finger (Bhendi tori) belongs to family *Malvaceae*. It is one of the most popular and edible vegetables all over the world. It is thought that its origin is tropical Africa. Okra is a vital crop of tropical and sub-tropical regoins of the world. It is assumed that it has been grown in agro Asian countries since ancient time [1]. It is one of the most popular vegetables around the world and in Pakistan being cutivated on a larger area as a *kharif* crop [2]. Paki-

Table 1. Disease rating scale for okra yellow vein mosaic virus.

Rating scale	Severity range (%)	Response
0	No symptoms on plants (0%)	Immune
1	Few scattered lesions observed up to 10% of plant (10%)	Highly resistant
2	Visible lesions up to 25% of plant (11–25%)	Moderately resistant
3	Visible lesions up to 50% of plant without stem girdling (26–50%)	Tolerant
4	Lesions up to 50–60% of plant with stem girdling (51–60%)	Moderately susceptible
5	Initiation of vein yellowing with mosaic pattern on 75% of plant (61–70%)	Susceptible
6	Yellowing of veins and mosaic pattern+ stem girdling (71–100%)	Highly susceptible

stan is at 5th rank in okra production with the total area of cultivation on 13919 hectares and total annual production of 0.112 million tons [3]. Okra is rich in vitamins, minerals, carbohydrate fibre, protein, fat and phenols [4, 5]. Like other crops, okra is also threatened to many biotic and abiotic factors resulting in yield losses to considerable extent. Biotic factors include viruses, fungi, bacteria and nematodes cause different diseases in okra crop. Among these, viral diseases caused by viruses; okra yellow vein mosaic virus (OYVMV), okra mosaic virus (OMV) and okra leaf curl virus (OLCV), are one of the potential factors for limitation in production [6, 7]. Okra yellow vein mosaic disease (OYVMD) is one of the devastating and widely distributed disease in okra fields around the globe including Pakistan. This disease is caused by okra yellow vein mosaic virus (OYVMV) belong to *Begomovirus*, family *Geminiviridae*. It is transmitted by mechanically and whitefly (*Bemisia tabaci*) in persistent circulative manner [8]. Incidence of OYVMV was observed on plants with characteristic symptoms of mosaic pattern on leaves, vein clearing, formation of small fruit and stunting in severe case in Pakistan [9]. Heavy yield losses (75%) were recorded in India along with rhe characteristic chlorosis yellowing of leaves, malformation and small size of fruits [10]. Although few limited studies comprising screening against OYVMD has been carried out but scanty information is available on the distribution of OYVMV in relation to environmental factor in Pakistan [11].

Table 2. Correlation of infected plants and average whitefly population/plant with environmental factors for Sargodha division. 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).

	Infected plants	Average whitefly/plant
Average max temp	0.770**	0.764**
	0.000	0.000
Average mini temp	0.792*	0.847**
	0.000	0.000
Relative humidity	-0.309	-0.358
	0.184	0.121

Investigation on virus distribution, transmission and population dynamics of whitefly is the need of time. Therefore, this study was carried out involving survey of disease in Sargodha division of Punjab, Pakistan. The current study well not only help in monitoring the disease severity but also in formulating management strategies.

Materials and Methods

Field surveys of Sargodha division were held on regular basis with the interval of fifteen days to monitor the disease incidence and whitefly population. Sargodha, Khushab, Mianwali and Bhakkar districts were surveyed to record the disease incidence and whitefly population. Disease incidence and severity was recorded on the basis of disease rating scale developed by [12] with slight modification (Table 1).

Disease Incidence

In each district 1000 fields were selected and 100 plants were observed from each field and data on disease incidence and whitefly population were recorded fortnightly. Disease symptoms; yellowing of veins, chlorosis, yellowing and dwarfing of fruits in okra crop (Fig. 1) were basic criteria.

Following formula was used to calculate the disease incidence.

$$\text{Percent Disease Incidence (PDI)} = \frac{\text{Number of diseased plants}}{\text{Total number of plants examined}} \times 100$$

