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EVALUATION OF ONION CULTIVARS FOR RESPONSE TO PURPLE BLOTCH COMPLEX (*Alternaria porri*, *Stemphylium vesicarium*) AND YIELD PERFORMANCE

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Abstract

Onion (*Allium cepa*) is one of the most important spices in Bangladesh. It suffers from various diseases from seedbed to field. Purple blotch (*Alternaria porri*) and white blotch (*Stemphylium vesicarium*) simultaneously attack the crop, causing a purple blotch complex. To assess locally available onion cultivars for response to purple blotch complex and yield performance, a three-year experiment was conducted in the net house and research field of Sher-e-Bangla Agricultural University, Dhaka, during the winter of 2010-11, 2011-2012 and 2012-2013. Fourteen onion cultivars, namely BARI Piaz-1, BARI Piaz-2, BARI Piaz-3, BARI Piaz-4, BARI Piaz-5, Taherpuri, Indian hybrid, Lal Teer onion seed, Masud onion seed, Thakurgoan local, Faridpur local, Manikgong local, Indian big and Indian small were used in the experiment. Among the evaluated cultivars, BARI Piaz-3 showed the lowest disease incidence and severity and the maximum bulb yield, followed by BARI Piaz-2 and Indian big. The disease incidence, severity, and yield for BARI Piaz-3 were 54.45-36.33%, 5.75-12.01%, and 10.97-13.89 t/ha, while the corresponding values for BARI Piaz-2 were 41.49, 44.01, and 7.28-10.79 t/ha, respectively. In contrast, Indian big had disease incidence, severity, and yield values of 36.52-58.79%, 15.43-22.96%, and 8.41-10.60 t/ha, respectively. Therefore, the cultivar BARI Piaz -3 and 2 may be recommended for extension of cultivation.

Keywords: Screening, onion cultivar, purple blotch, disease, incidence, yeild.

Introduction

Onion (*Allium cepa*) is a major spice in Bangladesh, India and many other South Asian countries. It is cultivated throughout Bangladesh. In terms of annual world production, out of 15 important vegetables, onion stands second, as listed by FAO (Anon, 2011). However, onion suffers from many diseases causing substantial yield losses every year in Bangladesh (Ahmed and Hossain, 1985; Bose and Som, 1986). Two diseases, purple blotch (*Alternaria porri*) and white blotch (*Stemphylium vesicarium*), attack the onion plant simultaneously in a complex form, which is known as purple blotch complex (Ara, 2013). The purple blotch complex is noted as the most devastating disease in the country. It is a significant disease that is widespread wherever onion is cultivated and causes a severe drop in bulb yield (Rahman *et al.,*1988; Fakir, 2002).

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The disease is favored by moderate temperature (24-30°C) and high relative humidity (Gupta and Pathak, 1986; Evert and Lacy, 1990). As Bangladesh is a sub-tropical country, its climate favors the rapid development of diseases. According to onion growers and Extension Personnel, almost all cultivated onion cultivars grown in Bangladesh are attacked by the purple blotch complex. In response to their claims, it is essential to determine the current state of disease reactions of cultivated onion cultivars. Given the above facts, the present research was undertaken to determine the present status of incidence and severity of purple blotch complex on widely grown onion cultivars in Bangladesh.

Materials and Methods

Collection of cultivars

Fourteen onion cultivars grown in Bangladesh were selected for the experiment to find the present incidence and severity of the purple blotch complex caused by *Alternaria porri* and *Stemphylium vesicarium*. The cultivars were BARI Piaz-1, BARI Piaz-2, BARI Piaz-3, BARI Piaz-4, BARI Piaz-5, Taherpuri, Indian hybrid, Lal Teer onion seed, Masud onion seed, Thakurgoan local, Faridpur local, Manikgong local, Indian big and Indian small. The experiment was conducted in the net house and research farm of Sher-e-Bangla Agricultural University, Dhaka, during the Rabi season (Winter-November to March) of 2010-11, 2011-12 and 2012-13.

