**Pakistan Journal of Phytopathology**
**Published by:**
Pakistan Phytopathological Society
www.pakps.com
www.pjp.pakps.com
info@pakps.com

*Pak. J. Phytopathol.,*
*Vol. 24(1): 39-43, 2012.*

# CORRELATION OF ENVIRONMENTAL CONDITIONS WITH BACTERIAL BLIGHT DISEASE OF COTTON (*GOSSYPIUM HIRSUTUM L.)*

**Muhammad Imran Hamid[a], Muhammad Aslam Khan[b] Zafar Iqbal[a], Muhammad Usman Ghazanfar[a], Yasir Iftikhar[a] and Naeem Akhtar[a]**
[a]*University College of Agriculture, University of Sargodha, Sargodha, Pakistan*
[b]*Department of Plant pathology, University of Agriculture, Faisalabad, Pakistan*

## ABSTRACT

Bacterial blight (BL), caused by *Xanthomonas campestris* pv. *malvacearum* (Smith) Dye, is a common disease affecting the growth, development and yield of cotton (*Gossypium hirsutum* L.) in Pakistan. Field trial was conducted for a season to determine the influence of environmental conditions representing heavy and low rainfall periods, wind speed and direction on disease incidence by growing 101 commercial varieties. However, out of 101 varieties, a total of 68 varieties were moderately susceptible response while 8 were susceptible to bacterial blight disease. A total of 25 varieties were moderately resistant to bacterial blight disease. No variety was resistant to bacterial blight disease. Except radiation and wind speed, overall correlation of maximum and minimum air temperature, relative humidity, rainfall and pan evaporation with bacterial blight disease severity was statistically significant. The poor correlation of wind speed with disease severity may also be due to frequency and amount of air currents received in a certain adjoining areas of Faisalabad district of Pakistan and its indirect role to create humid conditions. Similarly relative humidity is different at different levels of crop canopy and largely depends upon the amount of moisture resulted due to rain showers and irrigation.
**Key words:** BLB epidemiology, *Xanthomonas campestris* pv. *Malvacearum,*

## INTRODUCTION

Cotton (*Gossypium hirsutum*) is the back bone of national economy of Pakistan. It is grown over 15% of the total cultivated area in the country. It accounts for 8.6% of the value added in agriculture and about 1.9% to GDP (Anonymous, 2006). Bacterial blight (BL) of cotton caused by *Xanthomonas campestris* pv. *malvacearum* (Smith) Dye affects the entire aerial parts of cotton plant i.e. necrosis of parenchymatous tissue in the local phase and blockage of xylem vessels in its systemic phase (Casson *et al*., 1977). In Pakistan, the disease was first recorded near Multan in 1965 (Ali, 1968) where 50% infection in most of the cotton growing fields of Multan was recorded. It can reduce the yield of the crop upto 50% under favorable environmental conditions of disease development (Hussain, 1984). In Faisalabad district (Pakistan), its incidence was recorded 20-37% (Bhutta and Bhatti, 1983). Resistant varieties are the valid option in any disease management strategies. Except for some exotic lines immune to all the races of *Xanthomonas campestris* pv. *malvacearum*, none of the available commercial varieties were found to be resistant to the bacterial blight (Khan, 1996). In the absence of durable resistance containing varieties, control of the disease through chemicals, seed treatment or acid delinting is recommended but bactericide alone or in combination with fungicides dose not eradicate the pathogen completely (Khan and Ilyas, 1999; Hussain and Tahir, 1993). Characterization of environmental factors conducive for bacterial blight disease may provide a basis to forecast the disease and issue advance warning to cotton growers for its timely management.

## MATERIALS AND METHODS

**Isolation & Identification of bacterium from infected leaves:**Cotton leaves showing typical symptoms of bacterial blight were collected from the field and the bacterium was isolated by dilution plate technique (Clifton, 1958). The stock culture of the bacterium was maintained on nutrient agar in culture tubes at 4$^{o}$C. The isolated bacterium produced yellow and round colonies on nutrient agar. It was rod shaped and motile with single polar flagellum. The bacterium was then purified streaking to purify on Yeast Extract Dextrose $CaCO_3$ Agar (YDCA) medium (Bhutta, 1992). The bacterium indicated Gram-negative reaction. All these characteristics indicated that the bacterium belonged to the genus *Xanthomonas* (Breed et al., 1957).

