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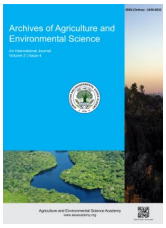

ORIGINAL RESEARCH ARTICLE

Growth and yield performance of okra genotypes in acidic soil at Sylhet Region, Bangladesh

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ABSTRACT

A field experiment was conducted at the field laboratory of Department of Crop Botany and Tea Production Technology, Sylhet Agricultural University from August 2016 to January 2017 to select the best suited okra genotype(s) considering growth and yield performance among eleven genotypes *viz.* BARI Dherosh−1 (control) and 10 exotic (Japanese okra) cultivable in acidic soil conditions. All okra genotypes were evaluated in relation to morphological characteristics and yield performance at defined area of study. The treatment combinations were laid out in a Randomized Complete Block Design (RCBD) with three replications. In almost all parameters, significant variations were observed. Experimental findings revealed that BARI Dherosh−1, JO−2, JO−6 and JO−10 showed excellent performance in germination capacity. The high yielding genotype BARI Dherosh−1 exhibited taller plant at final harvest. Early flowers, individual fruit weight with maximum number of flowers and fruits plant^{-1} was observed in JO−6. The genotype JO−3 produced the highest number of branches, internodes and leaves at final harvest. The flowering duration was long in the genotype JO−2. The highest fruit setting (%) was observed in JO−1. The longest fruit length and the lowest number of aborted fruits were observed in JO−5 whereas BARI Dherosh−1 showed the largest fruit diameter at 9 DAF and heaviest hundred seed weight. The highest fruit fresh weight observed in JO−4 and the highest fruit dry weight observed in JO−5 at 9 DAF. Regarding fruit yield, the genotype JO−6, JO−10 and JO−3 performed better. The genotypes JO−6 and JO−10 were found to be promising genotypes in acid soil considering the morphological features and yield attributes. Since the variety of our research is suitable for Sylhet region acid soil, if our variety is combine with Sylhet's cropping pattern cropping intensity will be increase, which will benefit the farmer financially and meet the nutritional needs.

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INTRODUCTION

Okra (*Abelmoschus esculentus* L.) is an important and extensively cultivated under rainfed or in a irrigated conditions in a wide variety of soils, annual crop in both the tropical and sub-tropical provinces of the world (Petropoulos *et al.*, 2018; Eshiet and Brisibe, 2015; Ali *et al.*, 2014). It is widely grown during summer and rainy seasons for its tender green fruits and considered as one of the popular vegetables in Bangladesh (Sinnadurai, 1992). Okra is an annual herbaceous crop belonging to the family Malvaceae that is grown for its tender fruits consumed as vegetable (Chattopadhyay *et al.*, 2001) and other meal. Fresh okra fruit contains 35 calories, 89.6 g water, 6.4 g carbohydrate, 1.9 g protein, 0.2 g fat, 1.2 g fiber and minerals per 100 g of edible portion (Gopalan *et al.*, 2007). It is self-pollinated, mainly propagated by seeds with duration of 3 to 4 months (Nesru *et al.*, 2020).

Okra is a multipurpose crop and serves as a source of nutrition, bio-medicine and functional ingredient for the food and pharmaceutical industry (Kpodo *et al.*, 2019; Kumar *et al.*, 2017). Okra is said to be very useful against genito-urinary disorders, spermatorrhoea and chronic dysentery. Okra is reported to have good relieving effect in gastrointestinal ulcer by neutralizing digestive acid (Wamanada, 2007). According to (BBS, 2019), Total production of okra was about 54183 metric tons from 28647 acres of land in Bangladesh where in Sylhet region Okra production was 1446 metric tons i 907 acres of land which is very lower comparing the other developed countries. Because of importance of okra intensive research work should be done to increase the production by selecting suitable genotype(s). Sylhetregion is under the special Agro ecological Zoneof Bangladesh (AEZ-20: Eastern SurmaKushiyara Flood plain) due to its soil quality like acidity. Soil pH of the experimental site ranges from 4.5 to 6.5. The total production of okra in Sylhet District is only about 1904 metric tons (Anonymous, 2012) from 272 ha of land. The production is not enough to meet up the demand and some well suited genotypes need to be selected for this region to increase the production. So the present research work was conducted to evaluate the performance of genotypes based on growth and yield attributes of okra to select suitable one(s) from all genotypes under experiment.