Raising seedling

Seeds of those cultivars were collected from elite farmers of major onion growing areas, local seed markets, Bangladesh Agricultural Research Institute (BARI), Joydebpur and local seed-producing and marketing companies. Seedlings were raised in plastic trays in the net house of the university following the standard procedure (Mondal *et al*., 2011). Trays were prepared with a mixture of soil, sand and well-decomposed cow dung at a 2:1:1 ratio. The prepared soil was heaped like a square block. For sterilization, 4% formalin solution was mixed with the soil heap @ 200 ml/cft soil and covered with a polythene sheet for 48 hrs. After seven days, surface sterilized trays of 45 cm × 20 cm dimension were filled with the sterilized soil (Islam, 2005). Seeds were sown in the trays in early October every year and placed in the net house.

Land preparation

The experimental site belongs to the agroecological zone of "Madhupur Tract" (AEZ No. 28). The annual precipitation and potential evaporation of the site are 2152 mm and 1297 mm, respectively. The maximum and minimum temperature of the area is 30.34°C and 21.21°C, respectively with a mean temperature of 25.17°C. The temperature during the experimental period ranged between 12.2°C to 31.2°C. The humidity varied from 73.52% to 81.2%. The day length ranged between 10.5-11.0 hours and there was no rainfall during the experimentation. The soil of the experimental plot was clay loam with pH 5.1 and organic matter content of 1.14%.

The experimental field was well prepared for good tilth following recommended practice. The field was fertilized with Nitrogen (Urea), Phosphorus (Triple Super Phosphate-TSP), Potassium (Muriate of Potash-MP), Zinc ($ZnSO_4$) and Boron (Borax). The dosage and method of application were the same as

recommended by BARI (Mondal *et al*., 2011) and BARC (BARC, 1997).

Transplanting seedlings and intercultural operation

Forty-five-day-old seedlings were transplanted in the main field maintaining plant to plant distance of 20 cm and a line-to-line of 1 m. Before transplantation, leaf tips at a length of 5-6 cm and root tips at a length of 2 cm from the base were trimmed. Transplantation was done in the evening followed by watering. Irrigation, weeding and mulching were done whenever required.

Preparation of inoculum

The conidia suspension of *Alternaria porri* and *Stemphylium vesicarium* were prepared with sterilized water using 10 days and 30 days (respectively) old PDA culture, incubated at 22-24^{0}C under NUV light and dark cycle (12/12). The suspension was sieved through a double layered of cheese cloth to remove mycelia fragments and conidiophores. One drop of tween-20 (polyoxyethylene 20 sorbitan monolaurate) was added to the suspension to maintain uniform dispersion of conidia in suspension. The concentration of conidial suspensions were 21×10^5 per ml and 14×10^2 per ml, respectively for *Alternaria porri* and *Stemphylium vesicarium*. Inoculation

Seedlings of 2 weeks in the net house were inoculated with a mixed spore suspension of *A. porri* and *S. vasicarium*. the inoculation was done by spore suspension of *A. porri* ($21x10^5$spore/ml) and *S. vesicarium* ($14x10^2$ spore/ml) After establishment of the transplanted seedlings at 30 DAT, the inoculation by spore suspension of *A. porri* and *S. vesicarium* was done combinedly**.** Inoculation was completed in the afternoon and inoculated plants were exposed to night dew for ensuring infection.

Recording disease incidence and severity

At the age of 30 days, when visible symptoms of purple blotch complex appeared on the leaf of seedlings in the net house, disease incidence was recorded. Both incidence and severity of the disease were recorded from the fields 90 days after transplanting (DAT).

Disease incidence was expressed in percentage. The percentage was calculated using the following formula (Wheleer, 1969):

$$\text{Incidence (\% Leaf infection)} = \frac{\text{Number of infected leaves}}{\text{Total number of inspected leaves}} \times 100$$

The disease severity was indexed on a '0 - 5' scale as used by Harsfall and Barrett (1945), where, 0 = No disease visible symptoms, 1 = A few spots towards the tip covering 0.1 - 5.0% leaf/stalk area diseased, 2 = Several purple-white patches covering less 5.1 - 12.0% leaf/stalk area diseased, 3 = Several purple-white patches covering 12.1 - 25.0% leaf /stalk area diseased, 4 = Long purple-white patches covering 25.0 - 50% leaf /stalk area diseased and 5 = More than 50% leaves/ stalk area blotched and causing the breaking of leaves/stalk.