**Establishment of Disease Screening Nursery:**The cotton bacterial blight disease screening nursery was established in the departmental research area of plant pathology. During cotton growing season, 101 commercial cotton varieties obtained from the Central Cotton Research Institute (CCRI), Multan; Cotton Research Station, Multan; Pakistan; Cotton Research Institute, Ayub Agricultural Research Institute (AARI), Faisalabad, Pakistan; and Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, Pakistan. The seeds of these lines were neither treated with chemicals, nor given acid delinting to increase chances of primary infection of disease. Each variety was sown in 3 rows of seven meter length with 30 cm plant to plant and 75 cm row to row distance. Bacterial blight disease ratings were taken on weekly basis according to the scale modified from the scale (0-10 grades) described by Brinkerhoff (1977) after the first initiation of disease symptoms (Table 1).

**Table 1:** Disease rating scale used to determine the level of resistance or susceptibility of cotton varieties to bacterial blight disease in disease screening nursery (*Brinkerhoff; 1977)

| Grade | | Symptoms | Level of resistance/ susceptibility |
|---|---|---|---|
| Bacterial blight | | | |
| 0 | = | No symptoms | Immune |
| 0.2 | = | 1 to 2 angular lesions per plant | Highly resistant |
| 0.4 | = | 3 to 10 angular lesions per plant | |
| 0.6 | = | 11 to 25 angular lesions per plant | |
| 0.8 | = | 25 angular lesions + wet vein lesions per plant | |
| 1 | = | 25 angular lesions and wet vein lesions surrounded by yellowing and necrosis | Resistant |
| 2 | = | Leaves shed from nodes | |
| 3 | = | Leaves shed from three nodes | Moderately |
| 4 | = | Leaves shed from four nodes | resistant |
| 5 | = | Leaves shed from five nodes | |
| 6 | = | Leaves shed from six nodes + slight infection of leaves above bare nodes + black arm infection | Moderately susceptible |
| 7 | = | Leaves shed from six nodes + slight to moderate infection of above bare nodes + black arm phase | |
| 8 | = | Leaves shed from six nodes + moderate infection of leaves above bare nodes + black arm phase | Susceptible |
| 9 | = | Leaves shed from six nodes + severe infection of leaves above bare nodes + black arm phase | Highly |
| 10 | = | Leaves shed from six nodes + very severe infection of Leaves above bare nodes + black arm phase | susceptible |

**Collection of Environmental Data & Data Analysis:**Environmental data was collected from Department of Crop Physiology, University of Agriculture, Faisalabad, Pakistan. Data was statistically analyzed by ANOVA. Disease severity data was analyzed by using Least Significant Difference Test at P = 0.05. Correlation of environmental conditions and disease severity was performed by using Pearson's Correlation Co-efficient Test.

## RESULTS

During cotton season of 2006-2007, on the lower surface of cotyledonary leaves of susceptible variety (FH-1000), water soaked lesions were recorded in the last week of June which turned in to necrotic angular spots later on. Water soaked spots appeared on the lower side of cotyledonary leaves on cotton disease spreader AU-59 in the 2nd week of July. Disease symptoms were recorded on BH-162, BH-163, FH-116, FH-2925, CIM-506, CIM-473, CIM-443, CIM-446, MNH-786, MNH-732, MJ-7, NIAB-824, NIAB-884 and VH-142 in the 2nd week of July which showed overall reaction as moderately susceptible (Table 2). Rainfall of 27.0 mm in the 2nd week of July which continued with showering till the end of crop season resulted secondary spread of the disease in epidemic form. Disease symptoms were recorded on

