INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print), 2222-5234 (Online)
http://www.innspub.net
Vol. 12, No. 2, p. 1-7, 2018

RESEARCH PAPER OPEN ACCESS

Disease management of bacterial blight of cotton through upland cotton (*Gossypiumhirsutum*) Germplasm andchemotherapuents under field conditions

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Key words: Cotton (*Gossypium hirsutum* L.), Bacterial blight of cotton. *Xanthomonas campestris* pv. *malvacearum*, Cotton varieties/lines, Chemicals

http://dx.doi.org/10.12692/ijb/12.2.1-7 Article published on February 10, 2018

Abstract

Bacterial blight is becoming a devastating cotton disease due to the climate change in sub-continent regions. To grow resistant germplasm is an economical and effective tool to manage the disease. Thirty-one cotton varieties/lines were screened against bacterial blight of cotton disease under field conditions. Five varieties/lines viz. FH-142, FH-326, FH-Kehkishan, FH-468 and FH-152, exhibited resistant response against the disease.FH-344, FH-478, CIM-343,CIM-602, CIM-506, CIM-717 and MNH-992 were moderately resistant against the pathogen's virulence. Ten varieties/lines (FH-466, FH-342, FH-312, FH-412, FH-498, FH-494, FH-458, Lalazar, CIM-616 and CIM-632) responded moderately susceptible response against bacterial blight disease. FH-490, FH-444, FH-Noor, FH-315 and FH-242 were susceptible against the disease. FH-91, VH-363, CIM-573 and CIM-620 were found highly susceptible to the disease. Four different chemicals {(Flare-72 SP (Streptomycin Sulphate), Thrill-20 % WP (Bismerthiazole), Kasumin 4% WP (Kasugamycin) and Copper Oxychloride 50WP (Copper Oxychloride) were evaluated against bacterial blight of cotton disease at 1g/L, 2.5 g/L, 4.8ml/L and 3g/L respectively. Flare-72 SP (Streptomycin Sulphate) was found the most effective against the disease as compared to the other chemicals.

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Introduction

Cotton (*Gossypium hirsutum*) natively known as white gold is an important fiber cash crop of worldwide importance. It belongs to family "Malvaceae" and genus "Gossypium contains thirty-five species (Fryxell *et al*., 1976) but *Gossypium herbaceum, Gossypium barbadense, Gossypium arboreum* and *Gossypium hirsutum* are of economically important, the least two are most prominent for commercial cultivation.

In world, cotton is grown in more than 80 countries of the world. Total world cotton production in 2016-17 was 102 million bales, more than 6 percent from the preceding year. Globally in 2016-17, harvested area was recorded 24.10 million hectares which was 7 percent above the previous year(Meyer, 2016).

In Pakistan during 2016-17, the area under the crop was 2489 thousand hectares and now total production of 10.671 million bales was being expected(SUPARCO, 2012) Cotton accounts for 5.2 % of the value-added in the agriculture sector and about 1 percent to GDP(Survey, 2016-2017).

Cotton is attacked by a number of diseases inducing severe reduction in yield by influencing germination, killing the plants, reducing plant productivity and affecting the quality of lint. Root-rot, fungal wilt, bacterial wilt, anthracnose, cotton leaf curl and bacterial rust are the major diseases of cotton.
Bacterial blight of cotton caused by *Xanthomonas compestris* pv. *malvacearum* is known to be one of the most devastating disease in cotton (Innes, 1983). Bacterial blight can reduce the yield of the crop up to 50% in favorable conditions of the disease development(Bhutta and bhatti., 1983), however, in severe conditions the losses may exceed up to 90 %.Diseased symptoms include circular, dark-green and water soaked spots with red to brown margins that will finally turn into dark-brown or black necrosis and death of infected tissues will happen. In case of severe attack defoliation occurs. As the infection increases, the premature defoliation of leaf petiole and stem may become occur. Infected stem girdles with black lesions (black arm syndrome) causing it to die and break. A disease damaged boll has round water soaked spots causing it to rot (Singh, 2008).

The disease management approach through growing resistant germplasm is biologically and economically a cost effective practice (McGee, 1995). The strategy is beneficial for all poly-cyclic, mono-cyclic and polyetic pathogens. The resistant plant interferes with the pathogen's establishment, colonization and multiplication, hence, interferes with the pathogen's life cycle process and attritions pathogen's population pressure. Economically; this approach reduces the inputs of the grower dramatically to counter the disease. The cost for cultural and chemical practices to debacle the disease progression is too high comparing to this approach (Meynard *et al*., 2003).

