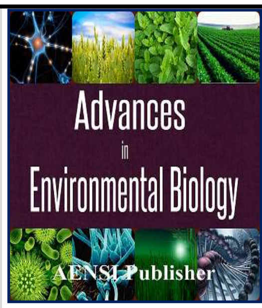
Advances in Environmental Biology, 10(4) April 2016, Pages: 194-203

AENSI Journals

Advances in Environmental Biology

ISSN-1995-0756 EISSN-1998-1066

Journal home page: http://www.aensiweb.com/AEB/



Epidemilogical Chrachterization Of Okra Yellow Vein Mosaic Virus And Its Vector

Faisal Siddique, Safder Ali, Muhammad Ehetisham-ul-Haq, Muhammad Atiq and Abdul Rashid

Department of Plant Pathology, University of Agriculture, Faisalabad, Pakistan.

Address For Correspondence:
Muhammad Ehetisham-ul-Haq, Department of Plant Pathology, University of Agriculture, Faisalabad, Pakistan.
E-mail: haq.uaf@gmail.com

Received 12 February 2016; Accepted 28 April 2016; Available online 24 May 2016

ABSTRACT

Okra (*AbelmoschusesculentusL.*) is a worldwide grown crop commonly known as lady finger. Okra Yellow Vein Mosaic is devastating pathogen of Okra, significantly lowers the yield upto 94%. Twelve varieties/lines of okra (Long Finger, Lush Green, Green Gold, SubzPari, N-220, China Red, OK-407, PusaSawani, JKOH-635, Punjab, Najuka and ArkaAnamika) were sown to evaluate environmental variables (Maximum and minimum air temperature, relative humidity, wind velocity and rainfall) response against Okra Yellow Vein Mosaic Virus (OYVMV).Significant positive correlation of OYVMV and *Bemesiatabaci*population was found with maximum air temperature, minimum temperature and negative correlation was noted with relative humidity, rainfall and wind velocity. Regression model was developed by selecting the three okra varieties (Long Finger, Lush Green and Green Gold). Maximum disease incidence and whitefly population was noted at 36 ^{0}C to 39 ^{0}C and 38 ºC to 39 ºC respectively. The minimum temperature 28.6 ºC to 28.8 ºCfavored the OYVMV disease progression and 28.8 ºC the whitefly population. Significant disease incidence was observed at 42 % to 45 % relative humidityand 42 % to 46 % relative humidity favored whitefly population. Maximum whitefly population and disease incidence wererecorded at 0.1 to 0.5 mm rainfall. Whitefly population and disease incidence was found maximum at 5.5 to 5.7 kmh^{-1} wind velocity.

KEYWORDS: *AbelmoschusesculentusL*; Okra Yellow Vein Mosic virus disease; *Bemisiatabaci* (Gennadius); Environmental variables, Correlation; Regression.

INTRODUCTION

Okra (*Abelmoschusesculentus L. Moench*)belongs to "Malvaceae" family [20].It is a perfect villager's vegetable commonly known as Bhindi or lady finger. Being an important source of vitamins (vitamin A, vitamin C,), proteins (15-26 %) edible oil (14%) and minerals. It is an extremely popular tropical vegetable in the developing countries [7]. In 2013, Okra was grown on an area of 1104 thousand hectareswith the annual production of 8689 thousand tons globally [18].India, Nigeria, Sudan, Iraq and Ivory Cost are top leading okra producing countries in the world. Pakistan at 6th in world's okra production, produces 108 thousand tons on the area of 35thousands acre annually(Fish, 2013).

Yellow Vein Mosaic Virus disease is the most serious disease in okra crop caused by a begomovirus "Okra Yellow Vein Mosaic Virus" [19] vectored by an important sucking pest *Bemisiatabaci*, having a wide host range [12]. *B. tabaci* transfers the virus persistently with one hour of acquisition feeding period and 30 minutes of transmission feeding period [11]. Okra yellow vein mosaic is a scourging okra disease, lowers the yieldup to30 % annually but in epidemicconditions losses may reach up to 90% [3]. The symptoms of OYVMV are homogenous interwoven network of yellow veins enclosing islands of green tissues within its leaf. In case of severe infection, the infected leaves become yellowish or creamy in color. Infected fruit shows stunting or reduction in size and deformed. The infected fruits are covered with yellow or creamy color, fibrous, small, and tough [22].

Disease is a dynamic process changes with time and space, significantly depends on classical disease triangle components (Susceptible host, virulent pathogen and the environment). Phytopathometery reflects the actual disease losses focusing to measure,predict and adopt the disease management strategies [6]. Environmentis characterized into two components (biotic and a-biotic) for disease progression. A-biotic environment (temperature, humidity, rainfall and wind velocity) significantly impacts on plant-pathosystem.Change in weather events significantly impacts on disease progression. Optimum environmental conditions are needed for successful infection and vector infestation.

The present study was aimed to assess the impact of different a-biotic environmental factors (maximum air temperature, minimum temperature, relative humidity, rainfall and wind velocity) directly (disease incidence)orindirectly (vector population)for disease forecasting.

MATERIALS AND METHODS

Certified seeds of 12 Okra varieties/Lines (Long finger, Lush green, Green gold, China Red, SabzPari, JKOH-635, OK-407, PusaSawani, Punjab Selection, N-220, Najuka, ArkaAnamika) were taken from Ayub Agricultural Research Institute (AARI), Faisalabad. To avoid from soil borne infection, seeds were treated by Dynesty @ 2ml Kg^{-1} for 10 minutes and air dried. Field trial was conducted at experimental area of Department of Plant Pathology, University of Agriculture, Faisalabad. The seeds were sown in augmented design with two repeatsby keeping the row to row and plant to plant distance at 75 and 30 cm respectively. Infection was relied upon natural inouclum. All agronomic practices were adopted.Percent disease incidencewas recorded by selecting diseased plants showing clear symptoms (yellow veins enclosing islands of green tissues) among total plants and was calculated by using the formula [3]:

$$\text{Disease incidence \%} = \frac{\text{infected plants}}{\text{Total plants}} \times 100$$

Data was recorded on weekly basis. *B. tabaci*population was recorded atback side of lower, middle and upper leaves of randomly selected okra plants from each variety/lineat 10:00 am daily.

