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RK PatelKrishi Vigyan Kendra (KVK),
NAU, Surat, Gujarat, India**Prashant B Sandipan**Main Cotton Research Station
(MCRS), NAU, Surat, Gujarat,
India**HR Desai**Main Cotton Research Station
(MCRS), NAU, Surat, Gujarat,
India**AD Patel**Regional Cotton Research
Station (RCRS), NAU, Bharuch,
Gujarat, India

Screening of *Gossypium hirsutum* varieties/breeding materials for resistance to Alternaria leaf spot and Bacterial leaf blight diseases under natural and rainfed conditions

RK Patel, Prashant B Sandipan, HR Desai and AD Patel

Abstract

Screening of *Gossypium hirsutum* varieties/genotypes against Alternaria leaf spot and bacterial leaf blight diseases under natural and rainfed field conditions was conducted during *kharif* seasons of 2014-15 and 2015-16 at Regional Cotton Research Station, Navsari Agricultural University, Maktampur farm, Bharuch, Gujarat. Two cotton genotypes *i.e.* GSHV-159 and GBHV-184 were found disease free; ten varieties/genotypes *viz.*, G.Cot.-34, G.N.Cot.-26, GBHV-177, GBHV-180, GBHV-183, G.N.Cot.-22, GBHV-185, GBHV-187, GBHV-193 and GBHV-202 as resistant, while the variety G.Cot.-16 were found moderately resistant against Alternaria leaf spot disease. Cotton genotype GBHV-193 was found disease free; nine varieties/genotypes *viz.*, GSHV-159, G.N.Cot.-26, GBHV-177, GBHV-180, GBHV-183, G.N.Cot.-22, GBHV-184, GBHV-185 and GBHV-202 as resistant, whereas three varieties/genotypes *viz.*, G.Cot.-34, G.Cot.-16 and GBHV-187 were found moderately resistant reaction against bacterial leaf blight disease.

Keywords: Screening, cotton, *Gossypium hirsutum*, varieties/genotypes, resistant, Alternaria leaf spot disease, bacterial leaf blight disease

Introduction

Cotton is one of the most important commercial crop and it is the back bone of national economy of our country. Within India, two-thirds of cotton is produced in the central cotton growing zone; including, the states of Maharashtra, Madhya Pradesh, Gujarat and Odisha where much of the crop is rainfed. *Gossypium hirsutum* represents 99.9 per cent of the hybrid cotton in India and all the current *Bt* cotton hybrids are either *G. hirsutum* or inter-specific hybrids with *G. barbadense*. The low productivity of cotton is mainly due to high incidence of insect pests and diseases caused by fungal, bacterial and viral pathogens. Gouda *et al.* (2014) [3] noted that the lower productivity of cotton was mainly due to crop grown under rainfed situation and incidence of insect pest (15-20%). Cotton is known to suffer from number of diseases caused by fungal, bacterial and viral origins. Among foliar diseases; bacterial blight, Alternaria leaf spot and grey mildew are the most important. In North India, the cotton leaf curl disease (CLCuD) caused by gemini virus and transmitted by whitefly *Bemisia tabaci* (Gennadius) has become a serious threat to cotton cultivation due to development of new recombinant strains and introduction of a number of susceptible *Bt* cotton hybrids in north zone (Monga *et al.*, 2011) [6]. In India, foliar diseases (fungal, bacterial and viral boll rot) have been estimated to cause yield losses up to 20 to 30% (Mayee and Mukewar, 2007) [4]. Under favourable conditions, losses to the tune of 26.59 % (Monga *et al.*, 2013) [5] and 38.23% (Bhattiprolu and Prasada Rao, 2009) [2] were recorded due to fungal diseases, leaf spot/blight caused by *Alternaria macrospora* Zimm. The bacterial blight is the most wide spread and destructive disease reported to cause yield losses up to 30 per cent (Sandipan *et al.*, 2016) [18]. Host plant resistance is one of the major components of IPM as it is eco-friendly, sustainable and easy to adopt. One of the most promising ways to reduce dependence on pesticides in agriculture is to plant insect-disease resistant crops. Keeping these in view, different cotton entries were screened under natural conditions.

Materials and Methods

During both *kharif* seasons, the experiment was conducted at Regional Cotton Research Station, Navsari Agricultural University, Maktampur farm, Bharuch, Gujarat.

Corresponding Author:**Prashant B Sandipan**Main Cotton Research Station
(MCRS), NAU, Surat, Gujarat,
India

Two rows of each cotton variety/genotype and ten dibbles in each row were sown for screening against diseases. The infector row of susceptible cultivar LRA-5166 was sown in between each two entries *i.e.* each four rows of cotton variety/genotype for creating maximum disease pressure. All the recommended agronomic practices adopted timely for raising the good crop. The experimental plot was kept without any fungicidal spray to allow occurrence of cotton diseases throughout the season. The details of the experiment are given in Table 1.

