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Assessment of Leaf Curl Disease Intensity in Bottle Gourd and its Relationship with Whitefly (*Bemisia tabaci*) Population in District Hyderabad

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ABSTRACT

Bottle gourd (*Lagenaria siceraria* L.) is the most nutritious and medicinally important vegetable crop in tropical and subtropical areas, including Pakistan. The leaf curl disease has been reported in bottle gourd along with other cucurbits, which is transmitted by whiteflies (*Bemisia tabaci* Genn). This study aims to quantify the intensity leaf curl disease of bottle gourd and analyze its correlation with whitefly population under agro-ecological conditions of Hyderabad. Surveys were conducted in ten (10) different fields of the Hyderabad district. During the survey, the incidence of the leaf curl symptoms was recorded using a standard mathematical formula and the severity of symptoms was estimated using a disease severity rating scale from 0-6. At the time of visual disease assessment, the whitefly population was recorded. A nonparametric Spearman rank correlation analysis was performed using PRISM v. 5.01 (GraphPad Software) to estimate the relationship between disease incidence and vector population, as well as disease severity and vector population. Results revealed that the diseased bottle gourd plants exhibited symptoms such as blistering, curling, crinkling, yellowing of the leaf blades, thickness of the veins, upward rolling of the leaf margins, and vein clearing. The incidence of the disease in the Hyderabad district ranges between 60 to 84 %. Statistical analysis exhibited significant variation in the disease incidence % in different fields of the Hyderabad district. The severity of the symptoms ranges between 1.36 to 1.8, indicating that 10 to 25 % of leaves show discolouration. However, statistically, there was no significant variation in leaf curl disease symptoms in all the surveyed fields across surveyed sites in Hyderabad district. Field 2 (Mola Bux Farm, Tando Fazal), Field 4 (Babar Ismail Arain Farm, Mirzapur), and Field 5 (Shadi Halepota Farm, Tando Qaiser) exhibited a negative and non-significant relationship of the disease incidence and vector population. Whereas the same relationship of vector population and the disease severity score was assessed in Field 4 (Babar Ismail Arain Farm, Mirzapur), and Field 5 (Shadi Halepota Farm, Tando Qaiser). The relationship of disease severity and vector population in Field 10 (Talpur Farm, Chukhi) was also negative. The remaining fields exhibited a positive but nonsignificant relationship between the disease incidence (%) and severity score with the vector population. Based on the present study, it is concluded that the leaf curl disease is occurring in the Hyderabad district.

Keywords: Intensity, leaf curl disease, bottle gourd, correlation, whitefly

INTRODUCTION

Bottle gourd (*Lagenaria siceraria* L.) is a plant belonging to the Cucurbitaceae family, which includes other familiar members such as cucumbers, pumpkins, and melons. The bottle gourd fruit has the greatest variation in shape and size, both within and between cultivars. It can be long, cylindrical, necked, oblong, flat, or round, conical, pyriform, or club-shaped, and its skin can be smooth or warded (Ilyas *et al.*, 2017). It is cultivated widely across various continents, including Asia, Africa, and South America. Revered for its culinary versatility and numerous health benefits, bottle gourd is important in various cultures and cuisines worldwide (Verma & Maurya, 2021). It is

a low in calories and rich in essential nutrients such as vitamins A, C, and K and minerals like calcium, magnesium, and potassium (Kumar & Singh, 2020). Moreover, it contains dietary fiber, which promotes digestive health and helps regulate cholesterol levels. The presence of antioxidants in bottle gourd, such as flavonoids and phenolic compounds, contributes to its potential health-promoting properties. These antioxidants help combat oxidative stress and inflammation in the body, thereby reducing the risk of chronic diseases like heart disease and certain cancers (Jeevitha & Sushmitha, 2019).