Environmental data (maximum air temperature, minimum temperature, relative humidity, rain fall and wind velocity) was recorded from weather station of Department of Crop Physiology, University of Agriculture, Faisalabad installed two hundred meters away from the experimental site. Recorded OYMV disease incidence and *B. tabaci*population on twelve varieties was correlated with environmental data using Pearson's correlation. Varieties exhibiting significant correlations were selected for regression analysis. The recorded data was analyzed by using "Statistical Analysis System (SAS 9.3)" computer simulated software [10] and graphical approaches were made through "Microsoft Office 2013" [25].

RESULTS AND DISCUSSION

Significant correlation between disease incidence of OYVMV and maximum air temperature, minimum temperature, relative humidity and weak negative correlation was seen with rainfall and wind velocity in all varieties (Table 1).Three varieties (Long Finger, Lush Green and Green Gold) were used for regression analysis. *B. tabaci*population had shown significant correlation with maximum air temperature, minimum temperature and relative humidity while rainfall and wind velocity had non-significant correlation with *B. tabaci*population (Table 2).

Maximum air temperature played a significant role in the development of OYVMV. Relationship between disease incidence and maximum air temperature was explained by simple linear regression model. Significant positive correlation was seen among all varieties.With the increase in maximum air temperature, disease incidence increased significantly. Maximum disease incidence was recorded at 36 ^{0}C to 39 ^{0}Cmaximum air temperature. (Fig 1). Relationship between *B. tabaci*population and maximum air temperature was explained by simple linear regression model. Significant positive correlation was seen between *B. tabaci*population and maximum air temperature on okra varieties (Long Finger, Lush Green and Green Gold). *B. tabaci*population increased with the increase of maximum air temperature. Maximum population was recorded at 38 ^{o}C to 39 ^{o}C (Fig 2)

Strong positive correlation was observed between disease incidence and minimum temperature. With the increase in minimum temperature the disease development was also increased. Maximum disease incidence was noted at minimum temperature 28.6 ºC to 28.8ºC. Significant correlation between disease incidence and minimum temperature was noted by okra varieties (Long Finger, Lush Green and Green Gold)(Fig 3). Strong positive correlation was observed between *B. tabaci* population and minimum temperature. As minimum temperature increased, *B. tabaci*population increased. Maximum *B. tabaci*population was noted at minimum temperature 28.8ºC (Fig 4).

A-biotic environmental factors (Temperature, humidity, rainfall, wind velocity) significantly impacts directly and indirectly on disease progression. Temperature plays a critical role in disease susceptibility and in resistance [23]. Vertical resistance is controlled by a single or two genes greatly depends on genetic expression of R genes [9]. The same happens in horizontal resistance where the mechanism of resistance is controlled by many genes [13]. Wheather the resistance is horizontal or vertical, temperature is an important factor. R genes requires dire need of optimum temperature for the proper function of many enzymes which involve in transcriptional and translational processes [5]. Failing to express R genes of a resistant variety, it may become susceptible against a pathogen. The same is true in case of the pathogen, it may lose its pathogenicity by changing climatic events. In complex plant-pathogen interaction, the environmental factors are critical for disease development especially in vector transferred disease. The Okra Yellow Vein Mosaic Virus disease is vectored by *B. tabaci* [12]. Both the virus and the insect needs optimum environmental conditions for their survival. From the above study; considering the maximum air temperature, disease incidence was found maximum at 36 ^{o}C to 36 ^{o}C and the maximum population was at 38 to 39 ^{o}C.*Bemisiatabaci*is a sucking insect, acquires the virus from the infected plant through persistent manner. Several biological reactions in *B. tabaci*body cells needs optimum temperature for their continuity. From this study, maximum air temperature from 38 ^{o}C to 39 ^{o}C favored *B. tabaci*population which reflects the optimum condition for the reproduction process. More the whiteflies, more the chances of virus acquisition and transmission and ultimately more the disease incidence will. The same is true in case of minimum temperature where disease incidence was found maximum at 28.6 ºC to 28.8 ºC at the same temperature (28.8 ºC) maximum *B. tabaci* population was noted.[17] determined the influence of weather factors on the incidence of OYVMV. They found that relative humidity and wind velocity had a highly significant and negative correlation with disease incidence. Maximum air temperature and total rainfall had a highly non-significant, positive and negative correlation with disease incidence respectively. [14] reported that density of *B.tabaci*was the lowest in kharifand winter crops. *B. tabaci* population on rabicrop started from first week of December with 5.12 whiteflies/3 leaves and there was a gradual increase in *B. tabaci* population with the increase in temperature

Linear trend was seen between disease incidence and relative humidity. Negative correlation was observed between disease incidence and relative humidity. As relative humidity increased, decrease in disease incidence was seen. Maximum disease incidence was noted at 42 to 45 % relative humidity. (Fig 5). Linear trend was seen between *B. tabaci*population and relative humidity. Strong negative correlation was observed between *B. tabaci*population and relative humidity. As relative humidity was increased, *B. tabaci*population was decreased. Maximum *B. tabaci*population was noted at 42 % to 46 % relative humidity (Fig 6).

Negative trend between disease incidence and rainfall was assessed. Increase in rainfall resulted into decrease of disease incidence. Maximum disease incidence was noticed at 0.1 to 0.5 mm of rainfall. Non-significant correlation between disease incidence and rainfall was observed by the three okra varieties (Fig 7). Between *B. tabaci*population and rainfall, negative trend was assessed. Increase in rainfall resulted into decrease of *B. tabaci*population. Maximum *B. tabaci*population was noticed at 0.1 to 0.5 mm of rainfall. Weak correlation between disease incidence and rainfall was observed by okra varieties (Fig 8).