Percent disease index was computed using the following formula (Islam, 2005):

$$PDI = \frac{\text{Total sum of numerical ratings}}{\text{Total No. of observations} \times \text{highest grade in the scale}} \times 100$$

Harvesting

Onion bulbs were harvested when plants showed signs of maturity. The bulbs were carefully lifted from the soil with precaution to protect the bulb from injury. Stalks were cut off at 2 cm above the bulbs. Bulbs were dried in the sun and weight per plot was recorded. The bulb yield was converted into tons per hectare.

Experimental design, layout and data analysis

The experiments were laid out in a randomized complete block design (RCBD) with 4 replications. The unit plot size was 2 m × 1.5 m, block-to-block and plot-to-plot distance was 1 m, row-to-row spacing 25 cm and plant-to-plant was 20 cm.

Data were analyzed statistically using MSTAT-C Computer Program. Whenever necessary, data were transformed following the Arcsine transformation method. Means of treatment were compared following Duncan's Multiple Range Test (DMRT) as described by Gomez and Gomez (1983).

Results and Discussion

Disease incidence at seedling stage

In each year, the trends in the incidence of purple blotch complex on the selected cultivars of onion recorded at 30 days after sowing (DAS) in the net house were more or less similar as evidenced by closeness in values of three important descriptive statistics (mean, standard deviation and range). The mean, standard deviation and range were 10.09, 9.919 and 11.534 in 2010-11; 6.324, 7.077 and 6.238 in 2011-12, and 0.00-21.20, 0.03-25.46 and 10.00-20.87 in 2012-13, respectively (Table 1).

In 2010-11**,** disease incidence was significantly different on different cultivars. BARI Piaz-3 was free from the disease. The lowest disease incidence was found in Indian big (2.11%), which was followed by Indian small (2.57%) and BARI Piaz-2 (3.63%). The highest disease incidence (21.20%) was recorded in Taherpuri followed by Manikgonj local (18.84%), Faridpur local (14.92%), Thakurgoan local (13.42%) and BARI Piaz-1 (13.23%). The incidence was 8.47% in BARI Piaz-5 (8.47%), which was followed by Lal Teer onion (8.95%) and Indian hybrid (Table 2).

Table 1. Descriptive statistics (mean, standard deviation and range) of disease incidence in three consecutive years

Descriptive statistics	Year of study		
	2010-11	2011-12	2912-13
Mean	10.0921	9.9193	11.5343
Std. Deviation	6.32367	7.07697	6.23753
Range	0.00-21.20	0.03-25.46	10.00-20.87

Table 2. Incidence of purple blotch complex on fourteen cultivars of onion at the age of 30 days in the net house for three successive years (2010-11, 2011-12, 2012-13)

Onion cultivars	Disease incidence at 30 DAS		
	2010-11	2011-12	2012-13
BARI Piaz-1	13.23 d	11.08 e	14.53 d
BARI Piaz-2	3.63 i	2.78 i	5.64 h
BARI Piaz-3	0.00 k	0.03 k	0.10 k
BARI Piaz-4	12.52 e	11.10 e	14.57 d
BARI Piaz-5	8.47 h	7.31 h	10.31 g
Taherpuri	21.20 a	25.46 a	20.87 a
Indian hybrid	9.94 g	9.69 f	11.46 f
Lal Teer onion seed	8.95 h	8.68 g	10.45 g
Masud onion seed	11.49 f	10.76 e	13.30 e
Thakurgoan local	13.42 d	12.96 d	14.62 d
Faridpur local	14.92 c	15.38 c	17.32 c
Manikgong local	18.84 b	19.35 b	20.17 b
Indian big	2.11 j	1.95 j	3.79 j
Indian small	2.57 j	2.34 j	4.35 i
LSD (0.01)	0.68	0.70	0.47
CV (%)	3.55%	3.60%	2.53%

Note: Values within the column with the same letter (s) do not differ significantly (p=0.01).