Plant viruses are vibrant pathogens infecting several crops including fruits and vegetables. Cucurbit

crops are seriously threatened by viral diseases, which can spread through a variety of means, including as mechanical transmission, fungal transmission, vector-borne transmission through insects, and seed transmission (Lecoq & Katis, 2014). More than 100 viruses have been found in cucurbit crops worldwide, according to earlier reports (Peng, 2019). The long-distance dissemination of plant viruses is significantly influenced by seed transfer. Seeds are the means by which about 20% of all plant viruses are transmitted (Mink, 1993).

Globally, diseases caused by viruses pose a serious threat to cucurbit production. These diseases have become more common and have appeared in the different places where crops are produced. They primarily affect the bitter melon, bottle melon, sponge melon, ridge melon, and squash or pumpkin. Virus species from different genera, including Begomovirus, Crinivirus, Cucumovirus, Nepovirus, Orthotospovirus, Polerovirus, Potyvirus, and Tobamovirus, are responsible for known disorders (Cruz et al., 2024). Begomoviruses often infect dicotyledonous plants and have bipartite genomes (designated as DNA-A and DNA-B). On the other hand, certain begomoviruses only contain one genomic DNA molecule.

Virus species belonging to the genus Begomovirus are transmitted by whiteflies (*Bemisia tabaci* Genn.) and cause leaf curl disease. The leaf curl disease has been documented in a variety of cucurbits, including bottle melon (Venkataravanappa et al., 2020). Sohrab et al. (2010) reported that bottle melon was observed to be seriously affected with severe stunting with slight pale-yellow curly leaf symptoms (Sohrab et al., 2010). The disease was identified as chlorotic curly stunt of bottle melon when the infected plants exhibited symptoms such as chlorotic mottling, minor curling, and severe stunting. These viruses cause stunted growth, yellowing, and curling of leaves, significantly reducing yield. The disease is extremely prevalent worldwide under protected and open field conditions and causes significant economic losses (Lapidot & Polston, 2006). Furthermore, the intensity of such symptoms is dependent on the vector population. However, there is no recent report to show the intensity of leaf curl disease in bottle melon and the impact of vector population on the intensity of leaf curl disease in bottle melon under the agro-ecosystem of Sindh. Therefore, the present study is planned to estimate the intensity of leaf curl disease in bottle melon in the vicinity of Hyderabad and their relationship with the vector population.

MATERIALS AND METHODS

Surveys were conducted in ten (10) different fields of Hyderabad district. During the survey, the incidence of the leaf curl symptoms was recorded using standard mathematical formula,

$$\text{Incidence (\%)} = \frac{\text{Number of symptomatic plants}}{\text{Total number of observed plants}} \times 100$$

The severity of symptoms was estimated using a disease severity rating scale from 0-6 used by Islam et al. (2011) with slight modifications. At the time of visual disease assessment, the whitefly population was recorded by randomly selecting leaves from the upper, middle, and lower portions of various plants, as described by Akram et al. (2013). A nonparametric Spearman rank correlation analysis was performed using PRISM v. 5.01 (GraphPad Software) to estimate the relationship between disease incidence and vector population, as well as disease severity and vector population. The collected data were compiled and analyzed statistically for the analysis of variance, and the mean difference was determined by the least significant difference test at 5% level of probability using Statistics 8.1 software (Analytical Software).

RESULTS

During surveys, the diseased bottle melon plants displayed symptoms such as blistering, curling, crinkling, yellowing of the leaf blades, thickness of the veins, upward rolling of the leaf margins, and vein clearing. As the symptoms worsened, the bottle melon plant's top and middle leaves turned a vivid yellow, whereas the bottom leaves stayed green. Additionally, the plant's growth was stunted, and its leaves were reduced in size throughout the districts of Hyderabad that were visited.

The incidence of leaf curl disease of bottle melon in different fields of Hyderabad district: Based on visually observed symptoms of leaf curl disease in bottle melon plants a significant maximum incidence of 86 % was noted in Field 8 (Bharoi Farm, Channel) and Field 9 (Muhammad Shah town Farm, Latifabad No. 02) and 84 % in Field 7 (Gul Farm, Kari Mori) followed by 80 % in Field 6 (Lashari Farm, Baksho Laghari), 78 % in Field 10 (Talpur Farm, Chukhi), 70 % in Field 1 (Latif Experimental Farm, SAU Tandojam), Field 2 (Mola Bux Farm, Tando Fazal), Field 4 (Babar Ismail Arain Farm, Mirzapur) and 68 % in Field 3 (Juman Halepota Farm, Husri) (Figure 1). Whereas statistically lower disease incidence (60 %) was recorded in Field 5 (Shadi Halepota Farm, Tando Kaiser) (Figure 1).