Humidity plays a significant role in disease progression and in *B. tabaci* population. Rainfall and relative humidity directly link to each other, more the rainfall more will be the humidity. After few hours of the rain, the atmospheric contains maximum water vapors which gradually decreases with the passage of time. A single female of *B. tabaci*lays approximately more than 119 eggs at the lower side of the leaf surface [4]. The rain splashes wash off the eggs, nymphs and adults from the leaf surface, hence, this is the main reason of population decline. With the passage of time, the *B. tabaci*population again builds up while on the other hand, the humidity in air decreases gradually. The same happened in our experiment where disease incidence and vector population decreased significantly by the rainfall and increase in humidity

Linear trend was seen between disease incidence and wind velocity. Negative correlation was observed between disease incidence and wind velocity. As wind velocity increased, disease incidence was decreased. Maximum disease incidence was noted at 5.5 to 6 km/h wind velocity. No significant correlation between disease incidence and wind velocity was observed in three okra varieties (Fig 9). Negative linear trend was seen between *B. tabaci*population and wind velocity. Strong negative correlation was observed between *B. tabaci*population and wind velocity. As wind velocity was increased, *B. tabaci*population decreased. Maximum *B. tabaci*population was noted at 5.25 to 6 km/h wind velocity. Weak correlation between *B. tabaci*population and wind velocity were observed in three okra varieties (Fig 10).

The wind velocity plays a vital role in viral acquisition and transmission efficacy of *B. tabaci*. The insect (*B. tabaci*)needs continuously more than an hour to acquire the virus from an infected leave and the same time is required for its transmission to the health plant. The strong wind recurrent greatly disturbs insect's attachment to the plant which results into failure of efficient Okra yellow vin mosaic virus acquisition and transmission causing to deline the disease incidence.

Pan et al. [16] explained that among the environmental factors temperature, rainfall, sunlight, humidity expressed significant correlation with disease incidence and *B. tabaci* population dynamics. Activity of *B.*

*tabaci*on summer started during first week of April 06 and reached a peak during last week of April 06 (14.91 whiteflies/3 leaves) and there was a decrease in *B. tabaci* abundance with the onset of monsoon. [24] reported that both pest (*B. tabaci*) and natural enemy populations decreased due to rainfall. Threhan [21] reported that high temperature and low rainfall were found to favor rapid multiplication of the pest. Same results were reported by Özgür et al. [15]. Ali et al. [1] determined the correlation of environmental factors (maximum and minimum temperature, relative humidity and rainfall) with percent plant infection of okra yellow vein mosaic virus (OYVMV). There was a significant correlation between environment and disease severity. Ali et al. [2] determined the correlation of environmental conditions (maximum and minimum air temperature, relative humidity, rainfall, clouds and wind velocity) with okra yellow vein mosaic virus (OYVMV) disease severity and *B. tabaci*population on commercially grown varieties of okra i.e. Pahuja, Safal, SubzPari and SurkhBhindi. Minimum temperature and relative humidity had significant correlation with OYVMV disease severity and *B. tabaci*population. The disease incidence increased with the rise in minimum temperature and *B. tabaci* population decreased with increase in the relative humidity.

Table 1: Correlation of environmental conditions with okra yellow vein mosaic virus disease on different okra verities/lines

Varieties/LINES	Maximum air temperature	Minimum Temperature	Relative Humidity	Rain Fall	Wind Velocity
Long Finger	.83*	0.91**	-.93**	-0.77	-0.617
	0.03	0.02	0.01	0.32	0.06
Green Gold	.857*	0.91**	-.97*	-0.79	-0.732
	0.03	0.02	0.01	0.26	0.1
China Red	.865*	.805*	-.920**	0.39	-0.62
	0.03	0.05	0.01	0.26	0.13
Lush Green	.834*	0.95**	-.98**	-0.72	-0.70
	0.01	0.01	0.01	0.17	0.12
SabzPari	.809*	.900*	-.936**	0.47	-0.58
	0.05	0.02	0.01	0.21	0.15
JKOH-635	.810*	0.889*	-.993**	0.31	-0.78
	0.05	0.02	0	0.3	0.06
OK-407	.838*	0.77	-.877*	0.4	-0.55
	0.04	0.06	0.03	0.25	0.17
PusaSawani	0.7	.872*	-.958**	0.23	-.837*
	0.1	0.03	0.01	0.35	0.04
Punjab Selection	0.55	0.72	-.885*	-0.03	-.890*
	0.17	0.09	0.02	0.48	0.02
N-220	0.59	0.77	-.851*	0.14	-.865*
	0.15	0.06	0.03	0.41	0.03
Najuka	.826*	.833*	-.992**	0.23	-.846*
	0.04	0.04	0	0.36	0.04
Arka-Anamika	.816*	0.77	-0.62	0.49	-0.78
	0.04	0.04	0	0.62	0.1

Table 2: Correlation of environmental conditions with *B. tabaci*population on different okra varieties/lines

Varieties	Maximum air temperature	Minimum Temperature	Relative Humidity	Rain fall	Wind velocity
Long Finger	.919*	0.78*	-.952**	-0.76	0.808
	0.031	0.03	0.002	0.284	0.08
Green Gold	.858*	0.74*	-.979**	-0.71	-0.732
	0.031	0.03	0.002	0.284	0.08
Lush Green	.906*	0.89*	-.950**	-0.88	-0.719
	0.017	0.052	0.007	0.286	0.085
China Red	0.777	0.724	-.847*	0.324	-0.527
	0.061	0.083	0.035	0.297	0.181
SabzPari	.866*	0.658	-.874*	0.215	-0.69
	0.029	0.114	0.026	0.364	0.099
JKOH-635	0.776	0.742	-.888*	0.264	-0.612
	0.062	0.076	0.022	0.334	0.136
OK-407	.889*	.930*	-.949**	0.557	-0.606
	0.022	0.011	0.007	0.165	0.139
PusaSawani	0.704	0.747	-.935**	0.099	-0.774
	0.092	0.073	0.01	0.437	0.062
Punjab Selection	.952**	0.705	-.905*	0.294	-0.762
	0.006	0.092	0.017	0.315	0.067
N-220	0.792	.819*	-.864*	0.469	-0.476
	0.055	0.045	0.03	0.213	0.209
Najuka	0.711	.842*	-.888*	0.387	-0.525

