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Research

Prevalence of Okra Yellow Vein Mosaic Viral Disease in Baltistan Region and its Correlation with Vector Population

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Abstract

Okra (*Abelmoschus esculentus* L. Moench) being an important vegetable crop is widely grown in tropical, temprate and subtropical regions of the world. *Begomoviruses*, such as okra yellow vein mosaic virus causing okra yellow vein mosaic viral disease (OYVMVD) and transmitted by whitefly (*Bemisia tabaci*) in persistent non-propagative circulative is major threat for okra production in Baltistan (GB). The disease and vector population was visually assessed approximately 65-70 days after sowing of okra under field conditions at commercial farmer fields in district viz., Kharmang, Skardu, shigar and khapulo of Baltistan (GB), Pakistan during the growing season of 2018-2019. Ten okra plants with three replications (N = 30) at ten different locations of each district were assessed. The characteristic symptoms of yellowing and vein clearing were under taken for assessment. Maximum disease incidence of 88.33 % was recorded in Skardu region followed by Khapulo region 81.0 %. At Skardu region the disease incidence ranged between 73.3 – 100 %. Statistically there was no significant difference in the disease severity among all four regions. However, the disease severity was higher (5.20) at Skardu region followed by Khapulo, Kharmang and Shigar with the disease severity of 5.18, 4.98 and 4.77, respectively. An average of 8.84 and 8.49 whiteflies per leaf were recorded in Skardu and Khapulo region, respectively. Whereas, 8.01 whiteflies per leaf were observed in Shigar region and lowest population were 7.48 per leaf in Kharmang region. The data showed relationship of the disease severity with the incidence at Kharmang r = 0.9565; P <0.0001, Skardur = 0.9416; P <0.0001, Khapulo r = 0.8913; P =0.0005 and Shigar region was r = 0.9073; P = 0.0003. Similarly, relationship between the disease severity and whitefly population was also good and significantly correlated at all the regions. Visual assessment showed that the disease is prevailing throughout all region monitored in this study and the disease is significantly correlated with vector population. However, maximum disease incidence and severity was recorded in Skardu. Therefore, it is recommended to validate various management practices at such high disease risk points for better management.

Keywords: Prevalence; Vector Population; Monitored

Introduction

Okra (*Abelmoschus esculentus* (L.) Moench) is one of the most important vegetable crops grown in tropical and sub-tropical regions of the world, including Pakistan. It is an annual, herbaceous, plant of erect growth habit, with or without branches and with bisexual flower, which belongs to family Malvacene. Because of high consumer demand and thereby better price, farmers grow okra widely during the rainy and summer season [1].

Although people of India, Pakistan, Nigeria, Cameroon, Iraq and Ghana are well known about this crop, but due to its nutritional composition the crop is getting popularity in European countries and North America even it is not cultivated in these regions [2].

Among these OYVMD caused by *okra yellow vein mosaic* virus (Genus Begomovirus and Family Geminiviridae) is considered as most severe which causes heavy yield losses in the crop by affecting the quality and yield of fruits and widely distributed [3,1,4,5]. The disease may appear at any time during all growth stags. Variety of symptoms may appear on successful infection such as, intermingled patches of green and yellow color, vein clearing and leaves chlorosis, and deformed, malformed and yellow fruits [6].

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Begomoviruses are transmitted by whiteflies (*Bemisia tabaci*) in a persistent, circulative manner, where the whiteflies feeds on the virus infected plants by inserting the stylets into the leaf and withdrawing virus contaminated sap from the phloem [7]. That is, once the vector feeds on an infected host plant and acquires the virus, transmission can then occur following a latent period of a few hours, and may continue for the life span of the vector [7]. Even a single whitefly is able to transmit the virus, but ten whiteflies per leaf are sufficient to induce 100% infection [2].