BH-89, BH-163, B-7, CIM-707, CIM-497, FH-114, FH-97, RH-514, PB-900, SLS-1, VH-61 and VH-59 in the 1st week of August which showed overall reaction as moderately resistant (Table 2). Out of 101 varieties, a total of 68 varieties gave moderately susceptible response while 8 were susceptible to bacterial blight disease. A total of 25 varieties were moderately resistant to bacterial blight disease. According to disease ratings made after the first initiation of disease symptoms, none of the cotton variety was found resistant to bacterial blight.Except radiation and wind speed, overall correlation of maximum and minimum air temperature, relative humidity, rainfall and pan evaporation with bacterial

**Table 2: Response of cotton varities for source of resistance against bacterial blight disease**

| No. | Varieties | Mean Grades | Response | No. | Varieties | Mean Grades | Response |
|---|---|---|---|---|---|---|---|
| 1 | FH-97 | 3.73 | MR | 52 | VH-156 | 3.06 | MR |
| 2 | BH-162 | 4.80 | MS | 53 | MNH-700 | 4.60 | MS |
| 3 | CIM-497 | 4.40 | MR | 54 | SLH-284 | 4.73 | MS |
| 4 | Alseemi Hybrid | 4.33 | MR | 55 | FH-114 | 2.80 | MR |
| 5 | NIAB-824 | 4.53 | MS | 56 | RH-514 | 4.40 | MR |
| 6 | VH-148 | 4.13 | MR | 57 | SLH-279 | 5.40 | MS |
| 7 | NIBGE-2 | 4.26 | MR | 58 | RH-512 | 4.93 | MS |
| 8 | BH-163 | 4.60 | MS | 59 | FH-113 | 5.06 | MS |
| 9 | FH-2000 | 4.00 | MR | 60 | FH-207 | 5.46 | MS |
| 10 | FH-2925 | 5.06 | MS | 61 | BH-164 | 4.66 | MS |
| 11 | CIM-534 | 4.73 | MS | 62 | FH-900 | 3.66 | MR |
| 12 | CIM-473 | 5.06 | MS | 63 | NIAB-846 | 6.66 | S |
| 13 | CIM-446 | 5.20 | MS | 64 | FH-919 | 5.86 | MS |
| 14 | PB-843 | 3.33 | MR | 65 | SLH-317 | 4.60 | MS |
| 15 | NIAB-111 | 3.80 | MR | 66 | VH-37 | 5.13 | MS |
| 16 | MJ-7 | 4.66 | MS | 67 | MNH-554 | 6.26 | MS |
| 17 | S-12 | 5.80 | MS | 68 | S-12 | 6.66 | S |
| 18 | CIM-506 | 5.40 | MS | 69 | MNH-536 | 5.00 | MS |
| 19 | CIM-443 | 6.13 | MS | 70 | MNH-512 | 4.60 | MS |
| 20 | CIM-498 | 5.33 | MS | 71 | CRIS-220 | 5.46 | MS |
| 21 | CIM-482 | 5.60 | MS | 72 | MNH-156 | 5.20 | MS |
| 22 | FH-2006 | 5.40 | MS | 73 | BH-89 | 4.46 | MR |
| 23 | NIAB-884 | 4.86 | MS | 74 | 149-F | 4.60 | MS |
| 24 | MNH-732 | 4.66 | MS | 75 | SL-7 | 5.00 | MS |
| 25 | PB-897 | 4.93 | MS | 76 | FH-925 | 4.80 | MS |
| 26 | FH-1000 | 7.13 | S | 77 | 124-F | 4.80 | MS |
| 27 | CIM-707 | 3.40 | MR | 78 | CRIS-121 | 5.86 | MS |
| 28 | CIM-496 | 3.80 | MR | 79 | FH-113 | 5.06 | MS |
| 29 | FH-115 | 4.06 | MR | 80 | MNH-770 | 6.13 | MS |
| 30 | PB-899 | 5.46 | MS | 81 | NIAB-78 | 6.46 | MS |
| 31 | CIM-438 | 5.20 | MS | 82 | MNH-129 | 5.06 | MS |
| 32 | CIM-499 | 4.73 | MS | 83 | CRIS-310 | 5.20 | MS |
| 33 | CIM-707 | 4.26 | MR | 84 | VH-61 | 4.46 | MR |
| 34 | S-12 | 6.86 | S | 85 | S-12 | 6.00 | MS |
| 35 | CIM-109 | 6.13 | MS | 86 | PB-900 | 4.46 | MR |
| 36 | CIM-519 | 3.40 | MR | 87 | VH-44 | 5.06 | MS |
| 37 | CIM-1100 | 5.73 | MS | 88 | MNH-506 | 6.00 | MS |
| 38 | CIM-240 | 6.33 | MS | 89 | MNH-501 | 7.33 | S |
| 39 | CIM-448 | 4.73 | MS | 90 | MNH-147 | 7.53 | S |
| 40 | MNH-786 | 5.33 | MS | 91 | MNH-633 | 5.33 | MS |
| 41 | CRIS-134 | 5.40 | MS | 92 | HA-118 | 4.60 | MS |
| 42 | BH-160 | 6.20 | MS | 93 | SLS-1 | 3.73 | MR |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 43 | NIAB-999 | 6.60 | S | 94 | B-8 | 6.13 | MS |
| 44 | NIAB-78 | 6.33 | MS | 95 | MNH-502 | 5.60 | MS |
| 45 | FH-1200 | 4.26 | MR | 96 | B-894 | 5.13 | MS |
| 46 | FH-116 | 5.33 | MS | 97 | B-7 | 2.60 | MR |
| 47 | FH-2014 | 6.06 | MS | 98 | MNH-93 | 6.60 | S |
| 48 | VH-142 | 5.00 | MS | 99 | VH-59 | 4.33 | MR |
| 49 | CIM-534 | 5.13 | MS | 100 | VH-42 | 5.20 | MS |
| 50 | S-12 | 6.06 | MS | 101 | CRIS-304 | 4.53 | MS |
| 51 | FH-984 | 5.53 | MS | | | | |