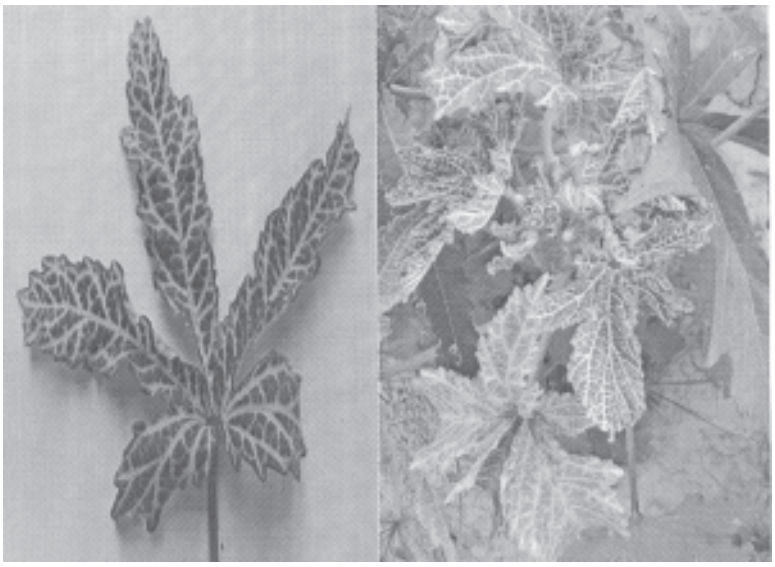

Fig. 1. Symptoms of OYVMV on leaves.

Environmental factors

Data of environmental factors; Maximum, Minimum Temperatures and relative humidity in Sargodha, Mianwali, Bhakkar and Khushab were collected from sowing to harvesting of okra crop (during April to August).

Statistical analysis

Data was analyzed by using "SAS" software. Correlation model was fitted for the interaction between disease severity, environmental factors and whitefly population.

Results and Discussion

Survey of okra yellow vein mosaic diseasein sargodha

Disease incidence in Sargodha division including four districts; Sargodha, Khoshab, Mianwali and Bhakkar was in the range of 51–88%. The maximum disease incidence was recorded 88% in district Bhakkar followed by Mianwali (55%) and Sargodha (64%). While the minimum disease incidence 51% was recorded in district Khoshab (Fig. 2).

Disease severity of OYVMD in Sargodha

Disease severity in was recorded according to disease rating scale by [12] with slight modification. Okra crop was found highly susceptible against OYVMV in Bhakkar district. While in other three districts (Sargodha, Khushab, Mianwali) okra crop showed susceptible response against OYVMV at the maturity of crop (Fig. 3).

Correlation of infected plants and average whitefly population/plant with environmental factors for Sargodha division

Environment factors showed a great impact on disease incidence and whitefly population. Maximum and minimum temperatures had highly significant correlation with disease incidence and whitefly population overall. Maximum temperatures had a positive impact on increase in disease incidence. Maximum disease

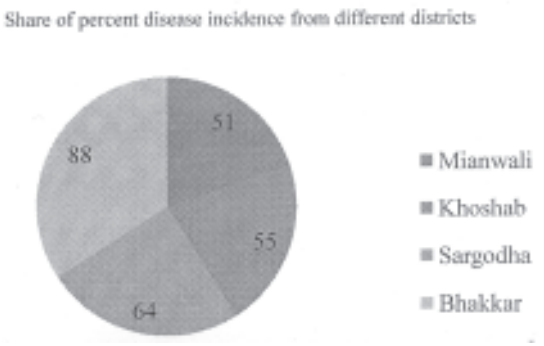

Fig. 2. Disease incidence of OYVMD in Sargodha division.

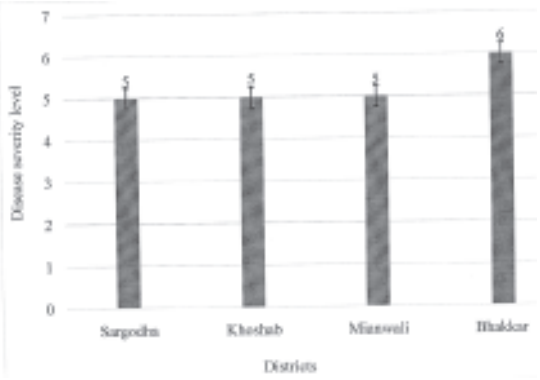

Fig. 3. Disease severity of OYVMV in Sargodha division.

incidence and whitefly population was recorded at maximum temperature of 42°C. Relative humidity had non-significant correlation on both disease incidence and whitefly population in Sargodha division (Table 2).

Correlation between infected plants and average vector/plant with environmental factors for district Sargodha, Khoshab, Mianwali and Bhakkar

In Sargodha and Khushab districts disease incidence and whitefly population correlated with environmental factors like maximum temperature, minimum temperature and relative humidity. Maximum temperature and minimum temperature were significantly correlated and had positive impact on disease incidence and whitefly population. The maximum temperature favored the disease development and whitefly population. While relative humidity had non-significant correlation on disease incidence and whitefly population. In Bhakkar district maximum temperature was significantly correlated with disease incidence and whitefly population. The increase in temperature was favoreable for disease development and whitefly population. Whereas minimum temperature had highly significant impact on disease incidence and whitefly population. When the temperature increases, the disease incidence and whitefly population were also increasing and vice versa. While relative humidity was non significantly correlated with disease incidence and whitefly population. High relative humidity increased the disease incidence but whitefly population was declining. Effect of environmental factors in relation to disease incidence and whitefly population for district Mianwali was also recorded. According to data minimum temperature was significantly correlated with disease incidence and whitefly population. Disease incidence and whitefly population was high at minimum temperature. Maximum temperature had non-significant negative correlation with disease incidence and vector population in district Mianwali. When temperature decreased the disease incidence and whitefly population increased (Table 3).

