DISEASE RESISTANCE OF CHILLI GERMPLASM AGAINST ANTHRACNOSE DISEASE CAUSED BY *COLLTOTRICHUM CAPSICI*

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ABSTRACT

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Selection of disease tolerant germplasm is the most effective means for optimization of quality crop production and unique opportunity for the breeders for developing new varieties. Here, we focused on the selection of chilli germplasm based on some agronomic performances under laboratory and net house trial under artificial inoculation by *Colletotrichum capsici*. Twenty-four chilli germplasm were considered under this trial against one virulent isolate of *Colletotrichum capsici.* Among the germplasm, 7 were categorized as resistant,13 were moderately resistant, 1 was intermediate, 3 were susceptible and 1 was highly susceptible. Disease symptoms appeared at 3 days after inoculation (DAI), and severe condition recorded at 9 DAI. Both mature hard and ripe fruits were found susceptible to anthracnose disease. Due to complete absence of disease symptoms in artificial condition, one local variety ubda morich can be recommended for the farmers for extensive cultivation through extension service and can also be considered for conventional breeding program.

Keywords: Anthracnose, chilli, *Colletotrichumc apsici*, germplasm, resistance

INTRODUCTION

Chilli (*Capsicum annuum*) is an important spice as well as vegetable crop cultivated worldwide. It has its unique place in the world diet in its ripe dried form (as a spice) as well as green fruits (as vegetable). Besides imparting pungency and red color to the dishes it is also a good source of vitamin C (175 mg / 100 g), vitamin A (870 IU / 100 g) and vitamin B (0.59 mg/10 g) (Begum *et al*. 2015). Besides its culinary uses, chili possesses rich pharmaceutical properties and is highly effective against cardiovascular disorders, obesity, ulcers and cancers (Srinivasan 2016). Chilli suffers from many diseases caused by fungi, bacteria, viruses, nematodes and also abiotic stresses. *Colletotrichum capsici* which causes varied disease symptoms *viz.*, anthracnose, die back, ripe fruit rot in chilli, is one of the major production constraints in tropical and subtropical areas (Bailey and Jeger 1992).

Management of the anthracnose disease is still under extensive research. Management strategies for this disease include use of disease free seed, resistant/tolerant cultivars and fungicidal sprays. Chemical control of anthracnose is hazardous and uneconomical, Biological control of chili anthracnose by inoculation of antagonistic fungi and bacteria isolated from grass rhizosphere and other sources has been considered as an alternative approach to chemical control (Vasanthakumari and Shivana 2013). However, these techniques only control anthracnose to a certain extent and are not completely effective due to high genetic variability among the *Colletotrichum* species. Hence development and use of resistant varieties is the most pragmatic way to keep the disease under check. Therefore, the aim of the study was to observe the resistance reactions of some chilli germplasm against virulent isolates of *Colletotrichum capsici* causing anthracnose disease.

MATERIALS AND METHODS

The experiment was conducted in the Seed Pathology Center (SPC), Department of Plant Pathology, Bangladesh Agricultural University. Twenty-four germplasm were screened for resistance to

anthracnose disease by artificial inoculation. The experiment was conducted in a completely randomized design with three replications. Data were taken from in each group of five fruits per replication. Twenty-four germplasm of chilli were collected from Mymensingh and Bogra districts.