**Table 3:** Overall correlation of weekly environmental conditions with bacterial blight disease severity recorded on 96 cotton varieties.

| Environmental Parameters | Bacterial blight disease severity |
|---|---|
| Maximum Temperature ($^{o}$C) | 0.825 |
| | 0.006* |
| Minimum Temperature ($^{o}$C) | 0.950 |
| | 0.000* |
| Relative Humidity | -0.988 |
| | 0.000* |
| Rain fall | -0.907 |
| | 0.001* |
| Pan Evaporation | 0.777 |
| | 0.014* |
| Radiation | 0.362 |
| | 0.338 |
| Wind Speed | -0.066 |
| | 0.866 |

Upper values in a column indicate Pearson's Correlation coefficients
Lower values indicate significance level at P = 0.05

blight disease severity was statistically significant (Table 3). When the data was split by variety, the level of correlation decreased. The cotton varieties having 50% or more environmental parameters were tabulated to get a better scenario of the disease environment interaction (Table 4). The correlation of maximum and minimum air temperature with BL disease severity recorded on majority of the cotton varieties was statistically non-significant (Table 3). Thus rainfall seems to play a role in the development of BL disease in epidemic form. The correlation of rainfall and wind speed with BL disease severity recorded on majority of cotton varieties was poor. This may be attributed to the fact that wind direction rather than speed is more important in driving the rain splashes and thus the bacterial inoculum. Similarly relative humidity is different at different levels of crop canopy and largely depends upon the amount of moisture resulted due to rain showers and irrigation.

## DISCUSSION

The correlation was made between disease severity and environmental factors. Diverse virulence of bacterial blight pathogen has been reported from different parts of the world (Hunter *et al*., 1968). Screening of cotton germplasm against bacterial blight has been reported by several research workers (Hussain and Yaqoob, 1977; Chauhan *et al*., 1986). None of the commercial varieties or lines was found resistant to *Xanthomonas campestris* pv. *malvacearum* in Pakistan (Hussain *et al.*, 1985). The commercial cotton varieties responded differently against bacterial blight to the changing environmental conditions (Khan *et al.,* 1999). So the response of the some varieties was slightly different to the changing environmental conditions. Bacterial blight primary infection takes place through sowing of seed infected by *Xanthomonas campestris* pv. *Malvacearum.* The bacterium has been reported to survive for six and three months in trash applied on the surface of the soil and buried 15 cm deep respectively (Verma *et al*., 1977). According to Alippi (1989), this pathogen was not detectable in non-sterile soil after 50 days and in sterile soil after 80 days. Secondary spread of the disease takes place through rain splashes and air currents. The results of these studies indicate that most of the commercial cultivars and advanced lines

of cotton lack durable resistant against BL. These moderately resistant or moderately susceptible varieties may be exploited for the integrated disease management.