Economic Threshold Level (ETL) directs to adopt the appropriate disease management strategies. Fungicides application is a reliable approach to manage the disease below to the ETL, however, is not an ecofriendly as these chemicals have defiled our terrestrial and hydral environment (Crathorne *et al*., 2001). However, by adopting prescribed safety measures, the environmental pollution hazards can be minimized (Waxman, 1998).

The present research was aimed to find the resistant cotton germplasm against bacterial blight of cotton disease by screening of cotton varieties/lines. Fungicide's efficacy was evaluated under field conditions for disease management.

Material and methods

Screening of resistant germplasm

Field trials were conducted at experimental area of Plant Pathology Research Institute, Ayub Agricultural Research Institute (AARI), Faisalabad, Pakistan in 2016. Certified seeds of thirty-one cotton varieties/lines viz. FH-142, FH-326, FH-Kehkishan, FH-468, FH-152, FH-344, FH-478, CIM-343,CIM-602, CIM-506, CIM-717, MNH-992, FH-466, FH-342, FH-312, FH-412, FH-498, FH-494, FH-458, Lalazar, CIM-616, CIM-632, FH-490, FH-444, FH-Noor, FH-315, FH-242, FH-91, VH-363, CIM-573, CIM-620 were taken from Cotton Research Institute, AARI, Faisalabad and Central Cotton Research Institute, Multan, Pakistan. Prior to sowing, linted seeds were soaked in bacterial suspension overnight to increase the chances of seed borne infection. Seeds were sown on beds by keeping row to row and plant to plant 75 and 30 cm respectively. Augmented design was used with two repeats. In each repeat, ten seeds of each variety/line were sown. All agronomic practices were adopted.

Inoculum of pathogenic bacterium was sprayed at seedling stage and repeated at seven days' intervals. Tap water was sprayed in morning and evening times to increase the humidity. Disease severity was recorded and varieties/lines were evaluated using Brinkerhoff's disease rating scale (Brinkerhoff, 1977) after the appearance of the disease.

Evaluation of different chemothera puents in field conditions

For field evaluation of different chemicals against the disease, certified seeds of "FH-91" variety were taken from Cotton Research Institute, AARI, Faisalabad. Trial was conducted at experimental area of Plant Pathology Research Institute, Ayub Agricultural Research Institute (AARI), Faisalabad, Pakistan. Four different chemicals {(Flare-72 SP (Streptomycin Sulphate), Thrill-20 % WP (Bismerthiazole), Kasumin 4% WP (Kasugamycin) and Copper Ox chloride 50WP (Copper Oxychloride)} were evaluated against bacterial blight of cotton disease at the recommended doses i.e. 1g/L, 2.5 g/L, 4.8ml/L and 3g/L respectively under field conditions. In control treatment, nothing was applied.

Randomized Complete Block Design (RCBD) was used with four repeats. In each replication, ten seeds of FH-91 cotton variety were sown keeping row to row and plant to plant distance 60 and 30 cm respectively. Chemicals were applied foliar at 4:00 pm after a weeks of emergence of seedlings by knapsack sprayer. Disease data was recorded after 7 days of application.

Statistical analysis

Recorded disease incidence data was analysed using Analysis of Variance (ANOVA). Efficacy of different treatments were compared by using Fisher's Least Significant Difference (LSD) test (Steel *et al.*, 1997). Data was analysed using SAS software (SAS, 2011-2012) and data representation was accessed through "Microsoft Office-2013" software (Wilson, 2014).

Results and discussion

Evaluation of resistant germplasm

Out of thirty-one cotton varieties/lines, no one variety/line was found immune and highly resistant against bacterial blight disease. Five varieties/lines viz. FH-142, FH-326, FH-Kehkishan, FH-468, FH-152 exhibited resistant response against the disease.FH-344, FH-478, CIM-343, CIM-602, CIM-506, CIM-717 and MNH-992were found moderately resistant against the pathogen's virulence. Ten varieties/lines (FH-466, FH-342, FH-312, FH-412, FH-498, FH-494, FH-458, Lalazar, CIM-616 and CIM-632) responded as moderately susceptible whileFH-490, FH-444, FH-Noor, FH-315 and FH-242were ranked as susceptible against the bacterial blight of cotton disease. FH-91, VH-363, CIM-573 and CIM-620were found highly susceptible to the disease (Table 1).

The disease management approach through growing resistant germplasm is a cost effective practice biologically and economically.