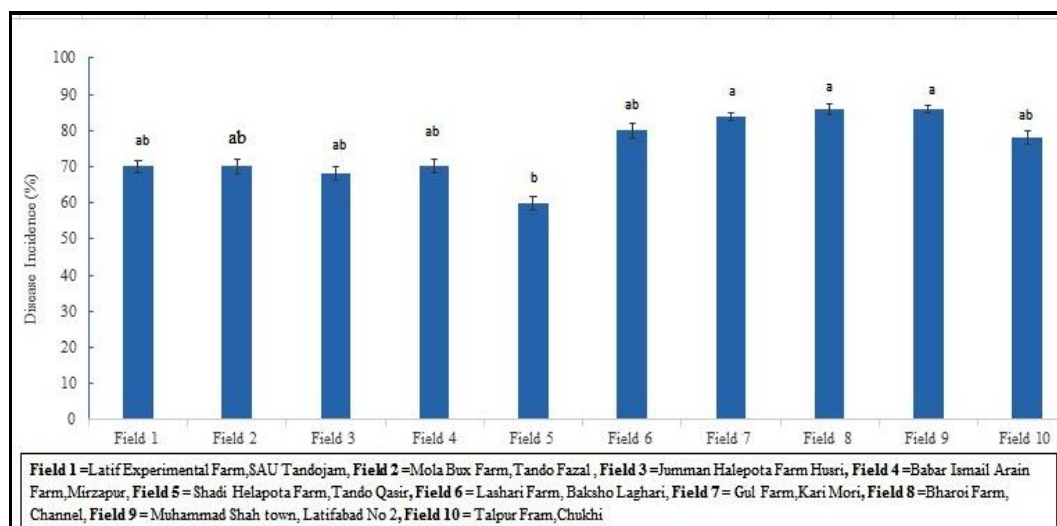


Figure 1. Incidence of the leaf curl disease in bottle gourd across Hyderabad district

The severity of leaf curl disease of bottle gourd in different fields of Hyderabad district: Maximum average severity score 1.9 was recorded in Field 8 (Bharoi Farm, Channel), followed by 1.86 in Field 6 (Lashari Farm, Baksho Laghari), 1.82 in Field 7 (Gul Farm, Kari Mori), 1.76 in Field 1 (Latif Experimental Farm, SAU Tandojam) and Field 10 (Talpur Farm, Chukhi) (Figure 2). Field 5 (Shadi Halepota Farm, Tando Qaiser) exhibited minimum 1.36 severity score

followed by 1.5 severity score in Field 3 (Juman Halepota Farm, Husri), 1.52 score in Field 2 (Mola Bux Farm, Tando Fazal), 1.54 score in Field 9 (Muhammad Shah town Farm, Latifabad No. 02), and 1.7 score in Field 4 (Babar Ismail Arain Farm, Mirzapur) (Figure 2). However, statistically there was not significant variation of leaf curl disease symptoms in all the surveyed fields in district Hyderabad