It is predicated that the virus may infect 100 % okra plants with range of yield losses between 50 to 94 % which is highly influenced by stage of crop being infected [8]. In India, during 1924 Kulkarni reported first time evidence of the disease in region of Bombay [9].

The assessment of the amount of the disease on okra plants in field condition is essential in any quantitative epidemiological study and so far to conduct field based experiments for managing the disease at regularly disease occurring region. Such studies are limited in case of OYVMVD in Baltistan (GB) region of Pakistan. Disease can be assess visually direct on or in plant material using descriptive or pictorial keys and indirectly by monitoring the propagative unit of infectious agent with help of various modern techniques [10,11]. Obviously visual assessment of disease in term of incidence, severity is simpler, cost effective and more strongly correlated with yield losses in the crop [10].

Therefore, this survey based study was conducted

1. To asses intensity of okra yellow vein mosaic viral disease in the fields.

2. To analysis correlation between the disease incidence, severity and vector population.

Materials and Methods

Disease Assessment

The disease was visually assessed under field conditions at commercial farmer fields in different regions viz., Kharmang, Skardu, Shigar and Khapulo. It is not possible to choose fields according to a stratified random sampling plan; rather, selection was based on attempting to achieve coverage of the main arable areas, coupled with the willingness of farmers to participate in the survey. Fields were managed by growers as farming practices recommended for okra production. Approximately 65-70 days after sowing, ten different locations of each district were assessed for the disease development. Ten okra plants with three replications (N = 30) at each location were observed for the okra yellow vein mosaic virus symptoms. The disease incidence percentage was calculated by dividing number of okra plants showing vein clearing symptoms with total number of plants examined for the disease and multiplying this value with hundred to get percentage.

Disease severity was measured by using 0-6 rating scale [12] where, 0 is indicating completely absence of disease symptoms, 1 = Vein Clearing 1-10%, 2 = Vein Yellowing of small leaves 11-25%, 3 = Yellow network on some leaves 25-50%, 4 = Yellow network on all leaves 51-60%, 5 = Complete leaves turn Yellow or cream color 60-70% and 6= Plant stunted, deformed and small fruits and the whole plants become colorless > 70%.

White Fly Scouting

Whitefly population (both adults and nymphs) were recorded from, upper leaf (first plant), middle leaf (second plant), lower leaf (third plant) at the time of visual disease assessment (Akram et al., 2013).

Statistical Analysiss

The mean disease incidence percentage, disease severity and white fly population per plant at each location will be compared for significant differences analysis among variance using LSD test ($\alpha = 0.005$) of completely randomized design using STATISTIX v. 8.1 software (Analytical Software). A nonparametric Spearman Rank correlation test will be used for the correlation analysis between the disease severity with disease incidence percentage and white fly population at each location of surveyed districts for the disease assessed using PRISM v. 5.01 (GraphPad Software).

Symptoms Induced By okra Yellow Vein Mosaic Virus

It is well documented that the virus can infect okra crop at any growth stage. We monitored the disease symptoms approximately 65-70 days after sowing in natural field conditions at farmer plots. The diseased plants were clearly showing network of yellow veins on top first leaf but in some plants all the leaves were showing such characteristic symptom and top leaf was showing entire leaf area as yellow (Fig. 1). This may due to time course the disease became sever on such crop plants. Although in most of fields just top leaf shows the disease symptom.

The Disease Incidence in Different Regions

The incidence of OYVMVD was studied during 2016 growing season in four different regions of Baltistan (GB), Pakistan. A total 10 commercial farmer fields for each region were visited at hub of vegetable production. Location to location the disease incidence was