Resistance/susceptibility primarily depends on the genome inheritance (Biffen, 1905), mainly controlled by one (vertical resistance) or many genes (horizontal resistance) (Vanderplank, 1984). Field resistance mainly depends on the genomic properties of the germplasm or by environmental factors (Govindaraj *et al.*, 2015). True resistance phenomenon comes when a plant resists against the pathogen infection in favorable environmental condition by the genomic property (vertical or horizontal resistance). Often, in the presence of susceptible host and virulent pathogen, it happens that infection may not be established due to unfavorable weather condition (Agrios, 2005).

In the above-performed experiment, it is clear that infection was established under the pathogen's favorable environmental conditions, which supports the idea that the variation among varieties/lines is due to genomic characterization.

Table 1. Response of different cotton varieties/lines against bacterial blight of cotton disease.

Grade	Symptoms Description	Level of Resistance/susceptibility	Varieties/lines	No. of varieties/lines
0	No. Symptom	Immune	-	0
0.2	1 to 2 angular lesions per plant	Highly Resistant	-	0
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	FH-142, FH-326, FH-Kehkishan, FH-468, FH-152	5
2	Leaves shed from two nodes			
3	Leaves shed from three nodes	Moderately Resistant	FH-344, FH-478, CIM-343,CIM-602, CIM-506, CIM-717, MNH-992	7
4	Leaves shed from four nodes			
5	Leaves shed from five nodes	Moderately Susceptible	FH-466, FH-342, FH-312, FH-412, FH-498, FH-494, FH-458, Lalazar, CIM-616, CIM-632	10
6	Leaves shed from six nodes (+) slight infection of leaves above bare nodes (+) black arm infection			
7	Leaves shed from six nodes (+) slight to moderate infection of l above bare nodes (+) black arm phase	Susceptible	FH-490, FH-444, FH-Noor, FH-315, FH-242,	5
8	Leaves shed from six nodes (+) moderate infection of leaves above bare nodes (+) black arm phase			
9	Leaves shed from six nodes (+) severe infection of leaves above bare nodes (+) black arm phase	Highly Susceptible	FH-91, VH-363, CIM-573, CIM-620	4
10	Leaves shed from six nodes (+) very severe infection of leaves above bare nodes (+) black arm phase			

Sajid *et al.* (2017) screened twenty eight varieties/advanced lines against the disease. Seventeen varieties (BT-Z-33, BT-S-78, BT-786, BT-A-ONE, BT -282, BT-886, BT-3701, BT-SPECIAL, BT-802, Non Bt-FH 901, BT-92, BT-131, BT-905, BT-SUPPER, Non Bt-MNH 496, Non Bt-FH 1000 and BT-121) expressed moderately resistant response. Five varieties viz. Non Bt-FH 207, Non BT-N 112, Non BT-FH 942, Non BT-MNH 6070 and Non Bt-FH941exhibited moderately susceptible response. Non BT-N 814, Non Bt-FH 900, Non BT-ANMOL and Non Bt-FH 2015 were found susceptible against the disease while Non BT-REDACOLA and Non BT-C 26 expressed highly susceptible response against bacterial blight disease of cotton.

Table 2. Relative efficacy of different chemicals against bacterial blight of cotton disease (ANOVA).

Source of Variation	Df	SS	MS	F	P
Treatments	4	1291.70	322.925	545.79	0.0000
Replications	3	6.15	2.050		
Error	12	7.10	0.592		
Total	19	1304.95			

Efficacy of different chemotherapuents against the disease in field conditions

Significant difference in efficacy was seen among the chemicals against bacterial blight of cotton (Table 2). Flare-72 SP (Streptomycin Sulphate) was found the most effective against the disease as compared to the other chemicals. Thrill 20% WP (Bismerthiazole) was less effective as compare to the Flare-72 SP (Streptomycin Sulphate) but was more effective than Kasumin 4% WP (Kasugamycin), Copper Oxychloride

50WP (Copper Oxychloride) and control (Untreated) treatments. Kasumin 4% WP (Kasugamycin) was more effectiveto manage the disease with respect to Copper Oxychloride 50WP (Copper Oxychloride). Copper Oxychloride 50WP (Copper Oxychloride) was the least effective for disease management as compared to the other chemicals. In control, maximum disease incidence was noted.