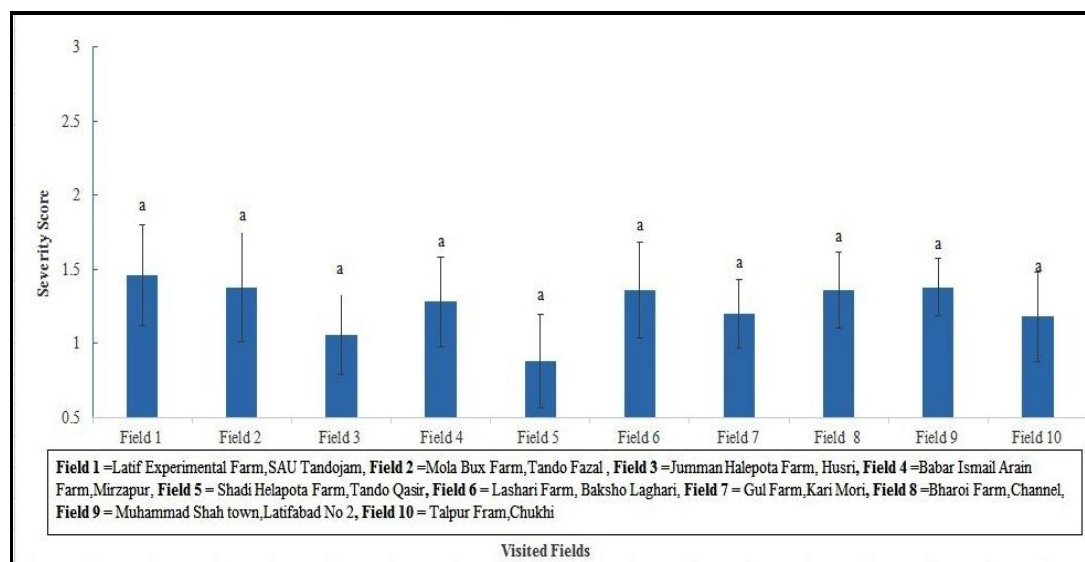


Figure 2. Severity of the leaf curl disease in bottle gourd across Hyderabad district

The population of whitefly the vector of leaf curl disease in bottle gourd in Hyderabad district: The maximum vector population was observed in Field 9 (Muhammad Shah town Farm, Latifabad No. 02) (1.62) followed by Field 2 (Mola Bux Farm, Tando Fazal) (1.22), Field 5 (Shadi Halepota Farm, Tando Qaiser) (1.18) and Field 8 (Bharoi Farm, Channel)

(1.14) and lowest vector populations were observed in Field 1 (Latif Experimental Farm, SAU Tandojam) (0.46) followed by Field 3 (Juman Halepota Farm, Husri) (0.70), Field 7 (Gul Farm, Kari Mori) (0.76), Field 4 (Babar Ismail Arain Farm, Mirzapur) (0.84), Field 6 (Lashari Farm, Baksho Laghari) (0.88) and Field 10 (Talpur Farm, Chukhi) (0.88) (Figure 3).

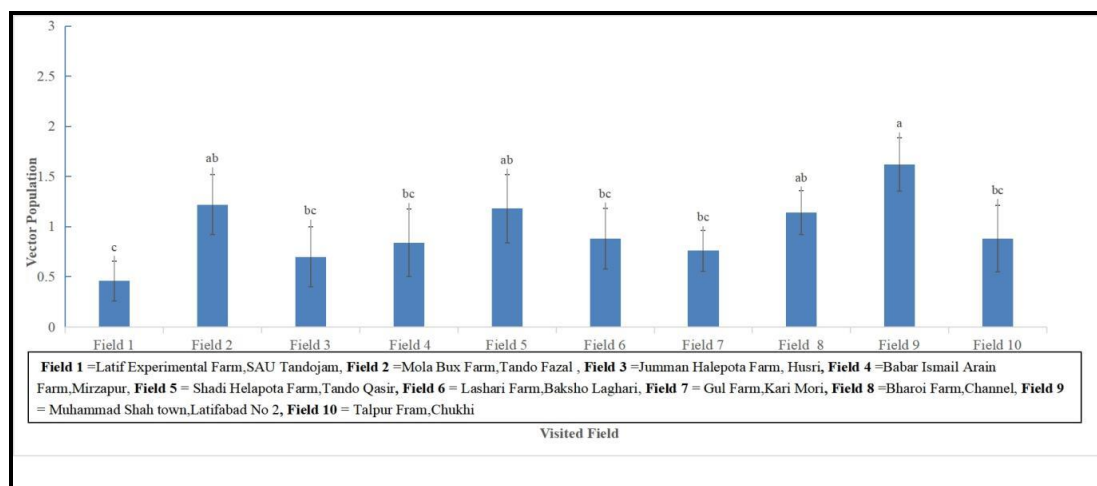


Figure 3. Population of vector (whitefly) of leaf curl disease in bottle gourd in Hyderabad district