MATERIALS AND METHODS

The study was conducted at the field laboratory of Department of Crop Botany and Tea Production Technology, Sylhet Agricultural University during the period from August 2016 to January 2017 belongs to the AEZ-20: Eastern Surma Kushiyara Floodplain where soil is clay loam type with characterized by acidic (pH 4.83) in nature. Heavy rainfall and high temperature in Kharif season with profound sunshine and cloudy weather remains in Sylhet region which make this part different from other parts of Bangladesh. Eleven genotypes were used as experimental materialsof which 10 advanced genotypes *viz.*, JO−1 (JO stands for Japanese Okra), JO−2, JO−3, JO−4, JO−5, JO−6, JO−7, JO−8, JO−9, JO−10 and other is BARI Dherosh−1 (control). Japanese genotypes of Okra collected from Japan and BARI Dherosh−1 was collected from the Horticultural Research Centre (HRC) of Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The experimental field was divided in 3 blocks representing 3 replications and each block had 11 individual plots. Treatments were randomly allotted in each block. The total numbers of plot were 33. The size of the plot was 2.3 m × 1.2 m. The adjacent blocks and neighboring plots were separated by 0.70 m and 0.50 m, respectively. Okra seeds were sown in lines with a spacing of 0.50 m × 0.40 m for row to row and plant to plant, respectively. There were three rows in a plot having 3 plants in each row. Hence, the total number of plants in a plot was 9. Cowdung, urea, triple super phosphate, muriate of potash were applied to the plots for okra cultivation at the rate of 3000, 150, 100 and 150 kg ha-1 respectively (BARC, 2012). Total amount of cowdung, triple super phosphate, muriate of potash and one third of urea were applied as basal dose during the final land preparation. Remaining urea was applied in two installments as top dressing at 25 days after sowing (DAS) and 40 DAS (days after sowing). Seeds were sown in the respective plot on August 21, 2016 in the rows with spacing of 0.50 m × 0.40 m. The seeds were soaked overnight in the water prior to sowing. Two to three seeds were sown in each pit. Then the seeds were covered with loose soil by hand. Seven days after germination, the weaker seedlings were removed keeping the healthier one in each pit to grow properly. Simultaneously any damage or dead seedlings were replaced by healthy seedling. Weeding was done manually from 15 DAS up to final harvest. Weeding was done 6 times to keep the plots free from weeds and the soil was mulched by breaking the soil crust for easy aeration and conservation of soil moisture. The plots were watered during the growth season to keep the field moist for better growth and development of plant. Six Okra plants from each plot were selected randomly for collecting data. The plants of the outer rows and the extreme end of the middle rows were excluded from data collection. The data collection on morphological growth parameters was started at 20 DAS and continued with an interval of 20 days until final harvest. Data on the morphological parameters [Seed germination (%), Plant height (cm), Number of branches, Number of leaves, Number of internodes] and yield parameters [Number of days to first flowering, Flowering duration, Total number of flowers plant^{-1}, Aborted fruits plant^{-1}, Number of fruits plant^{-1},Fruit setting (%), Fruit length (cm), Fruit diameter (mm), individual fruit weight (g), Fruit fresh weight (g), Fruit dry weight (g), Hundred seed weight (g), Fruit yield (t ha^{-1})] were collected from the selected plants during experimental period. The data were subjected to analysis of variance using the MSTAT-C (Russell, 1986) software and the means were separated according to Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Morphological characters of different genotypes

Germination percentage (%): Genotypes showed significance variation in terms of seed germination among the eleven genotypes ranged from (62.96%−96.30%) perhaps due to their inherent characters like seed weight, seed dormancy, seed size, soil effect, climatic factor etc (Figure 1). Germination percentage of BARI Dherosh−1, JO−2, JO−6 and JO−10 were statistically identical followed by JO−4 (92.59%) and JO-1 (92.48%). The lowest of emerged seedlings was percentage found in JO−9 (62.96%). Gentypes JO−8 (85.19%), JO−5 (81.48%), JO−7 (81.48%) and JO−3 (74.08%) showed intermediate performance. Genotypes BARI Dherosh−1, JO−2, JO−6 and JO−10 might have higher seed viability and seed vigor and suitable for the acid soil. (Bhatt and Rao, 1980) found considerable variation in germination influenced by the genotypes of Okra. (Saha, 2013) also showed the similar result in plant height at final harvest ranged from 44.4 to 97.45 % among 8 cultivars of Okra. (Shawon, 2015) observed the result in germination percentage from 68.33 to 87.42 % among eleven genotypes of okra (Figure 1).

Table 1. Effect of genotypes on plant height of okra at different ages (DAS).

Genotypes	Plant height (cm) at different ages (DAS)							
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	Final harvest
BARI Dherosh-1	11.10 bc	29.93 a	41.20 a	98.60 a	132.2 a	160.0 a	171.2 a	173.1 a
JO-1	8.96 de	16.83 d	31.47 b	41.17 ef	58.27 e	64.40 g	64.43 f	77.07 g
JO-2	11.57 abc	13.80 e	24.87 c	44.10 de	45.70 f	57.80 h	63.37 f	71.07 h
JO-3	7.63ef	12.53 e	22.00 cd	47.03 cd	64.80 de	85.30 d	93.53 d	104.5 d
JO-4	10.47 cd	17.23 cd	23.80 cd	39.70 efg	58.87 e	71.07 f	91.20 d	100.5 d
JO-5	10.57 cd	12.93 e	27.30 bc	86.97 b	115.2 b	125.2 b	149.8 b	152.4 b
JO-6	12.60 ab	17.80 bcd	27.13 bc	49.50 c	67.60 d	82.13 de	92.53 d	92.10 e
JO-7	12.93 a	18.77 b	26.37 c	35.80 g	65.63 d	71.80 f	79.83 e	83.93 f
JO-8	11.63 abc	18.37 bc	24.03 cd	38.37 fg	78.47 c	103.4 c	108.5 c	115.1 c
JO-9	6.20 f	12.50 e	19.47 d	43.47 de	66.27 d	71.47 f	77.43 e	82.63 f
JO-10	6.46 f	12.83 e	23.07 cd	40.50 efg	70.50 d	79.60 e	88.50 d	94.20 e
CV (%)	9.00	4.97	10.39	5.16	4.98	2.45	3.38	2.35
Level of significance	**	**	**	**	**	**	**	**

Mean(s) within a column bearing similar letter(s) are statistically similar; ** indicate significant at 1% level of probability.