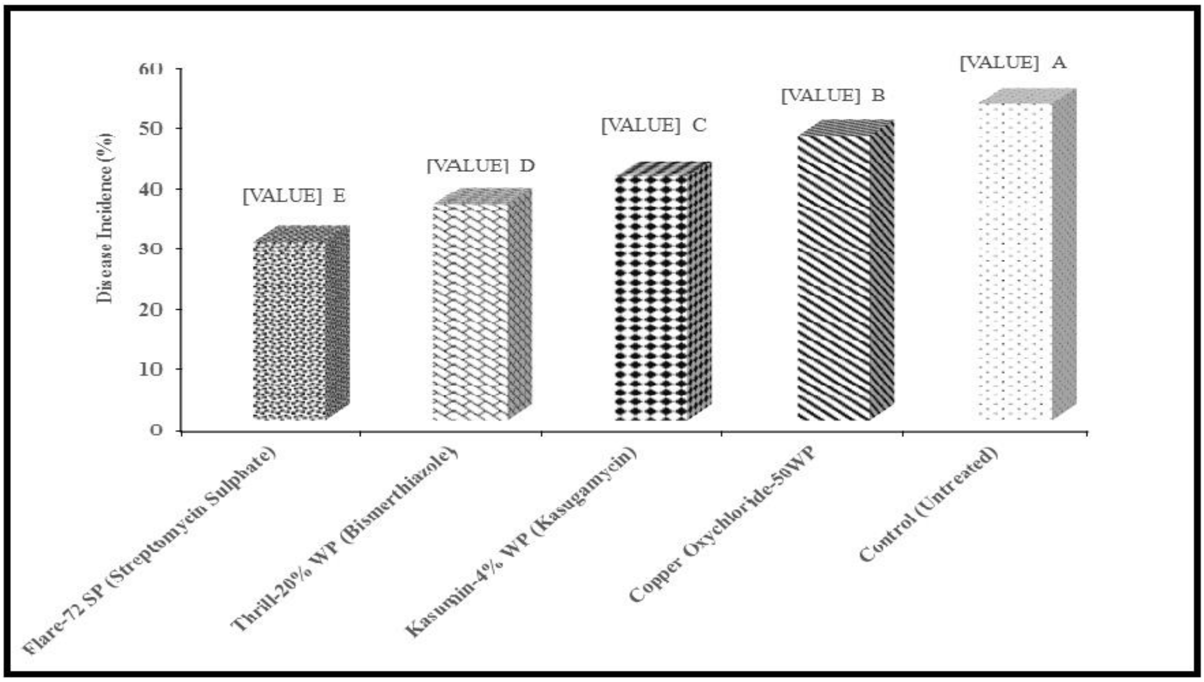

Fig. 1. Relative efficacy of different treatments against bacterial blight of cotton disease. LSD=1.185.

The chemicals effectiveness directly relates to the inert material/adjuvants added with active ingredient (Steurbaut, 1993), adsorption capability of active ingredient in plant system (Barak *et al.*, 1983) and persistence to the a-biotic environmental (Sigler *et al.*, 2000).

The inert material/adjuvant facilitates the dispersal and attachment of the active ingredient of the fungicide (Gent *et al.*, 2003, Ryckaert *et al.*, 2007).

The effectiveness of the fungicide may decrease if a chemical may fails to reach its target site. The absorbance of chemical in the plant part is also an important property of a fungicide.

The success of an effective fungicide may reduce if it doesn't absorb well to the plant. The fate of the fungicide highly dependents on the temperature (Munnecke, 1972, Sigler *et al.*, 2000).

The rate of volatility and dissociation of active chemical in fungicide may vary at different air temperatures. So, the time of application is also a factor of concern.

Furthermore, the efficacy of the tested fungicides may vary region to region because of the different temperature ranges. So, the relative efficacy of these tested fungicides may change at different regions of the world.

Pathak and Godika (2006)treated delinted seeds with streptocycline (100 ppm) for 2 h and foliar applied streptocycline (50 and 100 ppm) alone or in combination with 0.3% copper oxychloride to manage the bacterial blight of cotton disease. Seed treatment with 100 ppm streptocycline for 2 h followed by 2 sprays of 100 ppm streptocycline+0.3% copper oxychloride was the best treatment which was significantly superior over the control and other treatments.

Conclusion

Present study revealed that the "FH-142, FH-326, FH-Kehkishan, FH-468 and FH-152" varieties were found highly resistant against the disease, plant breeders may use these germplasms for their future trials and farmers may grow these varieties where the bacterial blight of cotton is is a serious problem in the field. Application of Flare-72SP (Streptomycin sulphate) may be used for the disease management.

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