Advances in Environmental Biology, 10(4) April 2016, Pages: 194-203

	0.089	0.037	0.022	0.26	0.182
Arka-Anamika	0.73	.852*	-.891*	0.587	-0.543
	0.089	0.037	0.022	0.26	0.182

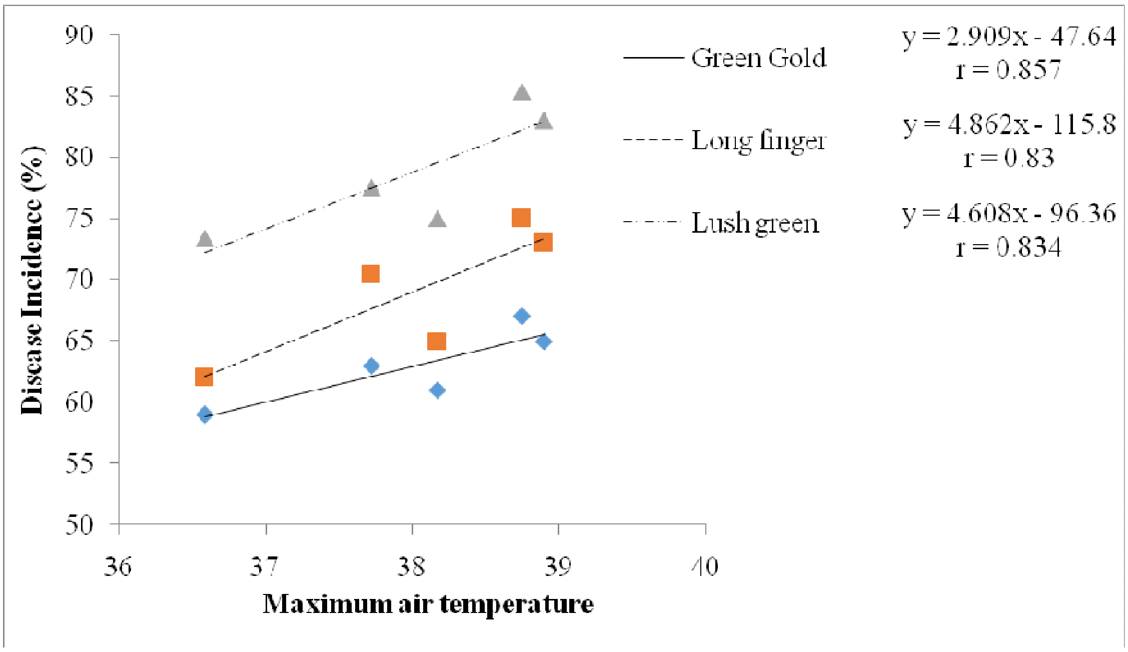


Fig. 1: Relationship between maximum air temperature and disease incidence on Long Finger, Green Gold and Lush Green

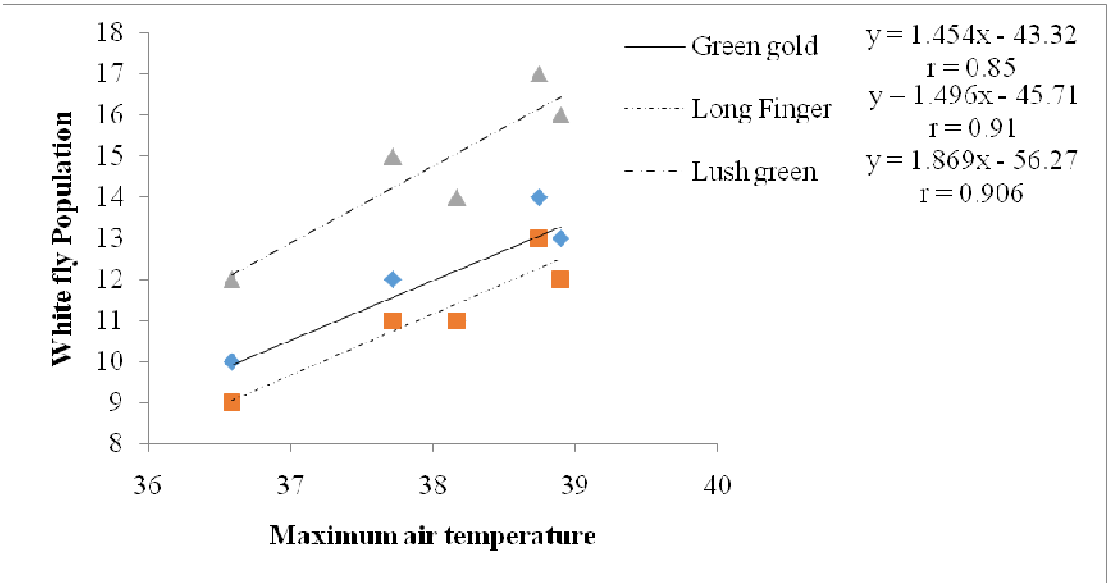


Fig. 2: Relationship between maximum air temperature and *B. tabaci* population recorded on Long Finger, Green Gold and Lush Green