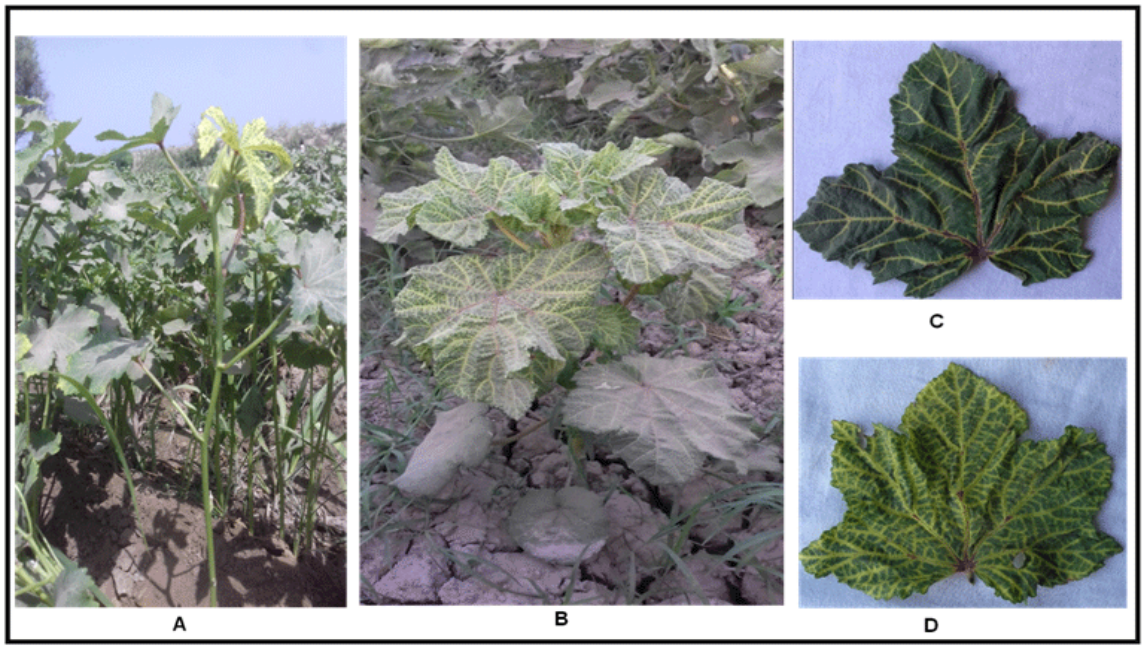

Figure 1. Symptoms produced by okra yellow vein mosaic viral disease under field conditions (A) plants are showing symptom at top leaf (B) most of plants are showing characteristic yellowing (C) major vein yellowing at initial stage and (D) extensive network of veins is showing yellowing collected by PARC, Mountain agricultural research station Skardu