In 2011-12, the lowest disease incidence was recorded in BARI Piaz-3 (0.03%) followed by Indian big (1.95%), Indian small (2.34%) and BARI Piaz-2 (2.78%). The highest disease incidence of 25.46% was recorded in Taherpuri followed by Manikgonj local (19.35%), Faridpur local (15.38%) and Thakurgoan local (12.96%). A moderate incidence was recorded in BARI Piaz-5 (7.31%) followed by Lal Teer onion (8.68%) and Indian hybrid (Table 2).

In 2012-13, the disease incidence was the minimum in BARI Piaz-3 (0.10%) followed by Indian big (3.79%), Indian small (4.35%), and BARI Piaz-2 (5.64%). The maximum disease incidence was recorded from Taherpuri (20.87%) followed by Manikgonj local (20.17%), Faridpur local (17.32%) and Thakurgoan local (Table 2).

Disease incidence in the field

During 2010-11, differences in disease incidence in the field on different cultivars were significant at a 1% level of significance**.** The lowest percent of leaf infection was recorded in BARI Piaz-3 (36.13%), which was statically similar to Indian small (36.52%). The incidence was 41.10, 43.95, 44.34, 45.97% in Indian big, BARI Piaz-2, Indian hybrid and Lal Teer onion. The highest disease incidence was recorded in Thakurgoan local (98.50%) which was statically similar to Manikgonj local (98.25%) and Faridpur local (98.22%) and Taherpuri (Table 3).

Table 3. Disease incidence of purple blotch complex on different onion cultivars at 90 DAT under the field conditions during three consecutive years

Treatments (Onion cultivars)		Disease incidence at 90 DAT		
		2010-11	2011-12	2012-13
T_1	BARI Piaz-1	92.11 bc	89.58 bc	92.85 b
T_2	BARI Piaz-2	43.95 e	41.49 efg	44.01 de
T_3	BARI Piaz-3	36.13 g	34.45 h	36.33 g
T_4	BARI Piaz-4	91.33 bc	90.33 b	93.06 b
T_5	BARI Piaz-5	55.61 d	53.94 d	55.84 c
T_6	Taherpuri	95.16 ab	91.23 ab	98.73 a
T_7	Indian hybrid	44.34 e	43.21 ef	44.70 de
T_8	Lal Teer onion	45.97 e	44.54 e	47.27 d
T_9	Masud onion seed	87.94 c	85.72 c	88.99 b
T_{10}	Thakurgoan local	98.50 a	93.73 ab	98.75 a
T_{11}	Faridpur local	98.22 a	95.20 a	98.63 a
T_{12}	Manikgong local	98.25 a	95.35 a	98.25 a
T_{13}	Indian big	41.10 ef	39.26 fg	42.69 ef
T_{14}	Indian small	36.52 fg	37.30 gh	38.74 fg
LSD (0.01)		4.60	4.10	4.14
CV (%)		3.48%	3.20%	3.10%

Note: Values within the column with the same with a common letter (s) do not differ significantly (p=0.01).

In the year 2011-12, the onion cultivars showed significant differences in disease incidence. The lowest incidence was recorded from BARI Piaz-3 (34.45%) followed by Indian small (37.30%), Indian big (39.26%) and BARI Piaz-2 (41.49%). The highest percent leaf infection was recorded in cultivar Manikgonj local (95.35%), which was statically similar to Faridpur local (95.20%), Thakurgoan local (93.73%) and Taherpuri (91.23%). The moderate leaf infection with purple blotch complex was recorded in Lal Teer onion (44.54%) followed by BARI Piaz-5 (Table 3).

In the year 2012-13, the differences in disease incidence were also significant. The lowest percent leaf infection with purple blotch complex was recorded in BARI Piaz-3 (36.33%), which was statically similar to Indian small (38.74%). The moderate leaf infection with purple blotch complex was recorded in Indian big (42.69%) followed by BARI Piaz-2 (44.01%) and Indian hybrid (44.70%). The highest leaf infection was noted in Thakurgoan local (98.75%), which was statically similar to Taherpuri (98.73%), Faridpur local (98.63%), and Manikgonj local (Table 3).