Table 1. Name and location of collected germplasm

SL No.	Name of infected germplasm	District & Location
		Mymensingh district
1.	Balujhuri	Kalibari Bazar
2.	Bindu	Fulpur Bazar
3.	Hybrid morich	Boirarchor
4.	Hybrid morich (Angur)	Muktijuddhar Bazar
5.	Angur morich	Bhangamari Chor
6.	Lomba morich	Kalibari Bazar
7.	Hybrid lomba	MoricharChor
8.	Sadamorich	Bhangamari Chor
9.	Danger	MoricharChor
10	48-84 (Hybrid)	Muktijuddhar Bazar
11.	Capsicum	Boirarchor
12.	Asarimorich	Fulpur Bazar
13.	3001 (Hybrid)	Rajgonj Bazar
14.	Hybrid hot pepper	Rajgonj Bazar
15.	Boromorich	Rashidpur Bazar
16.	Golmorich	Goupondi Bazar
		Bogura district
17.	Golapmorich	Bharotir Bazar
18.	Kamrangamorich (Hybrid)	Chander Bazar
19.	Kamranga morich	Kalibari
20.	Borsha morich	Rashidpur Bazar
21.	Chondromuk himorich	Chander Bazar
22.	Sonic (Hybrid)	Bharotir Bazar
23.	Ubdamorich	Kalibari
24.	Baromashi morich (Hybrid)	Goupondi Bazar

These were screened against *Colletotrichum capsici* causes anthracnose of chilli under artificially inoculated net house conditions. A previously characterized isolate of *Colletotrichum capsici* was multiplied in Potato Dextrose Agar (PDA) medium. Six days old culture was used for inoculation. Inoculation was done twice at 7 days interval with spore suspension of *Colletotrichum capsici*. One mL inoculum of 1×10^6 conidial suspension per ml was artificially introduced by spraying the entire plants with fruits when fruit ripening stage is start and immediately covered by a polythene bag for maintaining optimum humidity. From first inoculation date, every 7 days interval inoculation was done 3 times, The disease symptoms were recorded fifteen days after inoculation. The disease severity and disease resistance response on fruits was judged by percentage of infected sites (based on lesion development) over total inoculated sites and was scored on 0- 5 scale (Paul *et al.* 2008).

Severity scale	Fruit surface area infected (%)	Category of resistance
0	0	Highly resistant
1	1-20	Resistant
2	21-40	Moderately resistant
3	41-50	Intermediate
4	51-70	Susceptible
5	71-100	Highly susceptible

Percent disease incidence and severity (%) was calculated by using the following formulae:

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

$$\text{Disease Severity} = \frac{\text{No. of diseased plant parts}}{\text{Ttal no. of plants parts}} \times 100$$

Statistical Analyses

The recorded data on various parameters under the present study were statistically analyzed using STATIX 10 statistical package program. The level of significance and analysis of variance along with the Least Significant Difference (LSD) was done following Gomez and Gomez (1984). Mean differences were compared by Tukey's Test.

RESULT AND DISCUSSION

Variation in growth and yield parameters of the chilli gremsplasm

Screening of chilli germplasm were conducted to observe the resistance reaction against anthracnose disease and growth and yield parameters *viz.* plant height, no. of branching, per plant, no. of leaves per plant and no. of fruits per plants were determined (Table 2). Maximum plant height was recorded in Asarimorich (74.00 cm) followed by Borsha morich (70.00 cm), Chondromukhi morich (66.00 cm) and Kamrangha morich (Hybrid) (47.00 cm). Some of the popular varieties are comparatively medium in size like Balujhuri (23.00 cm), Bindu (20.00 cm), Angur (31.00 cm) and Sada morich (16.00 cm). Maximum no. of branches were recorded in capsicum (53) followed by hybrid angur morich (33), Angur morich (32), Golap morich (31) respectively. No. of leaves was recorded the highest in hybrid Kamrangha morich (206) followed by Asari morich (155), Golap morich (141) and Hybrid 3001 (134). Maximum No. of fruits per plant were recorded in Angur morich (86). The screening of chilli cultivars was also under taken by Kasyap *et al.* (2008), Naik*et al.* (2008), Haq *et al.* (2013).