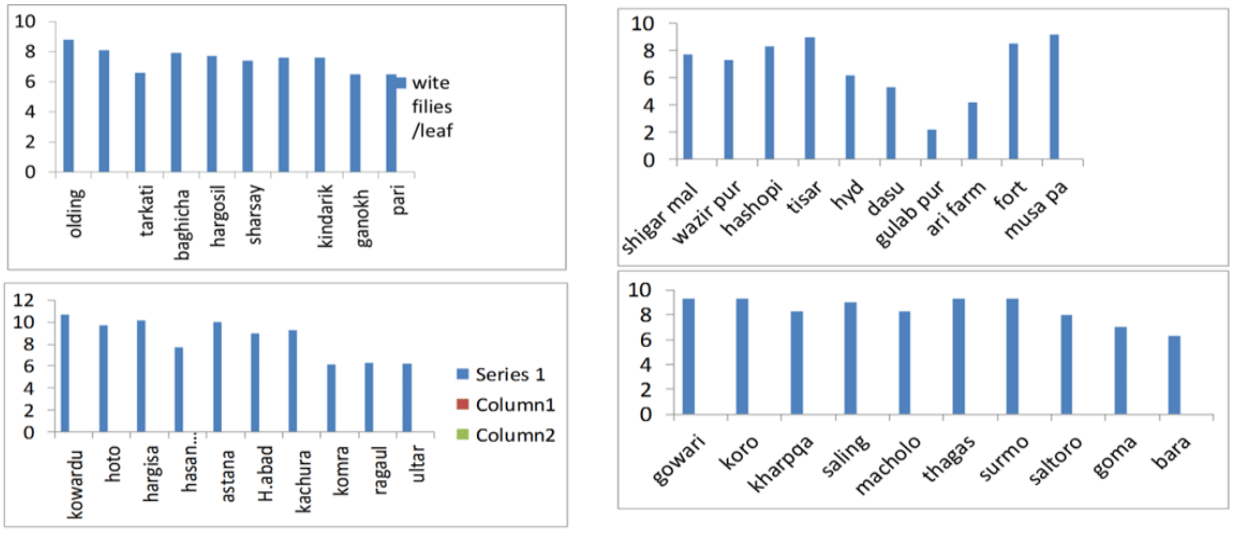

Figure 2. Okra yellow vein mosaic viral disease incidence at different locations of Kharmang, Skardu, Khapulo and Shigar districts.By PARC, Mountain Agricultural Research Station Skardu.

also varying between the ranges of 50 to 100 % (Fig. 2). At Skarduregion the disease incidence ranged between 73.3 – 100 % (Fig. 2). Plants at L1, L2, L3 of Skardu showed 100 % incidence of the disease, whereas, only L1 showed 100 % disease incidence in Khapulo region (Fig. 2). In other remaining regions, the disease incidence was 73.3 % with range of 50 – 93.3 % in Shigar and 71.67 % the disease incidence with range of 50 -96.6 % in Kharmang (Fig. 2). Maximum disease incidence of 88.33 % was recorded in Skardu region followed by Khapulo region 81.0 % and minimum disease Incidence was recorded 71.67 % at Kharmang region followed by 73.33 % at Shigar (Fig. 3).

The Disease Severity in Different Regions

The disease severity was also assessed using 0-6 disease rating scale at same plants evaluated for the disease incidence. The disease severity in the surveyed fields of Kharmang, Skardu, Khapulo and Shigar