Table 2. Effect of genotypes on leaf number plant^{-1} at different ages (DAS) and morphological characters of okra.

Genotype	Number of leaves plant^{-1} at different ages								Number of internodes plant^{-1}	Number of branches plant^{-1}
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	Final harvest		
BARI Dherosh-1	4.63 cd	12.33 a	14.27 ef	22.18 d	33.03 c	52.40 d	63.47 d	32.00 c	18.54 b	3.85 b
JO-1	5.76 ab	11.13 b	17.20 b	24.07 c	32.63 cd	55.47 bc	64.60 c	31.72 c	16.99 c	3.16 de
JO-2	5.16 bc	10.93 b	13.67 fg	27.93 b	35.63 b	53.17 cd	65.33 b	29.36 d	16.04 c	3.55 c
JO-3	4.66 cd	8.50 def	16.97 b	33.67 a	41.63 a	63.43 a	72.27 a	35.45 a	20.94 a	4.26 a
JO-4	4.50 cd	7.70 ef	13.07 g	21.53 d	31.57 de	44.43 ef	57.60 i	26.49 f	18.11 b	3.10 de
JO-5	5.33 abc	7.56 f	14.77 de	22.47 cd	32.20 cde	42.87 f	62.20 f	25.66 g	16.30 c	4.11 ab
JO-6	5.33 abc	8.40 ef	17.50 b	23.33 cd	28.37 g	39.57 g	53.23 j	20.24 i	16.88 c	3.92 b
JO-7	6.16 a	8.873 de	17.50 b	24.20 c	33.17 c	53.70 cd	60.43 g	27.76 e	18.66 b	2.98 e
JO-8	6.26 a	10.10 b	15.47 cd	23.17 cd	31.27 e	44.67 ef	59.33 h	29.83 d	17.09 c	2.33 f
JO-9	3.83 d	10.87 b	14.33 ef	23.00 cd	29.83 f	46.60 e	53.33 j	22.36 h	16.13 c	2.41 f
JO-10	3.90 d	9.56 cd	15.87 c	22.13 d	33.07 c	57.10 b	62.80 e	32.90 b	15.04 d	3.29 cd
CV (%)	10.29	6.47	3.16	4.06	1.85	2.69	0.18	1.30	2.47	3.50
Level of significance	**	**	**	**	**	**	**	**	**	**

Mean(s) within a column bearing similar letter(s) are statistically similar; ** indicate significant at 1% level of probability.

Plant height (cm): Significant variations on plant height were found among different genotypes (Table 1). Plant height increased in all the genotypes with the advancement of plant ages. The rate of plant height increment was rapid up to 60 DAS and then increased slowly. At final harvest, the highest plant height found BARI Dherosh−1 (173.1 cm) followed by JO−5 (152.4 cm). The lowest height was found in JO−2 (71.07 cm). (Saifullah and Rabbani, 2009) presented the resembling variation in plant height at final harvest ranged from 81.80 to 196.17 cm among 121 genotypes of Okra. (Saha, 2013) find out significant variation among eight cultivars of Okra ranges between 75.50 and 137.9 cm at final stage. (Shawon, 2015) find out significant variation among eight cultivars of Okra ranges between 77.53 and 137.6 cm at final stage (Table 1).

Number of leaves plant^{-1}: For all genotypes, the number of leaves increased with ages and found maximum at 105 DAS and then declined. The minimum number of leaves plant^{-1} was found in the genotype JO−9 (3.833) at 15 DAS, JO−4 (7.70) at 30 DAS, JO−2 (13.07) at 45 DAS, JO−4 (21.53) at 60 DAS (Table 2). In the present study, the higher number of leaves in JO−3 at reproductive stage helped to produce growth and yield. At the reproductive to final stage leave number of JO−10 was better so yield was high of that genotype also. (Shawon, 2015) find out significant variation among eleven cultivars of Okra 20 DAS (3.69 to 5.93), 40 DAS (6.56 to 14.80), 60 DAS (15.27 to 20.87), 80 DAS (25 to 35.07), 100 DAS (42.03 to 55.07), 120 DAS (52.37 to 63.85), 140 DAS (34.69 to 44.37) and final harvest (22.23 to 35.13).

Number of internodes plant^{-1}: The genotypes differed significantly at final harvest from one another in respect of number of internodes plant^{-1} (Table 2). The highest number of internodes were obtained from the genotype JO−3 (20.94), whereas minimum number of internodes were observed in JO−10 (15.04). The genotype JO−6 was given higher number of flowers (44.46) and fruits (27.90) plant^{-1} because of higher number of internodes similarly with JO−3. (Saha, 2013) oriented as like dissimilarity in both cases among 8 cultivars of Okra which was 13.44 to 18.78(13.44 were NO-003 genotypes and 18.78 was NO-007). (Shawon, 2015) found the significant variation of internodes ranges 14.08 to 19.19 (14.08 was China genotypes and 19.19 was BARI Dherosh-1).

Number of branches plant^{-1}: The number of branches plant^{-1} varied significantly among the genotypes (Table 2).