Table 2. Growth and yield response of chilli germplasm against anthracnose disease

Germplasm	Plant height (cm)	No. of branches/plant	No. of leaves/plant	No. fruits/ plant
Balujhuri	23 ijkl	12 efgh	51 mn	13 l
Bindu	20 jklm	12 efgh	45 no	26 gh
Hybrid morich	31 efg	13 efg	57 lm	53 d
Hybrid morich (Angur)	9.6 m	33 b	106 f	76 b
Angurmorich	31 efg	32 b	120 e	86 a
Lomba morich	17 lm	11 fgh	77 ij	21 hijk
Hybrid lomba	23 ijkl	17 cdef	109 f	19 ijkl
Sada morich	16 m	21 cd	72 j	39 e
Danger	34 ef	15 defg	81 hi	18 jkl
48-84 (Hybrid)	56 c	21 cd	71 j	52 d
Capsicum	26 ghij	53 a	13 k	14 l
Asari	74 a	15 defg	155 b	25 ghi
3001 (Hybrid)	37 e	23 c	134 d	23 ghij
Hybrid hot pepper	18 klm	15 defg	62 kl	19 ijkl
Boromorich	20 jklm	18 cde	97 g	28 fg
Golmorich	24 hijk	11 fgh	74 j	33 ef
Golapmorich	34 ef	31 b	141 c	24 ghij
Kamranga morich (Hybrid)	47 d	15 defg	206 a	15 kl
Kamranga morich	30 fgh	9 gh	72 j	13 l
Borshamorich	70 ab	18 cde	84 h	6 m
Chondromukhi morich	66 b	12 efgh	98 g	4 m
Sonic (Hybrid)	31 efg	9 gh	64 k	21 hijk
Ubda morich	15 mn	6 h	37 p	64 c
Baromashi morich (Hybrid)	29 fghi	12 efgh	41 op	49 d
LSD (0.05)	1.59	1.60	1.63	1.63
CV	6.16	6.29	6.23	6.28

Assessment of disease reaction of chilli germplasm

Net house experiments were carried out following artificial inoculation in order to observe the disease reaction of the chilli germplasm (Table 3). Data were recorded on no. of disease leaves per plant, no. of diseased fruit per plant, foliar disease incidence (%), disease severity in fruit (%) and severity category. The number of diseased leaves per plant was the highest in Angur morich (59) followed by Golap morich (31) and Hybrid sonic (29). No. of diseased leaves were comparatively low in Balujhuri (10), Bindu (6) and Asari morich (8) (Figure 2). No. of infected fruits were found maximum in Angur morich (80) followed by Hybrid 48-84 (48), Bindu (23), Ashari (21) and 3001 (Hybrid) (21). The number of infected fruits were less in Balujhuri (8) followed by Hybrid lomba (4), Borsha morich (2), Chondromukhi morich (3) (Figure 1). Interestingly, local chilli variety Ubda morich completely escaped the infection during artificial inoculation. Similar results were also obtained by Rajamanickam and Sethuraman (2014). They were tested four methods of inoculation under *in-vitro* condition to assess the effectiveness of infection. Among the various methods of inoculation, spraying spore suspension after pinpricking the fruits method was enabled to develop the maximum infection.

Disease incidence in foliar disease was the highest in Angur morich (49.16%) followed by Capsicum (46.15 %) and Hybrid sonic (45.31 %). On the other hand, lower foliar disease incidence was recorded in Hybrid Kamrangha morich (3.39 %), Asari (5.16 %) and Hybrid 3001 (8. 20 %). Based on fruit infection, the disease incidence was recorded the highest in Angur morich (93.02 %) followed by Hybrid 48-84 (92.30 %), Hybrid 3001 (91.30 %). Local varieties showed moderately resistant reaction like Sada morich (33.33 %) and Borsha morich (33.33 %). No disease was observed in the variety Ubda morich.