Advances in Environmental Biology, 10(4) April 2016, Pages: 194-203

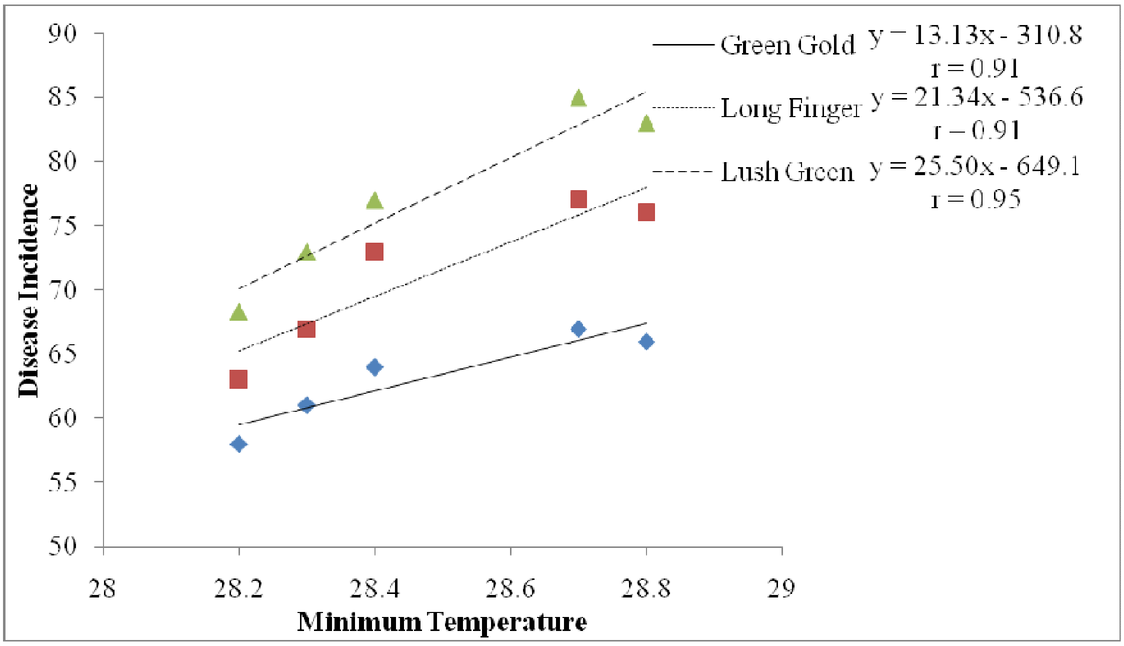


Fig. 3: Relationship between minimum temperature and disease incidence on Green Gold, Long Finger and Lush Green

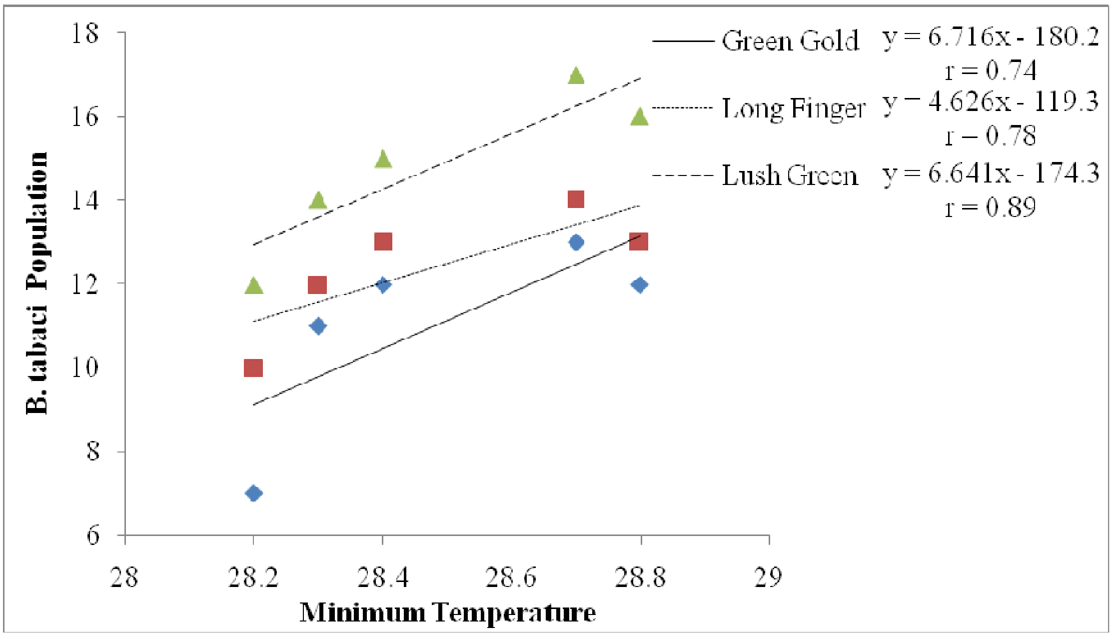


Fig. 4: Relationship between minimum temperature and *B. tabaci*population on Green Gold, Long Finger and Lush Green

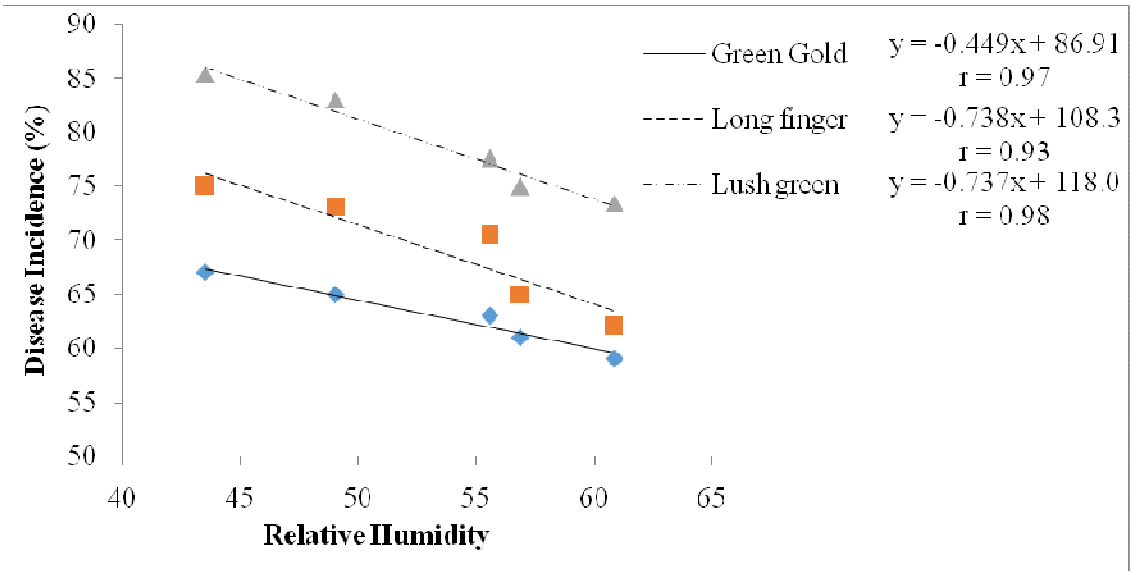


Fig. 5: Relationship between relative humidity and disease incidence on Long Finger, Green Gold and Lush Green