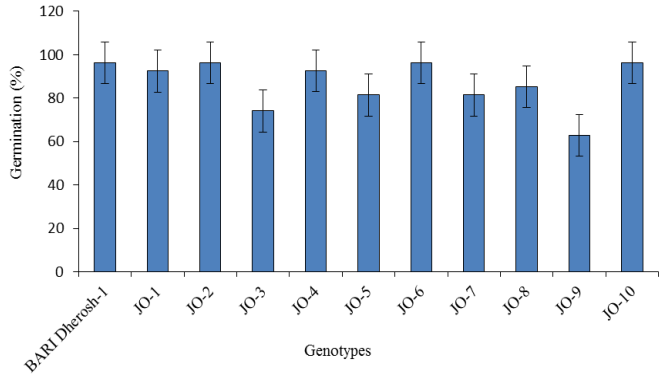

Figure 1. *Variations in germination percentage of different okra genotypes. Vertical bar represents LSD at 1% level of significance.*

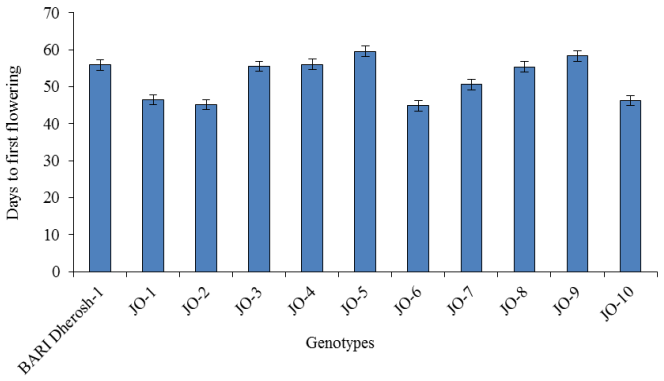

Figure 2. *Days to first flowering of different okra genotypes. Vertical bar represents lsd at 1% level of significance.*

The genotype JO−3 produced maximum branches plant^{-1} (4.263) which were statistically similar to JO−5 (4.113). JO−8 had lowest number of branches plant^{-1} (2.333) which was statistically similar to the genotypes JO−7 (2.983) and JO−9 (2.410). The result indicates that JO−3 genotype had vigorous growth habit than other genotypes. (Davinder *et al.*, 2018) found the significant variation of internodes ranges 2.00 to 5.27 (2.00 was HRB124-1-1genotypes and 5.27 was HRB143- 2-2) (Table 2).

Yield and yield contributing characters

Days to first flowering: The genotype JO−6 produced flower early (44.82 days) which was statistically similar to other genotypes (JO−2, JO−10 and JO−1). The genotype JO−5 showed delayed flowering (59.56 days) (Figure 2). In the present study, JO−6 was the early cultivar of flowering and gave long duration of flowering as a result longer reproductive time resulting high yield. The result was supported by (Saha, 2013) who reported that the first flowering ranged between 35.33 and 53.67 days among the 8 genotypes of Okra. (Saifullah and Rabbani, 2009) worked with 121 genotypes of Okra and found indicative variation in days to first flowering.

Flowering duration plant^{-1}: The highest flowering duration was found in the genotype JO−2 (67.74 days) which was statistically similar to the genotype JO−10 (67.61 days). On the opposite, the lowest flowering duration was found in the genotype BARI Dherosh−1 (47.13 days) which was similar to the genotype JO−9 (47.41 days) (Table 3). Flowering duration is an important parameter of this study. As the genotypes BARI Dherosh−1, JO−2, JO−10 showed high flowering duration resulted in the higher number of fruit and yield. The result of the present study showed similarity to (Uddin, 2013) in terms of flowering duration of Okra ranged 43.83 to 64.57 days.

Total number of flowers plant^{-1}: The highest number of flowers (44.46) was recorded in the genotype JO−6 which was similar to the genotype JO−3 (44.02) and the lowest number of flower (26.71) found in JO−8 was similar to the genotype JO−5 (27.94). On the other hand, the genotypes BARI Dherosh−1, JO−1, JO−2, JO−4, JO−7, JO−9 and JO−10 showed different number of flowers plant^{-1} (Table 3). (Shawon, 2015) observed significant variation among eleven genotypes of Okra ranged from 37.16 to 59.50.

Total number of fruits plant^{-1}: There was significant variation among the genotypes regarding the number of fruits plant^{-1} (Table 3). The greatest quantity of fruits plant^{-1} (27.90) was obtained in JO−3 followed by JO−6 (27.48). On the other hand, the least number of fruits (17.75) plant^{-1}was found in JO−7 which was significantly lower than other genotypes. The genotypes JO−4 and JO−9 showed the statistically similar number of fruits plant^{-1}. Variation in number of fruits plant^{-1}(5.30 to 33.30) was also recorded in the findings of (Saifullah and Rabbani, 2009). (Saha, 2013) spectacled 14.1 to 41.13 on the basis of total number of fruits plant^{-1}.(Shawon, 2015) found that the greatest quantity of fruits (39.11) plant-1 was obtained in Indian followed by China (38.89). On the other hand, least number of fruits (26.72) plant-1 was in JO-4 which was significantly lower than other cultivars (Table 3).