Okra yellow vein mosaic virus (OYVMV) is one of the most disturbing viral diseases of okra around the world. The quality and quantity of okra crop was decreased due to attack of this disease. Okra yellow vein mosaic virus has been reported in high proportion since last few years in the world. It is one of the most serious diseases of okra which is characterized by vein yellowing, vein clearing, stem girdling and fruit deformation. In extreme cases the infected plants growth become stunted and produce no or small fruits [13]. This virus is transmitted mechanically and through insect vector in nature. Whitefly (*Bemisia tabaci*) transmits the virus in persistent manner [14]. Our study showed the incidence in the range of 51–88% in Sargodha division. The maximum disease inci-

Table 3. Correlation between infected plants and average vector/plant with environmental factors for district Sargodha, Khoshab, Mianwali and Bhakkar. 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).

Districts	Environmental factors	Infected plants	Average vector/plant
Sargodha	Average max temp	0.830	0.791
		0.082	0.111
	Average mini temp	0.841	0.836
		0.074	0.078
	Relative humidity	-0.235	-0.324
		0.704	0.595
Khushab	Average max temp	0.712	0.692
		0.177	0.196
	Average mini temp	0.805	0.773
		0.100	0.125
	Relative humidity	0.019	0.024
		0.976	0.969
Mianwali	Average max temp	0.667	0.753
		0.219	0.141
	Average mini temp	0.911*	0.957*
		0.031	0.011
	Reative humidity	-0.389	-0.489
		0.517	0.403
Bhakkar	Average max temp	0.870*	0.871*
		0.050	0.050
	Average mini temp	0.966**	0.984**
		0.008	0.002
	Relative humidity	-0.497	-0.495
		0.395	0.397

dence was recorded 88% in district Bhakkar while the minimum disease incidence was 51% in district Khushab. Okra crop was highly susceptible to OYVMV in Bhakkar district as compared to other three districts (Sargodha, Khushab and Mianwali). Our results regarding disease incidence and severity were in accordance with Prakasha et al. [15]. They surveyed the different location of Karnataka (India) to monitor the incidence of OYVMV and whitefly and calculated the disease incidence 15.2–48.9% in different localities. They also monitored the *B. tabaci* population in okra dields infected with OYVMVD and concluded after analysis that warm temperature favored disease incidence and whitefly population. The disease incidence in our study followed the same pattern as observed [16, 17]. They conducted a survey in different localities of districts of Dharwad and Belgaum to record the incidence of OYVMV in different okra varieties during *kharif* and summer seasons. The disease incidence was 15.08% in *kharif* season and 58.14% in summer season.

Environmental factors had great impact on disease incidence and whitefly population. Maximum temperature, minimum temperature and relative humidity had significant correlation with disease incidence and whitefly population in overall. Maximum temperature, minimum temperature and relative humidity favored the disease development and multiplication of whitefly population [18]. Our results were accorded with of Nath and Saikia [19]. They observed that temperature has a great influence on the insect vector population. Low temperature was not favorable for the crop growth, disease incidence and whitefly population. Warm temperature (March, April and June) was favorable for crop growth, disease incidence and vector population. Prabu et al. [20] also recorded the relationship between environmental factors, disease incidence and whitefly population. They observed that low humidity and high temperature favored for the multiplication of whitefly. While low temperature favored the disease development. Whitefly population decreased at high humidity. During a study hot temperature with no or little rainfall favored the development of OYVMD with the increase in whitefly population [21]. Low temperature with high humidity and rainfall were not favorable for whitefly population. Similarly, [19, 22] reported the influence of sowing time on the OYVMV and vector population on okra. They found the low population of vector in early sowing of crop (Feb–March). A positive relationship was recorded between whitefly, disease incidence, relative humidity and temperature. Goswami et al. [23] conducted trails in okra fields to record the effect of sowing date on the disease incidence. The lower disease incidence 16.7% observed on okra crop that was sown in cool season (October) and highest disease incidence of 100% was recorded in warm season (May and June) sown crop. Mazumder et al. [24] also concluded that warm temperature favored the disease incidence and vector population as compared to cool temperature.

Conclusion

Regarding this study it was concluded the OYVMD

in one of the infectious and widely distributed virus disease in okra which is transmitted by whitefly in Sargodha division. Moreover, overall impact of environmental factors was significant on disease development and whitefly population. Therefore we can manage this disease (OYVMD) through manu polation in sowing dates, application of insecticides well in time and introducing the resistant sources against this disease and insect vector.

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