For recording observations, randomly tag 5 cotton plants from net plot of each treatment and score 5 lower and 5 middle leaves of each plant in terms of 0-4 grade and record only maximum grade and this way maximum grade out of 5 plants were considered as final reaction of a particular test entry. The disease score for Alternaria leaf spot and bacterial leaf blight was recorded as mentioned below by using 0-4 scale as given by Sheo Raj (1988) [10]. Similar disease score was used by Anonymous (2014) [11], Venkatesh, I. (2014) [11] and Sandipan *et al.* (2017) [9].

For, Alternaria leaf spot (ALS) disease

Sr. No.	Scale	Category	Symptoms
1	0 grade	Immune or Disease Free (DF)	No infection
2	1 grade	Resistant (R)	A few small spots less than 2 mm, scattered brown in colour, leaf area covered is less than 5 per cent
3	2 grade	Moderately Resistant (MR)	Bigger spots up to 3 mm coalescing, brown in colour, 6-20 per cent leaf area covered
4	3 grade	Moderately Susceptible (MS)	Spots increasing in size 3-5 mm and irregular in Shape tending to coalescing and 21-40 per cent leaf area covered
5	4 grade	Susceptible (S)	Spots coalescing to form bigger lesions, irregular in shape and size, more than 40 per cent leaf area covered

For, Bacterial leaf blight (BLB) disease

Sr. No.	Scale	Category	Symptoms
1	0 grade	Immune or Disease Free (DF)	Plants completely free from infection
2	1 grade	Resistant (R)	Spots few, scattered, nearly 1 mm in diameter, dry, not coalescing, reddish, not angular, veins free
3	2 grade	Moderately Resistant (MR)	Spots initially wet but rapidly drying, several, larger, nearly 2 mm diameter, not coalescing, reddish, brown, veins and veinlets free or with dry lesions, leaf area covered up to 10 per cent
4	3 grade	Moderately Susceptible (MS)	Lesions large, 2 mm or more in diameter, angular, turning brown and black, coalescing, spreading linearly along the smaller veins, 11-20 per cent leaf area covered or water-soaked vein infection along the main veins
5	4 grade	Susceptible (S)	Lesions larger, water-soaked coalescing as above but covering more than 20 per cent leaf area and veins infected and extending up to pulvinus and petioles, lesions larger and coalescing, water-soaked at first later turning to brown or black, in severe cases branches and stem also attacked

Table 1: Experiment details

Sr. No.	Experiment details	Season	
		Kharif 2014	Kharif 2015
1	Location	Regional Cotton Research Station, N.A.U., Maktampur farm, Bharuch, Gujarat	
2	Design	Randomized Block Design (RBD)	RBD
3	Treatment/no. of entries	29 + 3 Local checks	23 + 3 Local checks
4	Replication	2	2
5	Spacing	120 cm x 45 cm	120 cm x 45 cm
6	Plot size	Gross: 2.40 m x 4.50 m Net: 2.40 m x 3.60 m	Gross: 2.40 m x 4.50 m Net: 2.40 m x 3.60 m
7	No. of rows of each variety/genotype	2	2
8	No. of dibbles/row	10	10
9	Fertilizer NPK	120-0-0 kg/ha	120-0-0 kg/ha
10	Previous crop	Pigeonpea	Pigeonpea
11	Date of sowing	21-07-2014	31-07-2015
12	Date of gap filling	04-08-2014 and 14-08-2014	08-08-2015
13	Irrigation	Rainfed	Rainfed

Varieties/genotypes of *G. hirsutum* cotton

2014-15	2015-16
GSHV-159, GISV-216, G.Cot.-34 (GISV-272), G.N.Cot.-26 (GBHV-170), GBHV-177, GBHV-164, GBHV-180, G.Cot-20, G.N.Cot-22, G.Cot-16, GSHV-172, GSHV-173, GSHV-175, GJHV-517, GJHV-519, GJHV-526, GJHV-473, GBHV-162, GBHV-183, GBHV-184, GBHV-185, GTHV-10/25, GTHV-7/70, GTHV-10/28, GBHV-187, GBHV-193, GBHV-195, GBHV-198, GBHV-202	GISV-267, G.Cot.-34 (GISV-272), GSHV-159, GSHV-162, G.N.Cot.-26 (GBHV-170), GBHV-177, GBHV-180, GBHV-183, G.N.Cot-22, G.Cot-16, GISV-308, GSHV-182, GSHV-184, GSHV-185, GBHV-184, GBHV-185, GBHV-187, GBHV-193, GBHV-200, GBHV-201, GBHV-202, GBHV-203, GBHV-204
Checks: <i>G. hirsutum</i> cotton: LRA 5166, <i>G. herbaceum</i> (Desi cotton): Divijay & 1027 ALF	Checks: <i>G. hirsutum</i> cotton: LRA 5166, <i>G. herbaceum</i> (Desi cotton): Divijay & 1027 ALF
Entries 29 + 3 Local checks	Entries 23 + 3 Local checks