Aborted fruits plant^{-1}: The highest aborted fruits plant^{-1} was observed in JO−6 (16.97) followed by the genotype JO−3 (16.12). The lowest number of aborted fruits plant^{-1}was observed in JO−5 (8.18). In the present study, BARI Dherosh−1, JO−2, JO−6, and JO−10 showed higher number of flower aborted fruit percentage (Table 3). Stephenson (1981) reported to annual review that if plants are planted in problem soil or environment, there is always a problem with slow flower setting and even flower and fruit abortion leading to failure in production of fruits. (Saha, 2013) reported that the aborted fruit plant-1 ranged between 14.1 and 41.13. (Shawon, 2015) showed the aborted fruit plant^{-1} ranged from 10.44 to 29.55.

Fruit setting (%): The highest fruit setting was found in the genotype JO−1 (71.43%) which is statistically similar to JO−5 (71.75). The lowest number of fruit setting was observed in JO−7 (56.76) (Table 3). (Saha, 2013) reported that fruit setting ranged from 50.56 to 71.2% among the genotypes of Okra. (Shawon, 2015) reported that the highest fruit setting was found in the variety China (75.80%) which is statistically similar with Bankim (75.30%) and Orka Indian (75.00%).

Fruit length (cm): Fruit length increased gradually upto 9 days of deflowering. The longest fruit (19.23 cm) and shortest fruit

Table 3. Effects of genotypes on yield and yield contributing characters of okra.

Genotypes	Number of flowers plant^{-1}	Flowering duration	Aborted fruits plant^{-1}	Number of fruits plant^{-1}	Fruit setting (%)	Fruit length (cm)				
						5 DAF	6 DAF	7 DAF	8 DAF	9 DAF
BARI Dherosh-1	38.92 bc	47.13 e	13.35 bc	25.57 bc	25.57 bc	7.76 cd	9.56 f	12.73 c	14.67 cd	15.73 g
JO-1	30.26 ef	59.50 bc	8.65 d	21.61 d	21.61 d	7.26 g	10.23 e	12.73 c	14.13 e	17.20 d
JO-2	37.75 c	67.74 a	13.15 bc	24.62 c	24.62 c	7.43 fg	11.10 c	13.20 b	14.60 cd	16.63 e
JO-3	44.02 a	51.70 e	16.12 a	27.90 a	27.90 a	7.50ef	9.63 f	12.57 c	14.30 de	15.77 g
JO-4	34.51 d	52.78 de	11.92 c	22.68 d	22.68 d	8.36 a	11.20 bc	13.50 b	16.10 b	18.07 b
JO-5	27.94 fg	49.44 e	8.18 d	19.76 e	19.76 e	8.13 b	12.30 a	14.60 a	17.93 a	19.23 a
JO-6	44.46 a	64.03 ab	16.97 a	27.48 a	27.48 a	7.23 g	10.57 d	12.67 c	14.77 c	16.30 f
JO-7	31.27 e	53.29 de	13.40 bc	17.75 f	17.75 f	7.63 de	10.80 d	13.47 b	14.80 c	17.53 c
JO-8	26.71 g	57.78 cd	8.48 d	18.28 f	18.28 f	8.30ab	11.37 b	13.47 b	16.27 b	17.83 b
JO-9	34.42 d	47.41 e	12.33 c	22.09 d	22.09 d	7.40 fg	9.53 f	11.93 d	14.80 c	15.73 g
JO-10	41.49 ab	67.61 a	15.28 ab	26.21 b	26.21 b	7.93 c	10.30 e	12.17 d	14.80 c	16.83 e
CV (%)	3.51	4.29	8.54	3.24	3.24	1.44	1.38	1.72	1.57	1.02
Level of significance	**	**	**	**	**	**	**	**	**	**

Mean(s) within a column bearing similar letter(s) are statistically similar; ** indicate significant at 1% level of probability.

Table 4. Fruit Diameter of okra genotypes at different ages after flowering.

Genotypes	Fruit diameter (mm) at different ages				
	5 DAF	6 DAF	7 DAF	8 DAF	9 DAF
BARI Dherosh−1	12.79 e	13.79 e	16.75 f	18.49 d	23.90 a
JO−1	13.52 d	15.66 c	18.22 d	19.09 bcd	22.51 ab
JO−2	12.47 e	17.23 a	20.19 a	20.99 a	20.17 b
JO−3	14.83 b	15.83 bc	17.50 e	19.40 b	21.53 ab
JO−4	11.67 f	15.60 c	16.89 f	19.11 bc	20.46 b
JO−5	13.72 d	16.12 b	19.48 b	21.47 a	22.53 ab
JO−6	12.57 e	17.27 a	18.49 cd	18.69 cd	22.73 ab
JO−7	14.18 c	16.04 b	17.06 f	18.71 cd	19.34 b
JO−8	12.74 e	14.23 d	16.91 f	19.16 bc	20.10 b
JO−9	11.90 f	13.26 f	13.63 g	14.11 e	16.05 c
JO−10	15.44 a	17.34 a	18.77 c	19.13 bc	22.10 ab
CV (%)	1.50	1.17	1.42	1.72	8.33
Level of Significance	**	**	**	**	**

Mean(s) within a column bearing similar letter(s) are statistically similar; ** indicate significant at 1% level of probability.

(15.73 cm) found in JO−5 and JO−9, respectively at 9 DAF (Table 3 and Plate 1). Fruit length of JO−9 found similar to BARI Dherosh−1 in all harvests. In the present study, 5 DAF to 9 DAF fruit length was recorded and at 9 DAF result varied from 15.73 to 19.23 cm which was similar to the (Saifullah and Rabbani, 2009). Typical variation in fruit length among different genotypes of Okra was recorded by several researchers (Halim, 2008; Prakash *et al*., 2001), Saifullah and Rabbani, 2009). Shawon (2015) reported that the longest fruit length (12.40 cm) was noted in Durga followed by Thai (12.25) and BARI Dherosh-1 (12.18cm) and the shortest fruit length (6.59) was recorded in China.