The correlation of leaf curl disease of bottle gourd with vector population: The results presented in Table 1 show a diverse relationship of the disease incidence (%) with the vector (whitefly) population. Field 2 (Mola Bux Farm, Tando Fazal), Field 4 (Babar Ismail Arain Farm, Mirzapur), and Field 5 (Shadi Halepota Farm, Tando Qaiser) exhibited a negative and non-significant relationship of the disease incidence and vector population (Table 1). Whereas the remaining fields show a positive but nonsignificant relationship between the two variables.

Similarly, Field 4 (Babar Ismail Arain Farm, Mirzapur), and Field 5 (Shadi Halepota Farm, Tando Qaiser) exhibited a nonsignificant negative relationship between the disease severity and vector population. The relationship of disease severity and vector population in Field 10 (Talpur Farm, Chukhi) was also negative (Table 1). Interaction of the disease severity and vector population was positive in all the remaining fields, but it was statistically nonsignificant (Table 1).

Table 1. Correlation of vector (Whitefly) population with the incidence and severity of leaf curl disease of bottle gourd

Fields	Incidence %		Severity Score	
	r	P	r	P
Field 1	0.2868	0.6833	0.1026	0.9500
Field 2	-0.1352	0.7833	0.1026	0.9500
Field 3	0.3078	0.6833	0.1000	0.9500
Field 4	-0.6309	0.2333	-0.6316	0.2333
Field 5	-0.6669	0.2333	-0.7000	0.2333
Field 6	0.2236	0.7833	0.000	1.05
Field 7	0.5774	0.3500	0.3591	0.5167
Field 8	0.3591	0.5167	0.7000	0.2333
Field 9	0.000	1.05	0.7906	0.1333
Field 10	0.0000	1.05	-0.1000	0.9500

DISCUSSION

In the year 2023 a severe leaf curl virus disease was observed at the different farmer's fields of district Hyderabad. Therefore, prevalence of the disease was estimated in current study. Symptoms of blistering, curling, crinkling, yellowing of the leaf blades, thickness of the veins, upward curling of the leaf margins, and vein clearing show the typical symptoms of leaf curl disease in bottle gourd. The leaf curl disease has been documented in a variety of cucurbits, including bottle gourd (Venkataravanappa *et al.*, 2020). Sohrab *et al.* (2010) reported that bottle gourd was observed to be seriously affected with severe stunting with slight pale-yellow curly leaf symptoms (Sohrab *et al.*, 2010). The disease was identified as chlorotic curly stunt of bottle gourd when the infected

plants exhibited symptoms such as chlorotic mottling, minor curling, and severe stunting.

The incidence of disease symptoms in surveyed fields ranged from 60 to 86%. Whereas the incidence of the disease was significantly varying among the surveyed fields. The disease severity ranged between 1.9 to 1.36 rating scores. This indicates that less than 10 to 25 % of leaves show discolouration. However, statistically, there was no significant variation in the severity of leaf curl disease symptoms in all the surveyed fields across surveyed sites in Hyderabad district. Such variation of disease symptoms in the field conditions has also been estimated for several other viral diseases. Such as, in the three agroecological zones of the Volta and Oti regions, Adzim (2023) has examined the prevalence of okra leaf curl disease (OLCD) and its whitefly vector. The

disease's mean severity index ranged from 1.18 to 1.44, and its mean incidence varied from 69.69 to 80.62%. In both years one and two, the mean illness incidence was greater in the coastal zone (77.42%) than in the transition (72.56%) and forest (71.85%) zones. It was projected that there were 38,504 whiteflies in total—25,978 during the minor season and 12,526 during the main. Similarly, Selangga *et al.* (2023) studied the connection between PYLCIV's field distribution and symptom changes and molecular characterization. Based on the findings, they deduced that yellow mosaic and leaf curl, and malformation were the most common symptoms observed in bell pepper plants, with respective incidence rates of 19.5 and 21.5%. The high incidence rate was brought on by the large number of whiteflies in both symptom types.