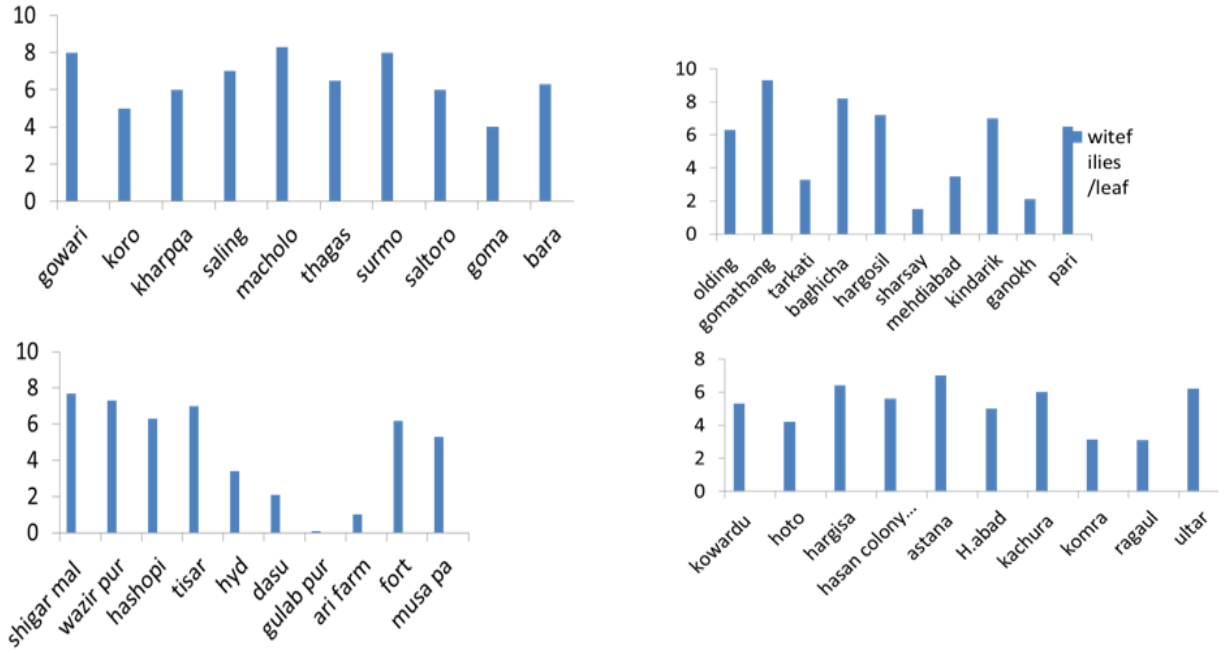

Figure 3. Okra yellow vein mosaic viral disease severity at different locations of Kharmang , Skardu, Khapulo and Shigar districts.

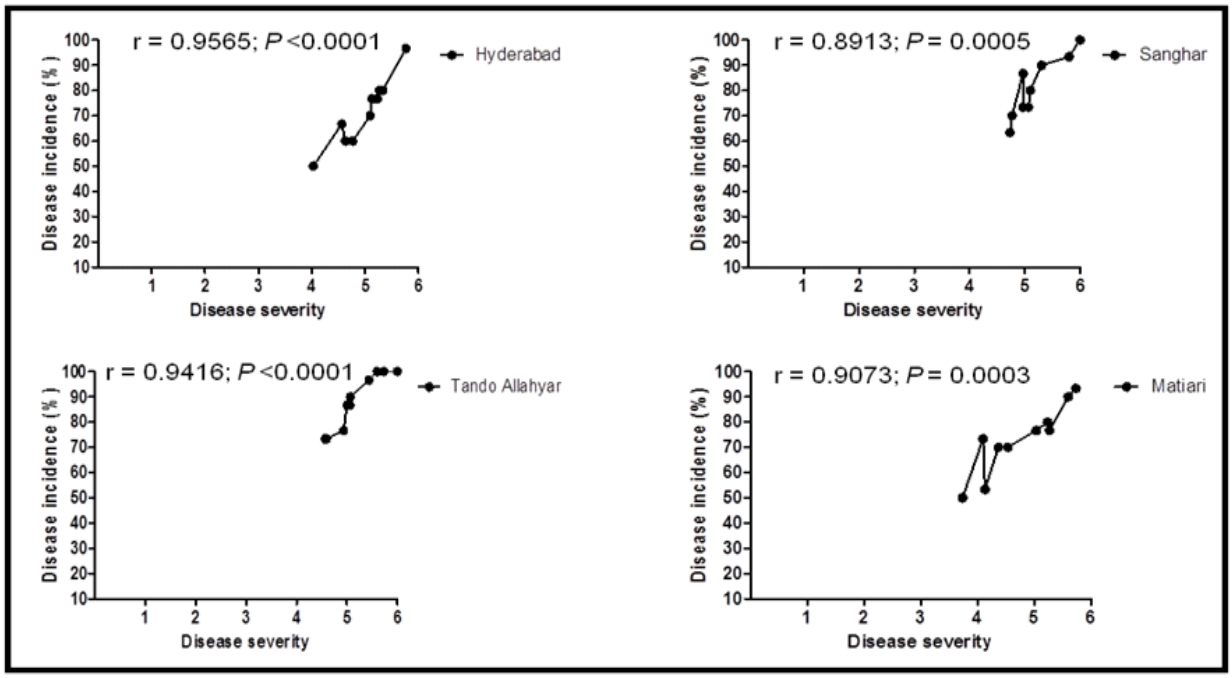

Figure 4. Scatter plot showing correlation coefficients for okra yellow vein mosaic viral disease severity with the disease incidence at different regions under field conditions.