Results and Discussion

Different varieties/genotypes of *G. hirsutum* cotton *i.e.* twenty nine and twenty three during *kharif*-2014 and *kharif*-2015,

respectively were evaluated under rainfed and natural field condition for their reaction against Alternaria leaf spot and bacterial leaf blight diseases. The results of thirteen cotton

varieties/genotypes with local checks, which were common during two seasons (2014-15 and 2015-16) are presented in

Table 2 and Table 3.

Table 2: Reaction of *G. hirsutum* varieties/breeding materials of cotton against Alternaria leaf spot disease under rainfed conditions at Bharuch during 2014-15 and 2015-16

Sr. No.	Cotton varieties/ genotypes	Alternaria leaf spot				Final Reaction
		2014-15		2015-16		
		Grade	Reaction	Grade	Reaction	
1	G.Cot.-34 (GISV-272)	1	R	1	R	R
2	GSHV-159	0	DF	0	DF	DF
3	G.N.Cot.-26 (GBHV-170)	0	DF	1	R	R
4	GBHV-177	1	R	0	DF	R
5	GBHV-180	0	DF	1	R	R
6	GBHV-183	0	DF	1	R	R
7	G.N.Cot.-22	0	DF	1	R	R
8	G.Cot.-16	1	R	2	MR	MR
9	GBHV-184	0	DF	0	DF	DF
10	GBHV-185	1	R	1	R	R
11	GBHV-187	1	R	1	R	R
12	GBHV-193	0	DF	1	R	R
13	GBHV-202	0	DF	1	R	R
Checks						
14	LRA 5166 (Infector row)	1	R	2	MR	MR
15	1027 ALF (desi cotton)	0	DF	0	DF	DF
16	Digvijay (desi cotton)	0	DF	0	DF	DF

DF- Disease Free, R- Resistant, MR- Moderately Resistant, MS- Moderately Susceptible and S- Susceptible

Alternaria leaf spot disease

The reaction of cotton varieties/genotypes against Alternaria leaf spot disease during 2014-15 presented in Table 2 indicated that eight varieties/genotypes viz., GSHV-159, G.N.Cot.-26 (GBHV-170), GBHV-180, GBHV-183, G.N.Cot.-22, GBHV-184, GBHV-193 and GBHV-202 showed disease free reaction. Whereas, remaining five cotton varieties/genotypes viz., G.Cot.-34 (GISV-272), GBHV-177, G.Cot.-16, GBHV-185 and GBHV-187 showed resistant reaction against Alternaria leaf spot disease. During 2015-16, three cotton genotypes viz., GSHV-159, GBHV-177 and GBHV-184 showed disease free reaction. Nine varieties/genotypes viz., G.Cot.-34 (GISV-272), G.N.Cot.-26 (GBHV-170), GBHV-180, GBHV-183, G.N.Cot.-22, GBHV-185, GBHV-187, GBHV-193 and GBHV-202 showed resistant reaction, while only variety G.Cot.-16 showed moderately resistant reaction against Alternaria leaf spot disease. Among checks, LRA 5166 showed resistant and moderately resistant reaction against Alternaria leaf spot during 2014-15 and 2015-16, respectively. The desi cotton checks viz., 1027 ALF and Digvijay showed disease free reaction during both the seasons.

In final reaction, two genotypes *i.e.* GSHV-159 and GBHV-184 showed disease free reaction against Alternaria leaf spot. Ten cotton varieties/genotypes viz., G.Cot.-34 (GISV-272), G.N.Cot.-26 (GBHV-170), GBHV-177, GBHV-180, GBHV-183, G.N.Cot.-22, GBHV-185, GBHV-187, GBHV-193 and GBHV-202 showed resistant reaction, while only variety G.Cot.-16 showed moderately resistant reaction against Alternaria leaf spot disease. The check LRA 5166 showed moderately resistant while 1027 ALF and Digvijay showed disease free reaction against Alternaria leaf spot disease of cotton.

The present finding of screening of *G. hirsutum* varieties/breeding materials for resistance to Alternaria leaf spot disease is more or less in accordance with Sandipan *et al.* (2017) [9] who observed that cotton entries viz., GISV-272, GSHV-159, GBHV-170, GBHV-180, GBHV-184 and GBHV-193 showed disease free reaction; GBHV-177, GBHV-185 and GBHV-187 as resistant whereas, GBHV-183 as moderately resistant reaction against Alternaria leaf spot disease.