The presence of the vector (whitefly) of leaf curl disease was noticed in every field. Diverse relationships of the disease incidence (%) and severity score with vector (whitefly) population were noted in the correlation analysis. Field 2 (Mola Bux Farm, Tando Fazal), Field 4 (Babar Ismail Arain Farm, Mirzapur), and Field 5 (Shadi Halepota Farm, Tando Qaiser) exhibited a negative and non-significant relationship between the disease incidence and vector population. Whereas the same relationship of vector population and the disease severity score was assessed in Field 4 (Babar Ismail Arain Farm, Mirzapur) and Field 5 (Shadi Halepota Farm, Tando Qaiser). The relationship of disease severity and vector population in Field 10 (Talpur Farm, Chukhi) was also negative. The remaining fields exhibited a positive but nonsignificant relationship between the disease incidence (%) and severity score with the vector population. A study was carried out to examine the relationship between the proportion of viruliferous *B. tabaci* and the disease incidence of Begomovirus on chili pepper crops. With an average density of 27.21 imago/yellow sticky card, the highest imago population was found at 6 WAP, whereas the highest nymph population was found at 8 WAP, with an average density of 4.26 nymph/leaf. At 12 WAP, the incidence of Begomovirus disease reached 83.07% due to the high population of *B. tabaci* nymphs and imago. According to the findings, a large *B. tabaci* population sped up the virus's spread in the field (Temaja *et al.*, 2022). In the present investigations, field to field change in relationships is perhaps adoption of different management strategies by the farmers. Non-significant correlations among disease incidence, severity and vector population were also reported by (Kumar *et al.*, 2019). The $r^2 = 0.20$ among incidence and vector population indicates non-significant relationship among the variables. Such non-significant relationship of CLCuD intensity and its vector dynamics on various genotypes has been estimated by Varma and Malathi (2003). Similarly, in another study conducted by Aktar *et al.* (2004) concluded that there was no relationship among

vector abundance of CLCuD and its intensity. Briddon & Markham (1994) also found such outcome of their observation and relationship analysis that the both (vector population and disease dynamics) are not associated with each other. Moreover, maximum and minimum temperature showed a significant negative correlation among the CLCuD incidence and its vector population, whereas, both variable exhibited positive relationship with relative humidity (Maharshi *et al.*, 2017). Monga, (2014) has also reported that in 1999 to 2009 observation the CLCuD incidence and whitefly were not significantly associated, however, significant negative relationship was examined minimum temperature and sunshine hours whereas relative humidity and rainfall have positive relationship with the incidence of CLCuD. This study was limited to a single season and did not include molecular detection of the virus. Environmental variables and host cultivar resistance were not analyzed. Future studies should integrate molecular identification and temporal vector monitoring.

CONCLUSIONS

Based on present investigations, it was concluded that bottle gourd plants affected by leaf curl disease exhibited symptoms such as blistering, curling, crinkling, yellowing of the leaf blades, thickness of the veins, upward rolling of the leaf margins, and vein clearing. Leaf curl disease incidence (60–86%) and severity (1.36–1.9) confirm widespread infection across Hyderabad, but no significant correlation with whitefly population suggests that additional ecological or management factors may modulate disease intensity.

AUTHOR CONTRIBUTIONS

Masooma Laghari conducted observations, recorded data and prepared manuscript, Abdul Rauf Koondhar compiled data, Jamal-U-Ddin Hajano designed experiment and did statistical analysis, Khadim Hussain Wagan revised manuscript, Abdul Waheed Solangi revised manuscript, and Rimsha Khaskheli compiled data, prepared graphs, and revised manuscript.

CONFLICTS OF INTEREST

The authors declare no conflict of interest

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