Disease severity (PDI) on onion cultivars

During 2010-11, disease severity (PDI) on fourteen onion cultivars at 90 DAT under field conditions was significantly different with few exceptions. The lowest PDI was recorded in BARI Piaz-3 (9.56%) followed

by Indian small (10.88%) and Indian big (13.43%). Moderate severity was recorded in BARI Piaz-2 (21.67%) followed by Indian hybrid (27.06%) and Taherpuri (27.20%). The highest PDI was recorded in Manikgonj local (38.81%) and Masud onion (38.07%) followed by Thakurgoan local (37.20%), Lal Teer onion (35.82%). and Faridpur local (Table 4).

In 2011-12, the lowest PDI was recorded in BARI Piaz-3 (5.75%) followed by Indian big (11.18 %) and Indian small (11.20 %). Higher PDI was recorded in Masud onion (37.15 %), Manikgonj local (36.81 %) and Thakurgoan local (35.95%) but these were statistically similar. Moderate severity was recorded in BARI Piaz-2 (Table 4).

In the third year (2012-13), the lowest PDI of 12.01% was found in BARI Piaz-3, which was followed by Indian small (10.78%), Indian big (16,03), and Indian big (17.06). The highest PDI was recorded from Manikgonj local (43.4), which was statistically similar to Lal Teer onion (41.23) but significantly higher compared to other cultivars. Moderate severity of 22.96% was found in BARI Piaz-2 (Table 4).

Yield performance of onion cultivars as affected by leaf blotch complex

During 2010-11, the highest bulb yield was recorded from cultivar BARI Piaz-3 (11.98 t/ha) followed by BARI Piaz-4 (8.83 t/ha), Indian small (9.82 t/ha) and Indian big (9.81 t/ha). The yield was 9.15 t/ha and 9.82 t/ha

Table 4. Severity (PDI) of purple blotch complex on onion cultivars under field conditions in three consecutive years from 2010-11 to 2012-13

Onion cultivars	Disease severity PDI at 90 days after transplanting		
	2010-11	2011-12	2012-13
BARI Piaz-1	29.24 e	25.51 cd	31.05 d
BARI Piaz-2	21.67 h	15.43 f	22.96 e
BARI Piaz-3	9.56 j	5.75 h	12.01 g
BARI Piaz-4	28.30 ef	24.62 cd	30.08 d
BARI Piaz-5	25.72 g	19.97 e	28.46 d
Taherpuri	27.20 fg	22.70 de	29.04 d
Indian hybrid	27.06 fg	22.81 de	29.32 d
Lal teer onion	38.07 ab	37.15 a	41.23 ab
Masud onion seed	35.82 c	29.82 b	38.18 bc
Thakurgoan local	37.20 bc	35.95 a	38.39 bc
Faridpur local	33.97 d	26.89 bc	35.35 c
Manikgong local	38.81 a	36.81 a	43.47 a
Indian big	13.43 i	11.18 g	17.06 f
Indian small	12.88 i	11.20 g	16.03 f
LSD (0.01)	1.51	3.57	4.00
CV (%)	2.93	8.08	7.16

Note: Values within the same column with a common letter (s) do not differ significantly (p=0.01).

in cultivars BARI Piaz-2 and BARI Piaz-5, respectively which were statically similar. The lowest yield (4.27 t/ha) was recorded from Manikgonj local, which was statically similar to Thakurgoan local (3.41 t/ha), Faridpur local (3.49 t/ha) and Lal Teer onion (Table 5).

In 2011-12, the maximum yield was obtained from BARI Piaz-3 (13.89 t/ha) followed by BARI Piaz-2 (10.79 t/ha), BARI Piaz-5 (10.75 t/ha), Indian big (10.60 t/ha), Indian small (10.30 t/ha), BARI Piaz-4 (10.20 t/ha), BARI Piaz-1 (8.99 t/ha), Indian hybrid (8.43 t/ha) and Lal Teer onion (4.95 t/ha). The lowest yield (4.50 t/ha) was recorded from Manikgonj local which was statically similar to Faridpur local (4.70 t/ha), Taherpuri (8.23 t/ha), Masud onion (5.51 t/ha) and Thakurgoan local (5.72 t/ha) (Table 5).