Fruit diameter (mm): Fruit diameter increased gradually upto 9 days of flowering (Table 4). At 5 DAF, the lowest fruit diameter was obtained in JO−4 (11.67 mm) and the highest fruit diameter was in JO−10 (15.44 mm). At 9 DAF lowest fruit diameter was in JO−9 (16.05 mm) and the highest fruit diameter was in BARI Dherosh−1 (23.90 mm). Statistically similar result of fruit diameter of the genotypes JO−1, JO−5, JO−6 and JO−10 were 22.51, 22.53, 22.73 and 22.10 mm, respectively. Saifullah and Rabbani (2009) also reported the variation in fruit diameter from 1.26 to 2.12 cm. (Saha, 2013) spectacled fruit diameter between 1.20 and 1.67 cm among 8 different cultivars. (Shawon, 2015) spectacled fruit diameter between 1.21 and 1.47 cm among 11 different cultivars (Table 4).

Individual fruit weight (g): Single fruit weight differed significantly among the genotypes (Figure 3). It was ranged from 16.28 to 20.42 g. The highest fruit weight (20.42 g) was recorded in the genotype JO−6 which was statistically similar to JO−10 (20.40 g) and the lowest fruit weight was JO−9 (16.28 g). This variation in individual fruit weight may be due to the genetic potentiality of eleven Okra genotypes. In the present study, the genotypes JO-6 and JO-10 were highest fruit weight which finally responsible for the highest yield contribution. (Shawon, 2015) reported that individual fruit weight was ranged from 10.62 to 14.48 g. The highest fruit weight (14.48 g) was recorded in the cultivar JO-3 and the cheapest fruit weight (10.62 g) was found in China (Figure 3).

Fruit fresh weight of okra at different ages (g): Fresh weight of fruit differed significantly (Table 5). Fruit weight increased

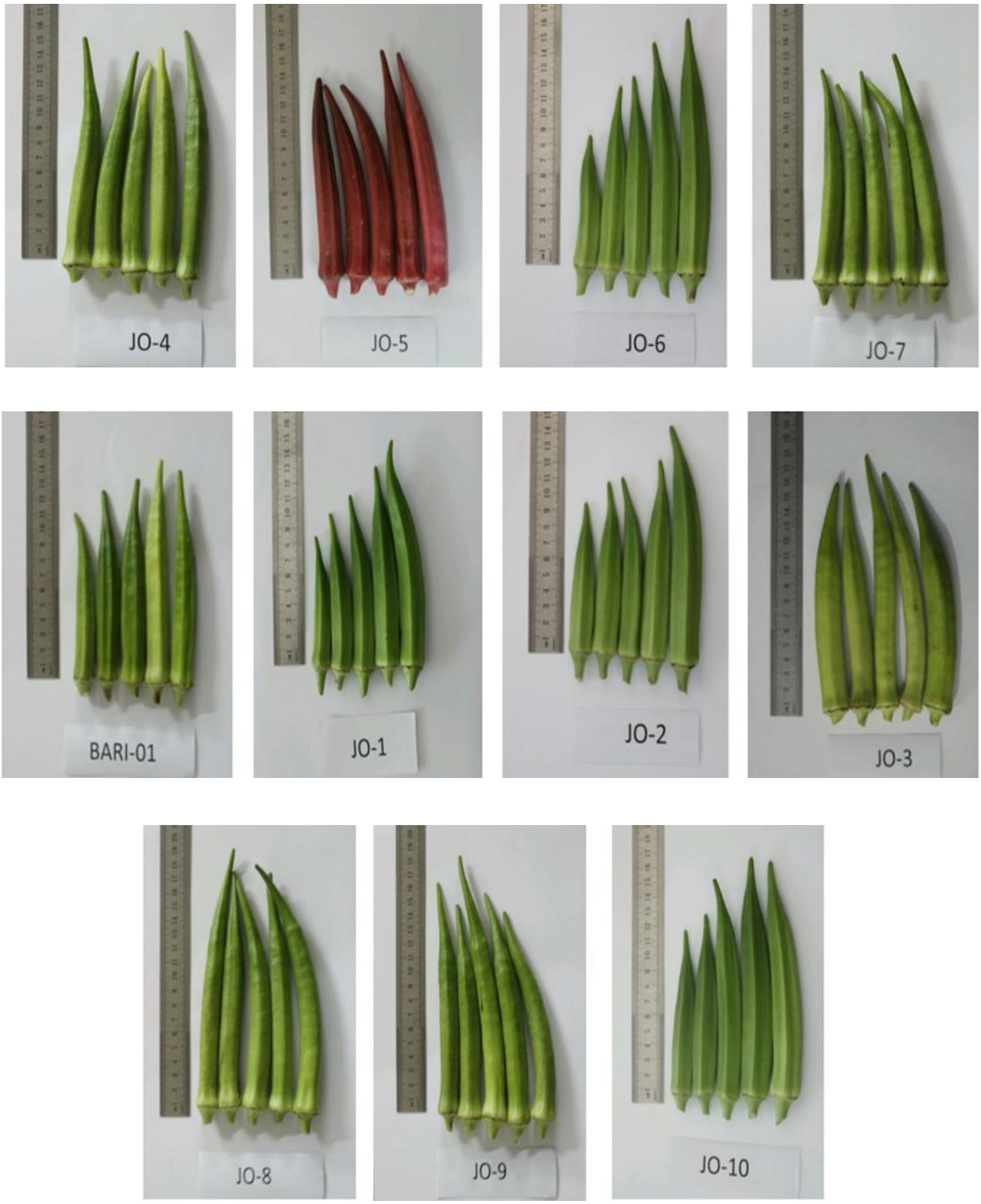

Plate 1. *Pictorial presentations of different okra genotypes during study period.*