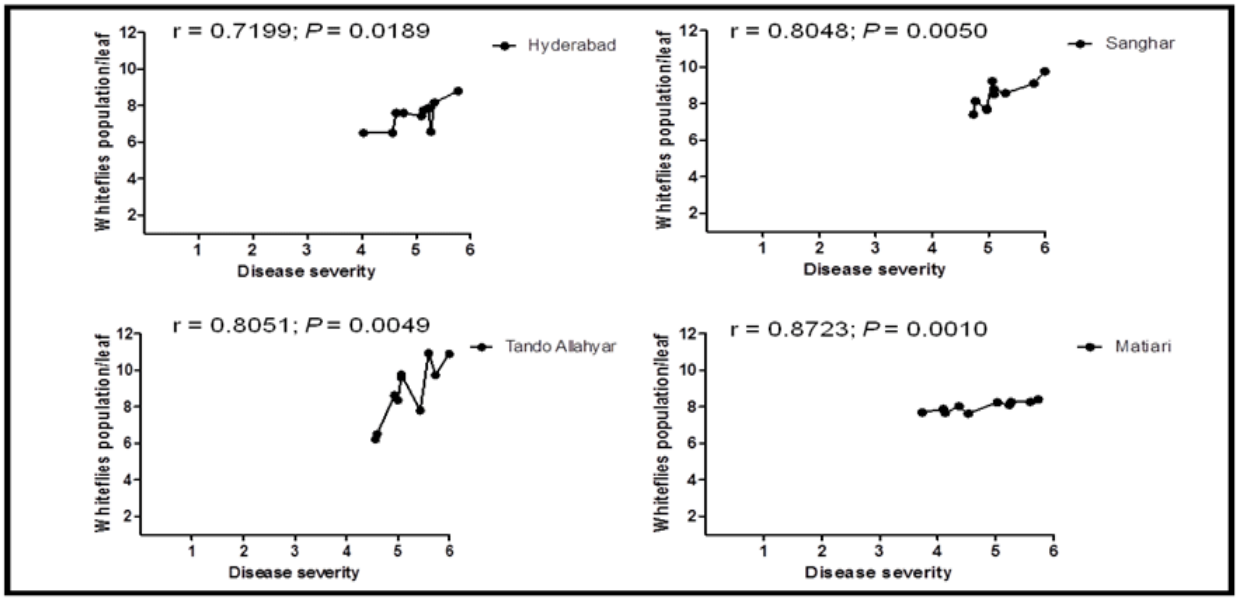

Figure 5. Scatter plot showing correlation coefficients for okra yellow vein mosaic viral disease severity with the whiteflies population at different regions under field conditions

ranged between 5.8-4, 6-4.7, 5.7-4.7 and 5.7-3.7, respectively (Fig. 4). Minimum the disease severity of 3.7 was only observed at L10 of Shigar region (Fig. 4). However, the average disease severity was higher (5.20) at Skarduregion followed by Khapulo, Kharmang and Shigar with the disease severity of 5.18, 4.98 and 4.77, respectively (Fig. 5). This result indicates that the disease is prevailing throughout okra cultivation in surveyed regions with severe level.

Whiteflies Population at Different Regions

Whiteflies population was scout out at plants used for visual disease assessment on upper, middle and lower leaves. Whiteflies population at fields of Kharmang ranged 8.8 to 6.5 per leaf, whereas it was 10.7 to 6.3 at Skardu, 9.3 to 7.3 at Khapulo and 8.4 to 7.6 at Shigar (Fig. 6). An average of 9, 8 and 8 whiteflies per leaf were recorded in SkarduKhapulo and Shigar region, respectively (Fig. 7). While, significantly lower population of 7 per leaf was recorded in Kharmang region (Fig. 7). This indicates whiteflies are playing major role for the disease epidemic in these okra production regions.