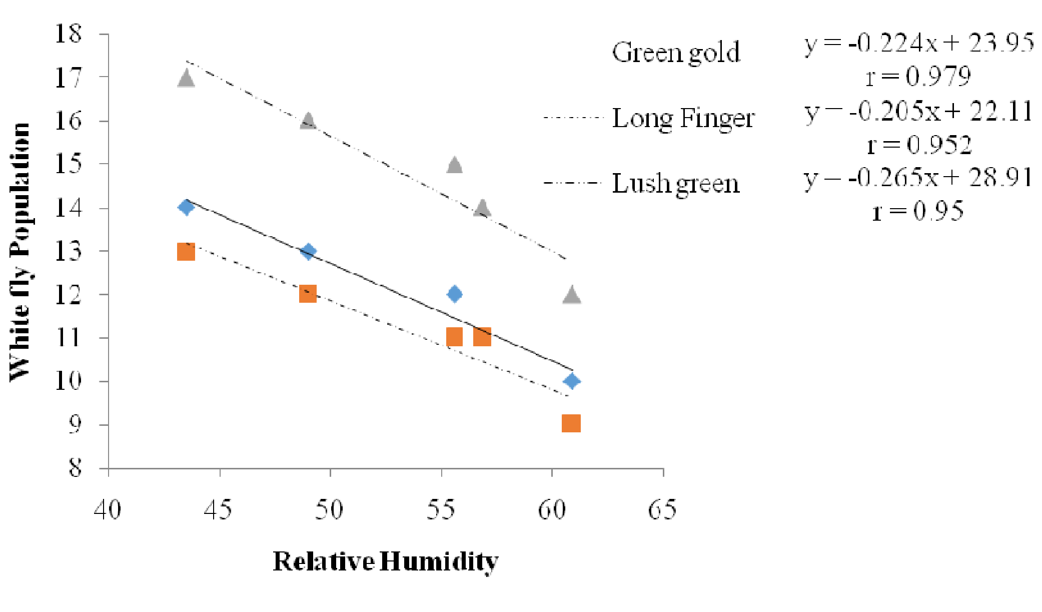


Fig. 6: Relationship between relative humidity and *B. tabaci*population recorded on Long Finger, Green Gold and Lush Green

Advances in Environmental Biology, 10(4) April 2016, Pages: 194-203

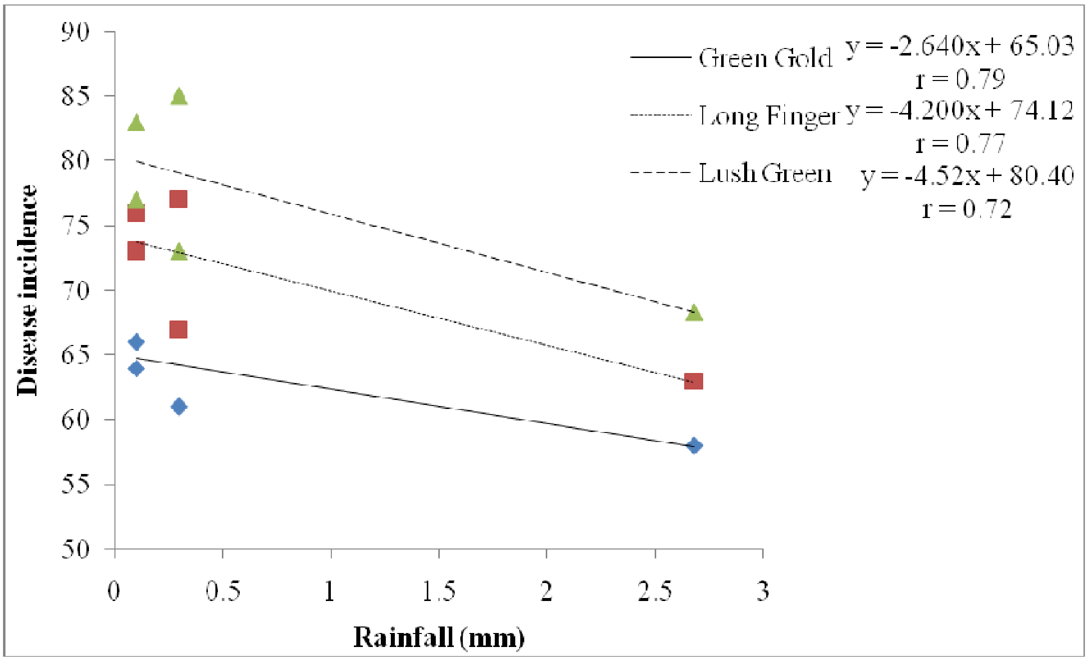


Fig. 7: Relationship between rainfall and disease incidence on Long Finger, Green Gold and Lush Green