Table 5. Fruit fresh weight of okra genotypes at different ages.

Genotypes	Fruit fresh weight of okra (g fruit^{-1}) at different ages				
	5 DAF	6 DAF	7 DAF	8 DAF	9 DAF
BARI Dherosh−1	7.11 e	10.90 efg	16.47 d	18.36 f	28.49 e
JO−1	7.63 c	11.20 ef	18.99 a	23.98 c	30.72 cd
JO−2	6.14 h	12.83 cd	19.03 a	23.70 c	30.00 d
JO−3	8.69 b	14.04 ab	17.91 bc	24.51 c	31.66 bc
JO−4	7.38 d	10.31 g	18.56 ab	28.08 a	34.45 a
JO−5	7.25 de	12.61 d	17.28 cd	26.35 b	32.55 b
JO−6	9.09 a	13.55 bc	19.33 a	20.42 e	29.94 d
JO−7	8.64 b	14.65 a	16.64 d	21.98 d	33.80 a
JO−8	6.61 f	10.46 fg	17.74 bc	27.96 a	33.81 a
JO−9	6.38 g	9.48 h	12.89 e	16.62 g	19.66 f
JO−10	6.23 h	11.52 e	16.70 d	20.40 e	28.66 e
CV (%)	1.12	3.91	3.17	3.38	1.23
Level of Significance	**	**	**	**	**

Mean(s) within a column bearing similar letter(s) are statistically similar; ** indicate significant at 1% level of probability.

Table 6. Fruit dry weight of okra genotypes at different ages.

Genotypes	Fruit dry weight of okra (g fruit^{-1}) at different ages				
	5 DAF	6 DAF	7 DAF	8 DAF	9 DAF
BARI Dherosh−1	0.77 de	1.09 e	1.73 de	2.08 d	2.70 e
JO−1	0.97 b	1.20 de	1.48ef	2.32 c	3.22 d
JO−2	0.84 cd	1.30 cd	2.03bc	2.15 d	2.83 e
JO−3	0.97 b	1.41 c	2.06bc	2.82 b	3.58 c
JO−4	0.82 cd	1.16 de	2.11 b	3.18 a	3.71bc
JO−5	0.72ef	1.23 de	1.84bcd	2.95 b	3.90 a
JO−6	0.88 c	1.20 de	1.63 de	2.15 d	2.83 e
JO−7	1.10 a	1.64 b	1.78 cd	2.21 cd	3.70bc
JO−8	0.73ef	1.96 a	2.54 a	3.32 a	3.80ab
JO−9	0.73ef	1.09e	1.45ef	1.68 e	3.09 d
JO−10	0.66 f	0.95 f	1.24 f	1.60 e	2.06 f
CV (%)	4.71	5.79	8.51	3.82	2.62
Level of Significance	**	**	**	**	**

Mean(s) within a column bearing similar letter(s) are statistically similar; ** indicate significant at 1% level of probability.

gradually with plant ages 9 DAF. The highest fruit weight was found in JO−4 (34.45 g), which was statistically similar to JO−7 (33.80 g) and JO−8 (33.81 g). The lowest fruit weight was found in JO−9 (19.66 g) (Table 5).

Fruit dry weight of okra at different ages (g): Dry weight of an individual fruit differed significantly among the genotypes (Table 6). Dry weight increased upto 9 DAF. The highest dry weight was found in JO−5 (3.903 g) followed by JO−8 (3.807 g). Dry weight of JO−4 (3.717 g) and JO−7 (3.703 g) were statistically similar. The lowest dry weight was found in JO−10 (2.06 g) (Table 6).

Hundred seed weight (g): 100 seed weight varied significantly among the genotypes (Figure 4). It was varied from 4.457 to 6.907 g. The heaviest seed weight (6.907 g) was found in the genotype BARI Dherosh−1. The lowest seed weight (4.457 g) was found in the genotype JO−10. Other genotypes showed intermediate seed weight within the range. Variation in the 100 seed weight was genetically controlled characters and may be affected by availability of food materials in the initially formed fruits. (Saha, 2013) obtained 4.77 to 6.62 g in 100 seed of okra. Similar variation observed by (Saifullah and Rabbani, 2009) where weight of 100 seeds varies from 5.50 to 8.25 g. (Shawon, 2015) found 4.59 to 6.46 g in 100 seed of okra (Figure 4).