During 2012-13, significantly the highest bulb yield was recorded from BARI Piaz-3 (10.97 t/ha), The second highest yield was found in Indian big (8.87 t/ha), which was statistically similar to Indian small (8.41 t/ha), BARI Piaz-5 (7.90 t/ha), BARI Piaz-4 (7.79 t/ha), BARI Piaz-2 (7.28 t/ha) and BARI Piaz-1 (7.25 t/ha), The lowest yield (3.78 t/ha) was recorded from Manikgonj local which was statically similar to Faridpur local (4.09 t/ha), Thakurgoan local (4.30 t/ha), Indian hybrid (4.74 t/ha), Masud onion (4.91 t/ha), Lal Teer onion (5.07 t/ha) and Taherpuri (Table 5).

Table 5. Yield performance of different onion cultivars as affected by purple blotch complex during three consecutive years

Onion cultivars		Bulb yield (t/ha)		
		2010-11	2011-12	2012-13
T_1	BARI Piaz-1	7.47 d	8.99 b	7.25 b
T_2	BARI Piaz-2	9.15 c	10.79 b	7.28 b
T_3	BARI Piaz-3	11.98 a	13.89 a	10.97 a
T_4	BARI Piaz-4	10.76 b	10.20 b	7.79 b
T_5	BARI Piaz-5	9.82 c	10.75 b	7.90 b
T_6	Taherpuri	6.82 d	8.23 b	5.07 c
T_7	Indian hybrid	7.25 d	8.43 b	4.74 c
T_8	Lal Teer onion seed	4.51 e	4.95 c	5.07 c
T_9	Masud onion seed	6.82 d	5.41 c	4.91 c
T_{10}	Thakurgoan local	4.41 e	5.72 c	4.30 c
T_{11}	Faridpur local	4.48 e	4.70 c	4.09 c
T_{12}	Manikgong local	4.27 e	4.50 c	3.78 c
T_{13}	Indian big	9.81 bc	10.60 b	8.87 b
T_{14}	Indian small	9.82 bc	10.30 b	8.41 b
LSD (0.01)		0.92	2.36	1.90
CV (%)		6.43 %	14.69 %	15.54

Note: Values within the same column with a common letter (s) do not differ significantly (p=0.01).

In general, the lowest incidence and severity of purple blotch complex appeared in three consecutive years on BARI Piaz-3, both in net house and field. This cultivar is noted as maximum tolerant to the disease. Cultivars Indian big and BARI Piaz-2 were moderately tolerant to the disease. The local onion varieties were comparatively low tolerance or susceptible to the disease. The findings of the present experiment are in agreement with the findings of Kibria (2010) and Das (2010). Kibria (2010) reported that no disease incidence of purple blotch of onion caused by *A. porri* was noticed in BARI Piaz-3 at the seedling stage in the nursery bed. In his study, this variety recorded only 8% disease severity of purple blotch and was graded as resistant. Das (2010) also submit a similar report while he studied the resistant reaction of onion cultivars against *S. vesicarium* causing white blotch of onion. He reported that the incidence of white blotch was noticed in BARI Piaz-3, Indian big and Indian small. In a screening test with 8 onion cultivars against purple blotch, Bhonde *et al*. (1992) found that Light red cultivars gave good yield and showed the lowest incidence and severity of purple blotch disease incidence and severity. Almost every year, the highest yield was obtained from BARI Piaz-3 followed by Indian big and BARI Piaz-2. The lowest yield was recorded from local cultivars, Thakurgoan local, Manikgonj local, Faridpur local and Lal Teer onion seed. Disease incidence, severity and yield were 54.45-36.33%, 5.75-12.01% and 10.97-13.89 in BARI Piaz-3; 41.49, 44.01 and 7.28-10.79 in BARI Piaz-2; and 36.52-58.79, 15.43-22.96 and 8.41-10.60 in Indian big, respectively. These cultivars may be recommended for the extension.

Conclusion

Among fourteen onion cultivars tested, BARI Piaz-3 showed the lowest disease incidence and severity and the maximum tolerance to purple blotch complex. Other than Piaz-3, low disease incidence was found in Indian big, BARI Piaz-2, and Indian small. The highest disease incidence was observed in cultivars Taherpuri, Manikgonj local, Faridpur local, Thakurgoan local and in BARI Piaz-1 in the three successive years. BARI Piaz-5, Lal teer onion and Indian hybrid showed moderate

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