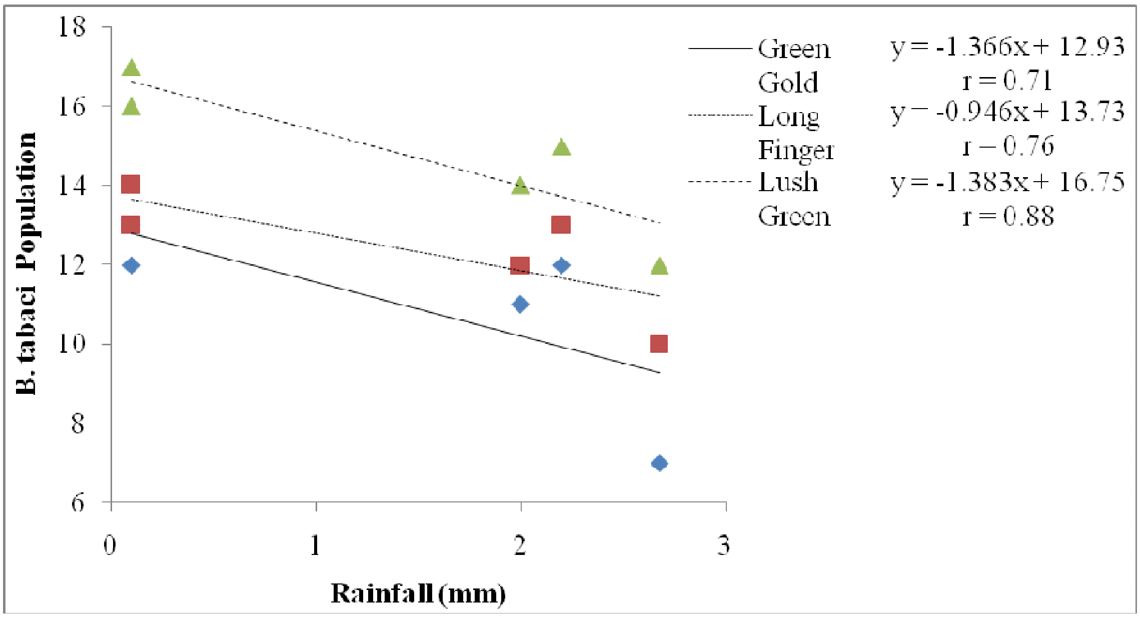


Fig. 8: Relationship between rainfall and *B. tabaci*population recorded on Long Finger, Green Gold and Lush Green

Advances in Environmental Biology, 10(4) April 2016, Pages: 194-203

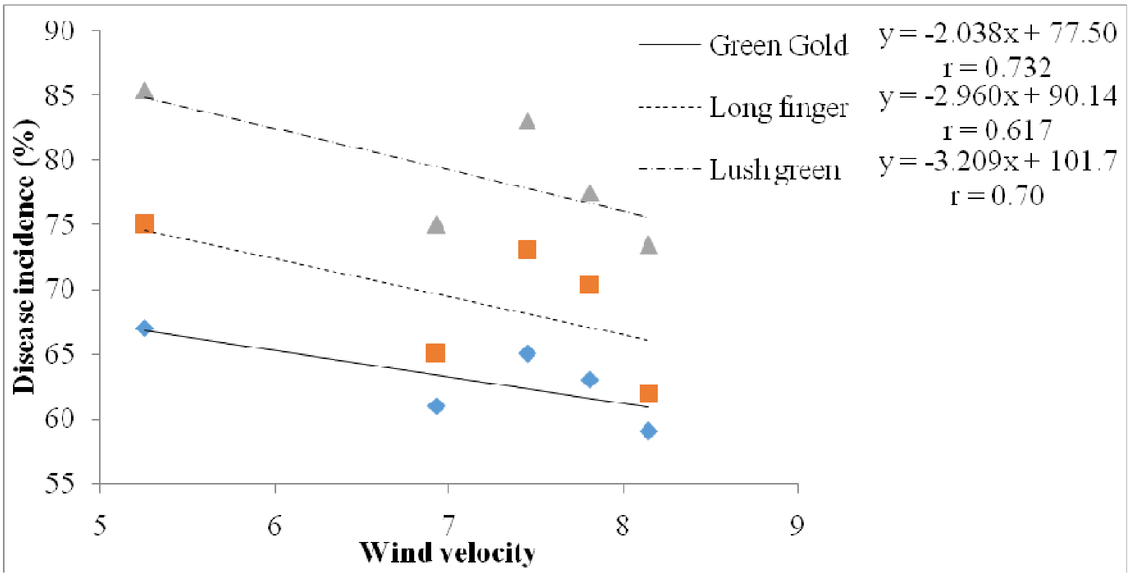


Fig. 9: Relationship between wind velocity and disease incidence on Long Finger, Green Gold and Lush Green

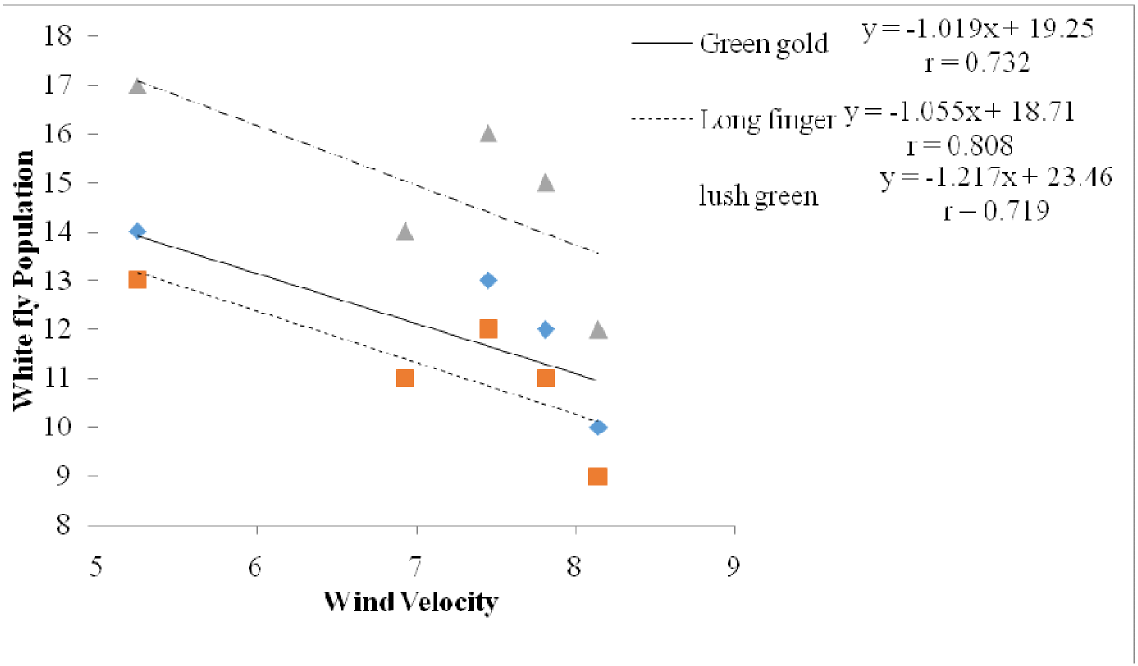


Fig. 10: Relationship between wind velocity and *B. tabaci*population recorded on Long Finger, Green Gold and Lush Green