Our findings indicate some useful traits in chilli that have been linked with resistance to anthracnose, which can be considered as basis for breeding resistant varieties or in the program of Marker Assisted Selection (MAS) breeding of chilli varieties (Susheela 2012). Disease severity was maximum in Golmorich (75.00 %) followed by Angur morich (67.47 %) and Capsicum (62.96 %). Susheela (2012), reported that hybrid bearing less no. of fruits has sown less disease intensity due to pathogen dissemination in the field is

more efficient in prolific genotypes. Kaur *et al.* (2011) also reported that genotypes EC 21667 and IC 11670 with more number of fruits per plant showed more fruit rot symptoms. On the basis of disease reaction, the germplasm in the experiments as Highly resistant, Resistant, Moderately resistant, Intermediate, Susceptible, Highly susceptible. Among the germplasm, one was highly resistant (Ubda morich), six were resistant, 12 were moderately resistant, 1 was intermediate and one was highly susceptible. It was observed that hybrid CCH-3 was promising with stable performance for yield and other characters and can be recommended for general cultivation. The program traditionally emphasizes the development of hot and source specific sweet pepper populations, lines, cultivars, and hybrids with multiple disease resistance and high quality fruits, benefiting from a large gene bank of genotypes native to Brazil and also introduced from abroad (Ribeiro *et al*. 2008). In India, anthracnose resistant lines under natural infestation in open field conditions have been reported (Babu *et al*. 2011). None of the test genotype was immune and highly susceptible to anthracnose. Taylor (2007) also observed that *Colletotrichum capsici* also infects on resistant varieties or genotypes and cause reduction in yield of chillies indicating that there is no immune variety.

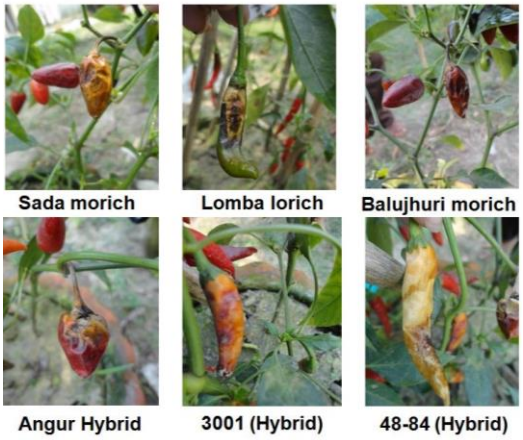

Figure 1. Development of anthracnose disease on chilli fruits inoculated by *Colletotrichum capsici*

Figure 2. Development of symptoms on chilli leaves inoculated by *Colletotrichum capsici*

Table 3. Reaction of different chilli germplasm inoculated by *Colletotrichum capsici* in net-house

Germplasm	Diseased leaves/plant	Diseased fruit/Plant	Foliar disease incidence(%)	Fruit disease incidence(%)	Fruit disease severity(%)	Severity Category
Balujhuri	10 efgh	8 ghi	15.68 cdef	61.53abc	28.12ef	MR
Bindu	6 h	23 c	13.33 cdefg	88.46 a	40.00 d	MR
Hybrid morich	9 fgh	16 def	15.78 cdef	30.18abc	22.72fg	MR
Hybrid morich (Angur)	16 cde	13 fgh	15.09 cdef	17.10bc	15.93 hi	R
Angur morich	59 a	80 a	49.16 a	93.02 a	67.47 b	S
Lomba morich	10 efgh	14 efg	12.98 cdefg	66.66abc	24.48efg	MR
Hybrid lomba	13 cdefg	4 ij	11.93 cdefg	21.05 ab	13.28ij	R
Sadamorich	14 cdef	13 fgh	19.44 cd	33.33abc	24.32efg	MR
Danger	10 efgh	13 fgh	12.34 cdefg	72.22 ab	23.23fg	MR
48-84	13 cdefg	48 b	18.30 cde	92.30 a	49.59 c	I
Capsicum	6 h	11 fgh	46.15 b	78.57 ab	62.96 b	S
Asari	8 fgh	21 cd	5.16 fg	84.00 ab	16.11 hi	R
3001 (Hybrid)	11 defgh	21 cd	8.20 efg	91.30 a	20.38gh	MR
Hybrid hot pepper	7	17 cdef	11.29 defg	89.47 a	29.62 e	MR
Boromorich.	12 defgh	12 fgh	12.23 cdefg	42.85abc	19.20ghi	R
Golmorich	10 efgh	20 cde	13.51 cdefg	60.66abc	75.00 a	HS
Golap morich	31 b	11 fgh	21.98 cd	45.83abc	25.45efg	MR
Kamranga morich (Hybrid)	7 gh	4 ij	3.39 g	26.66abc	4.97 k	R
Kamranga morich	11 defgh	7 hi	15.27 cdef	53.84abc	21.11gh	MR
Borshamorich	19 c	2 ij	22.61 c	33.33abc	23.33fg	MR
Chondromukhi morich	17 cd	3 ij	17.34 cde	75.00 ab	19.60ghi	R
Sonic (Hybrid)	29 b	14 efg	45.31 ab	66.66abc	50.58 c	S
Ubda morich	7 gh	0 j	18.91 cde	0 c	6.93jk	HR
Baromashi (Hybrid)	19 c	14 efg	46.34 ab	28.57abc	36.66 d	MR
LSD (0.05)	1.63	1.59	2.89	1.28	1.65	