Table 3: Reaction of *G. hirsutum* varieties/breeding materials of cotton against bacterial leaf light disease under rainfed conditions at Bharuch during 2014-15 and 2015-16

Sr. No.	Cotton varieties/ genotypes	Bacterial leaf light				Final Reaction
		2014-15		2015-16		
		Grade	Reaction	Grade	Reaction	
1	G.Cot.-34 (GISV-272)	2	MR	1	R	MR
2	GSHV-159	0	DF	1	R	R
3	G.N.Cot.-26 (GBHV-170)	1	R	1	R	R
4	GBHV-177	1	R	1	R	R
5	GBHV-180	1	R	1	R	R
6	GBHV-183	1	R	1	R	R
7	G.N.Cot.-22	1	R	1	R	R
8	G.Cot.-16	1	R	2	MR	MR
9	GBHV-184	0	DF	1	R	R
10	GBHV-185	0	DF	1	R	R
11	GBHV-187	0	DF	2	MR	MR
12	GBHV-193	0	DF	0	DF	DF

13	GBHV-202	0	DF	1	R	R
Checks						
14	LRA 5166 (Infector row)	2	MR	2	MR	MR
15	1027 ALF (desi cotton)	0	DF	0	DF	DF
16	Digvijay (desi cotton)	0	DF	0	DF	DF

DF- Disease Free, R- Resistant, MR- Moderately Resistant, MS- Moderately Susceptible and S- Susceptible

Bacterial leaf blight disease

The data presented in Table 3 indicated that six cotton varieties/genotypes *viz.*, GSHV-159, GBHV-184, GBHV-185, GBHV-187, GBHV-193 and GBHV-202 showed disease free reaction against bacterial leaf blight disease during 2014-15. Another six cotton varieties/genotypes *viz.*, G.N.Cot.-26 (GBHV-170), GBHV-177, GBHV-180, GBHV-183, G.N.Cot.-22 and G.Cot.-16 showed resistant reaction, whereas only G.Cot.-34 (GISV-272) showed moderately resistant reaction against bacterial leaf blight disease. Only the genotype GBHV-193 showed disease free reaction against bacterial leaf blight disease during 2015-16. Ten cotton varieties/genotypes *viz.*, G.Cot.-34 (GISV-272), GSHV-159, G.N.Cot.-26 (GBHV-170), GBHV-177, GBHV-180, GBHV-183, G.N.Cot.-22, GBHV-184, GBHV-185 and GBHV-202 showed resistant reaction, while two varieties/genotypes *i.e.* G.Cot.-16 and GBHV-187 showed moderately resistant reaction against bacterial leaf blight disease. The check LRA 5166 showed moderately resistant reaction, while two desi cotton checks *i.e.* 1027 ALF and Digvijay showed disease free reaction against bacterial leaf blight disease during both the seasons.

The single cotton genotype GBHV-193 showed disease free reaction against bacterial leaf blight disease in final reaction. Nine cotton varieties/genotypes *viz.*, GSHV-159, G.N.Cot.-26 (GBHV-170), GBHV-177, GBHV-180, GBHV-183, G.N.Cot.-22, GBHV-184, GBHV-185 and GBHV-202 showed resistant reaction, whereas three varieties/genotypes *viz.*, G.Cot.-34 (GISV-272), G.Cot.-16 and GBHV-187 showed moderately resistant reaction against bacterial leaf blight disease. The check LRA 5166 showed moderately resistant while 1027 ALF and Digvijay showed disease free reaction against bacterial leaf blight disease.

In past, Reddy *et al.* (2016) evaluated fifty *Bt* cotton hybrids against sucking pests and foliar diseases under unprotected conditions to identify those with multiple resistance. They indicated that twenty-six cotton hybrids were resistant to foliar diseases. Six hybrids *viz.*, Ajeet 155, Indra Vajra, Jackpot BG II, Mallika BG II, Sandeep and Pratheek BG II were resistant to both sucking pests and foliar diseases. Whereas, four hybrids *viz.*, Ajit 155, Dr Brent BG II, Neeraja BG II and SWCH 4769 BG II recorded more than 20q ha⁻¹, besides tolerance to the sucking pests and foliar diseases. Sandipan *et al.* (2017) ^[9] reported that *G. hirsutum* entries *viz.*, GISV-272, GSHV-159, GBHV-184 and GBHV-193 observed disease free; GBHV-177, GBHV-185 and GBHV-187 as resistant whereas, GBHV-180 and GBHV-183 as moderately resistant reaction against bacterial leaf blight disease. Contrastingly, they observed GBHV-170 as moderately susceptible against bacterial leaf blight disease.

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