REFERENCES

[1] Ali, M.I., M.A. Khan, A. Rashid, M. Ehetisham-ul-Haq, M. T. Javed, M. Sajid, 2012. Epidemiology of Okra Yellow Vein Mosaic Virus (OYVMV) and Its Management through Tracer, Mycotal and Imidacloprid. American Journal of Plan Sciences, 3: 1741-1745.

[2] Ali, S., M. Khan, A. Rasheed, Y. Iftikhar, 2005a. Correlation of environmental conditions with Okra Yellow Vein Mosaic Virus and *Bemisia tabaci* population density. International Journal of Agriculture and Biology, pp: 142-144.

[3] Ali, S., M. A. khan, A. Habib, S. Rasheed, Y. Iftikhar, 2005b. Management of yellow vein mosaic disease of okra through pesticide/bio-pesticide and suitable cultivars. International Journal of Agriculture and Biology, 7: 145-147.

[4] Atwal, A.S., G.S. Dhaliwal, 2005. Agricultural Pests of South Asia and Their Management, 5 ed. Kalyani Publishers, India.

[5] Bell, A.A., 1981. Biochemical mechanisms of disease resistance. Annual Review of Plant Physiology, 32: 21-81.
[6] Cooke, B., D.G. Jones, B. Kaye, 2006. The Epidemiology of Plant Diseases. Springer Science & Business Media.
[7] El-Nahry, F., M. El-Ghorab, R. Younes, 1978. Nutritive value of local varieties of fresh and sundried okra (*Hibiscus esculentus*) pods and seeds. Plant Foods for Human Nutrition (Formerly Qualitas Plantarum), 28: 227-231.
[8] Fish, F., 2013. Pakistan: Okra, production quantity (tons). http://www.factfish.com/statistic-country/pakistan/okra,+production+quantity, Pakistan.
[9] Flor, H.H., 1971. Current status of the gene-for-gene concept. Annual review of phytopathology, 9: 275-296.
[10] Inc., S.I., 2011-2012. SAS 9.3 Help and Documentation. SAS Institute Inc., Cary, NC.
[11] Jones, D.R., 2003. Plant viruses transmitted by whiteflies. European Journal of Plant Pathology, 109: 195-219.
[12] Nagaraju, N., A. Padmaja, G.B. Gowda, R. Pushpa, 2015. Vectors of Plant Viruses of crop plants in southeast Asia, New Horizons in Insect Science: Towards Sustainable Pest Management. Springer., pp: 159-176.
[13] Nelson, R., 1978. Genetics of horizontal resistance to plant diseases. Annual Review of Phytopathology, 16: 359-378.
[14] Ohnesorge, B., N. Sharaf, T. Allawi, 1980. Population studies on the tobacco whitefly *Bemisia tabaci* Genn.(Homoptera; Aleyrodidae) during the winter season. Zeitschrift für Angewandte Entomologie, 90: 226-232.
[15] Özgür, A., E. Sekeroglu, B. Ohnesorge, H. Göçmen, 1990. Studies on host plant changes, migration and population dynamics of the cotton whitefly *Bemisia tabaci* in Çukurova (Turkey). Mitteilungen der Deutschen Gesellschaft für Allgemeine und Angewandte Entomologie, 7: 653-656.
[16] Pan, H., X. Li, D. Ge, S. Wang, Q. Wu, W. Xie, X. Jiao, D. Chu, B. Liu, B. Xu, 2012. Factors affecting population dynamics of maternally transmitted endosymbionts in Bemisia tabaci. PloS one, 7: e30760.
[17] Pun, K., S. Doraiswamy, 2000. Influence of weather factors on the incidence of Okra Yellow Vein Mosaic Virus disease. Journal of the Agricultural Science Society of North-East India, 13: 91-96.
[18] Rubatzky, V. E., M. Yamaguchi, 2012. World vegetables: principles, production, and nutritive values. Springer Science & Business Media.
[19] Sayed, S., D. Rana, G. Krishna, P. Reddy, P. Bhattacharya, 2014. Association of Begomovirus with Okra (*Abelmoschus esculentus* L.) leaf curl virus disease in southern India. SAJ Biotechnol, 1: 2-2.
[20] Sharma, R., K. Prasad, 2010. Classification of promising okra (*Abelmoschus esculentus*) genotypes based on principal component analysis. J. Trop. Agric. and Fd. Sc., 38: 161-169.
[21] Threhan, K. N., 1994. Distribution of whitefly in the Punjab. Indian Farming, 5: 514-515.
[22] Usha, R., G. Rao, P. Kumar, R. Holguin-Peña, 2008. Bhendi yellow vein mosaic virus. Characterization, diagnosis & management of plant viruses. Volume 3: vegetable and pulse crops: 387-392.
[23] Vanderplank, J. E., 2012. Disease resistance in plants. Elsevier.
[24] Venugopalrao, N., A. Reddy, K.T. Rao, 1989. Natural enemies of cotton whitefly, Bemisia tabaci Gennadius in relation to host population and weather factors. Journal of Biological Control, 3: 10-12.
[25] Wilson, K., 2014. Microsoft Office 2013, Using Microsoft Office 2013. Springer, pp: 1-5.