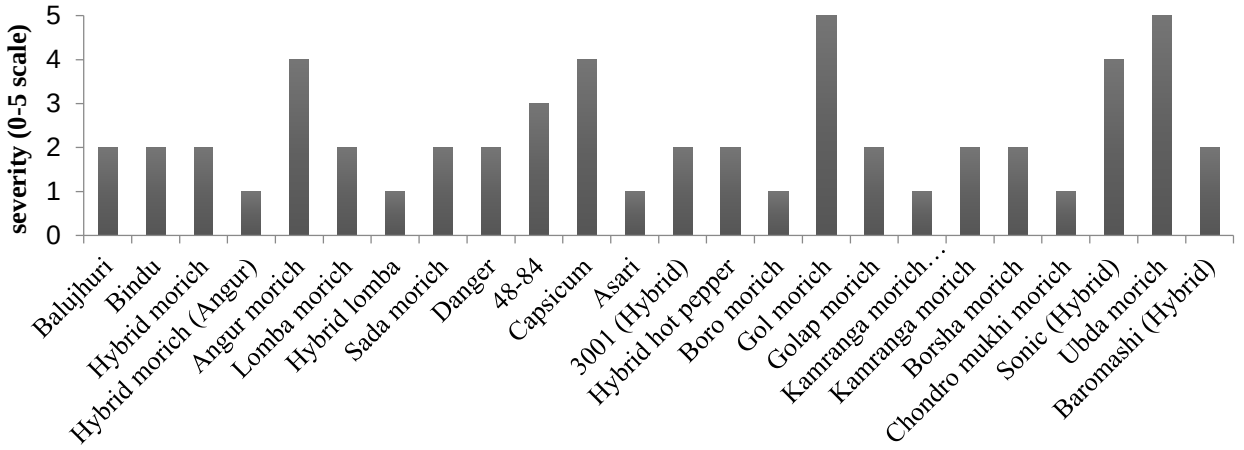

Figure 3. Disease severity index of different chilli germplasm inoculated by *Colletotrichum capsici* in net-house

CONCLUSION

The present study revealed that different levels of resistance exist among the popular and hybrid chilli germplasm in Bangladesh. A local germplasm (Ubdamoric) showed the highest resistance against anthracnose disease in artificial inoculated condition whereas Hybrid morich (Angur), Asari, Boro morich, Kamranga morich (Hybrid) and Chondromukhi morich were categorized as resistant, twelve were moderately resistant (Balujhuri, Bindu, Lomba morich, Sada morich, Danger, 3001 (Hybrid), Hybrid hot pepper, Golap morich, Kamranga morich, Borsha morich and Baromashi (Hybrid). Ubda moric, Gol morich, Angur morich, Capsicum and sonic (hybrid) can be potential resources for the chilli breeders.

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