Relationship Between the Disease and Whitefly Population

Of the 40 selected fields for record the disease incidence and severity in four region of Baltistan (GB) province, no any field was found free of the disease. It was predicated the disease may occur in these regions but not be severe, therefore correlation analysis was performed to explore relationship of the disease severity and incidence. Correlation analysis showed the disease severity at all regions was significantly and strongly correlated with the disease incidence. However, the data showed relationship of the disease severity with the incidence at Kharmang r = 0.9565; P <0.0001, Skardur = 0.9416; P <0.0001, Khapulo r = 0.8913; P =0.0005 and Shigar region was r = 0.9073; P = 0.0003 (Fig. 8). Similarly, relationship between the disease severity and whitefly population was also good and significantly correlated at all the regions (Fig. 9). This indicates that the disease development and vector population was directly correlated in these regions. Such a strong relation may severely reduce crop productivity or may destroy entire plant with in time.

Discussion

This study presents extensive data on the disease development and vectors population in Baltistan(GB), demonstrating that it is widespread in all of the regions studied. During the survey, diagnosis was based only on visual symptom expression. Yellowing of vein encircling green tissue is known characteristic symptom of the disease [6]. In this study, the diseased plants were also showing such severe symptoms under field conditions. The disease was observed at all the locations of the four regions; more than 50 % plants were infected. The average of 5.0342 severity of the disease was found in all regions focused for this study. However, highest the disease incidence and severity was recorded at Skardu. Some locations of Skarduregion were showing 100 % incidence with chronic and severe condition of the disease, such specific locations maybe selected for field based experiment, including resistance screening. This region to region and location to location variation maybe associated with planting

time, environmental conditions, variety used for plantation. Similarly [13], showed that variety Pusa sawani was strongly correlated with environmental factors. Here in our study, temperature remains slightly vary but humidity percentage may vary in these regions. On other hand field characteristics are also important for disease epidemiology where vector may survive, or weeds, alternate hosts may provide major source of initial inoculums which is directly correlated to any disease epidemic. Similarly, Environmental conditions (maximum and minimum air temperature, relative humidity, rainfall, clouds and wind velocity) has been shown to influence OYVMV incidence and white fly population on commercially grown varieties of okra i.e. Pahuja, Safal, Subz Pari and Surkh Bhindi. The disease incidence increased with the rise in minimum temperature and whitefly population decreased with increase in the relative humidity. Surkh Bindi was found to be highly resistant among the okra cultivars [12]. Similarly [14], evaluated resistance potential of different okra varieties and its correlation with environmental conditions. The result showed that the variety Saloni F1 is highly resistant, Subz Pari is moderately resistant, Diksha as the tolerant variety while Lush Green is moderately susceptible. Furthermore, the disease severity is significantly correlated with environment factors.This indicates that in our study the disease prevalence might be varied due to varieties and influence of environmental conditions.

Furthermore, there was a strong relationship between the disease incidence, severity and whiteflies abundance, as has been demonstrated from studies conducted elsewhere for other diseases [12 ,15]. However, our study showed a severe OYVMVD epidemic situation exists in the surveyed areas. Even though, due to capriciousness in whiteflies population, latent period and proper symptom expression it is difficult to find such relationship [16,17,]. Therefore, surveys should be conducted frequently after some interval of time for better understanding of the relationship between whiteflies and OYVMV occurrence at the hub of vegetable production [18,19].

Conclusions

Our results show that OYVMVD vectored by whitefly is widely distributed in Baltistan (GB), Pakistan, with higher severity levels. Vector population is also strongly correlated with the disease development. This indicates that the disease development and vector population was directly correlated in these regions. Such a strong relation may severely reduce crop productivity or may destroy entire plant with in time. This survey first time is conducted to provide a baseline information on the OVYMVD spread in Baltistan (GB) division, Pakistan.

Recommendations

It is important to take into consideration that due to widely cultivation of the disease susceptible cultivars and unavailability of management practices would be perilous threats to okra production of Pakistan in future. Therefore, here is immediate need to validate management practices at such high disease risk points and to control the disease spread at these vegetable production hub.

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