**Conclusion:** This study demonstrates the incidence of disease in field of cotton and its relation with the environmental conditions. It was seen that out of 101 commercial varieties of cotton in Pakistan, none is resistant to bacterial blight disease and wind direction rather than wind speed is more important to drive the bacterial inoculums through rain splashes.

## REFERENCES


Ali, M. 1968. Pests and diseases of cotton in Multan. Ann. Prog. Rep. Cotton Res. Sta., Multan: 14-15.

Alippi, A.M. 1989. Survival of *Xanthomonas campestris* pv. *malvacearum* in soils. Turrialba, 39(2): 176-178.

Anonymous. 2006. Federal Bureau of Statistics, Govt. of Pakistan, Ministry of Food, Agriculture & Livestock, Islamabad. pp: 12-13.

Bhutta, A.R. and M.A.R. bhatti. 1983. Incidence of bacterial blight of cotton and reaction of different cultivars to *Xanthomonas campestris pv. malvacearum*. The Pak. Cott. 27(1): 75-78.

Bhutta, A.R. 1992. Comparative studies for detection of *Xanthomonas campestris pv. malvacearum* from cotton seed in Pakistan. Pak. J. Agric. Res. 13(3): 277-281.

Buchanan, P.E. and N.E. Gibbons. 1974. Burgey, s Manual of Determinative Bacteriology, 8th Edit. Williams Wilkinson Co., Baltimore. 244 P.

Brinkerhoff, L.A. 1977. Bacterial blight of cotton. FAO consultant Report Pak/73/026. Submitted to FAO (UNO), Rome, 11 P.

Casson, E.T., P.E. Richardson, L.A. Brinkerhoff and R.K. Gholson. 1977. Histopathology of immune and susceptible cotton cultivars inoculated with *Xanthomonas campestris* pv. *malvacearum*. Phytopathology.67:195-196.

Chauhan, M.S., J.P.S Yadav and D.K. Jain. 1986. Reaction of cotton (*Gossypium hirsutum* L.) to angular leaf spot (*Xanthomonas campestris* pv. *malvacearum*) disease of cotton in Haryana. Ind. J. Pl. Path. 4(2): 171.

Clifton, C. E. 1958. Introduction to bacteria. II Edition McGraw Hill Book Co. Inc., New York: 236-279.

Hunter, R.E., L.A. Brinkerhoff and L.S. Bird. 1968. The development of a set of upland cotton lines for differentiating races of *Xanthomonas malvacearum.* Phyto. Path.58: 830-832.

Hussain, T., T. Mehmood, L. Ali, N.N. Bhatti and S. Ali.1985. Resistance of some cotton lines to bacterial blight in Pakistan. Trop. Pest Manag. 31(1): 73-77.

Hussain, T. and Tahir, M. 1993. Chemical control of bacterial blight of cotton. Pak. J. Phytopathol. 5(1-20: 119-121.

Khan, M.A. 1996. Relationship of *Xanthomonas campestris pv. malvacearum* population to development of symptoms of bacterial blight of cotton.Pak. J. Phytopathol. 8(22): 152-155.

Khan, M.A. and M.B. Ilyas. 1999. Cotton germplasm response of slow blighting against *Xanthomonas campestris pv. Malvacearum* and slow curling against CLCuV infection. Proc. 2nd. National Conf. of PI. Path. Sep. 27-29, U.A.F. pp. 138-139.

Verma, J.P., M.L. Nayak and R.P. Singh. 1977. Survival of *Xanthomonas malvacearum* under North Indian conditions. Ind. Phytopath. 30: 361-365.