Yield (t ha^{-1}): The yield is the result of complex interaction of the parameters like number of fruits, fruit setting (%), individual fruit weight etc. Fruit yield (t ha^{-1}) differed significantly among genotypes of Okra (Figure 5). The highest yield (18.30 t) was obtained in genotype JO−6 and the lowest yield (9.63 t ha^{-1}) was recorded in genotype JO−7. BARI Dherosh−1, JO−1, JO−2, JO−3, JO−4, JO−5, JO−8, JO−9, JO−10 response the yield 15.44, 13.36, 15.27, 16.29, 13.71, 11.13, 10.57, 11.70 and 17.41 t ha^{-1}, respectively. In the present study, it was revealed that genotypes JO−6 and JO−10 produced high yield and suitable for growing in the acid soil for higher yielding. Yield (t ha^{-1}) between 9.28 and 12.56 found in research work among 8 cultivars of Okra by (Saha, 2013). (Shawon, 2015) reported analogous variation in fruit yield the highest (17.15 t ha^{-1}) fruit obtained in cultivar JO-3 and the lowest (11.12 t ha^{-1}) fruit yield was recorded in cultivar JO-4 (Figure 5).

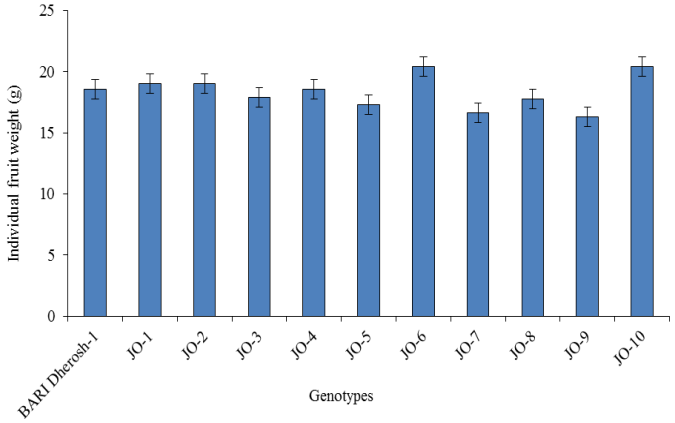

Figure 3. *Variation in individual fruit weight (g) of different okra genotypes. Vertical bar represents lsd at 1% level of significance.*

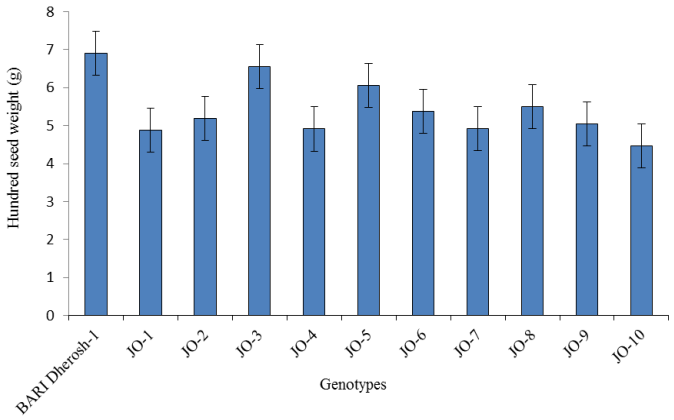

Figure 4. *Variation in hundred seed weight of different okra genotypes. Vertical bar represents lsd at 1% level of significance.*

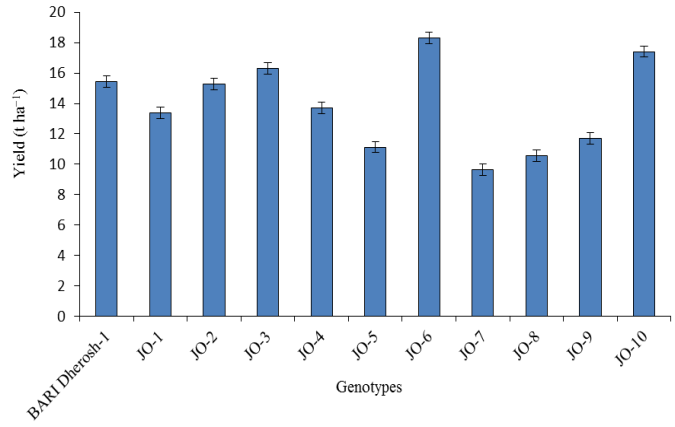

Figure 5. *Variation in yield (t ha^{-1}) of different okra genotypes. Vertical bar represents lsd at 1% level of significance.*

Conclusion

Present study revealed on the basis of morphological and yield contributing characters. There were significant differences among the cultivars. None of the cultivars explained all rounding performance in all parameters studied. Though different cultivars showed varied performances in different parameters, the investigations suggest that the genotype JO−6 and JO−10 were very promising for better yield in acidic soil conditions of Sylhet. They are well fit in a cropping pattern that would increase the cropping intensity as well as net crop in the region. The genotype JO−6 showed better performance for its yield, fruit size, shape and softness. The genotype JO−10 appears as early flowering and it was the second highest fruit yielder. Genotype JO−3 was also soft in nature and yield was also comparable. Fruits of JO−3, JO−4, JO−7, JO−8 and JO−9 were ridgeless, slender, smooth and uniform in shape and size which makes it more attractive to consumers. As JO-5 red in colour it has lycopene and anthocyanin. Lycopene is an antioxidant that has been shown to reduce heart disease risk, protect the eyes, fight infections, and protect against damage from tobacco smoke. Small sized or 2-3 days of old fruits of the cultivars JO−5 for red in color and JO−3 for softness could be used as salads.

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