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Morphological traits of exotic and local okra cultivars in piedmont soil

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Abstract
Background
Soil acidity is a severe worldwide environmental problem that adversely affects soil properties and the crop growth such as okra.An experiment was conducted in the field laboratory of Department of Crop Botany and Tea Production Technology of Sylhet Agricultural University, Sylhet from March to October 2014 with a view to selecting the superior okra cultivar in relation to growth characters in acidic soil conditions.

Materials And Methods*:*
The experiment was laidout in a Randomized Complete Block Design (RCBD) with three replications. A total of 11 cultivars (treatments) viz. BARI Dherosh-1 (control), JO-1, JO- 2, JO-3, JO-4, Orka Onamika, Bankim, Durga, Indian, China and Thai were evaluated on the basis of growth parameters.
Results*:*
Significant variations wereobserved in all the parameters. The cultivar JO-1 cultivar showed superiority in germination capacity. Results revealed that high yielding cultivar BARI Dherosh-1 was taller at final harvest. JO-3 produced higher number of branches plant^{-1}*.*
Conclusion:
Based on overall performance in morphological comparatively JO-3 proved to be promising cultivar in acid soil conditions of Sylhet.
Key Word:*Morphological traits, okra cultivar, piedmont soil*

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I. Introduction

Okra is an annual plant, mainly propagated by seeds and has duration of 90-100 days to attain maturity.Okra, also known as "lady's finger" or "bamia" is one of the popular nutritious vegetables of North-East African origin that belongs to the Malvaceae (mallows) family, and named scientifically as *Abelmoschus esculentus.* The pods are usually consumed when they are green, tender, and at immature stage. The plant is cultivated in tropical, subtropical and warm temperate regions around the world. In Bangladesh, Okra is one of the most important and popular vegetables in summer season, even also used as salads, soups and stews, fresh or dried, fried or boiled [1], [2] . Okra is a popular nutritious vegetable as it contain vitamin A, and flavonoid anti-oxidants such as beta-carotene, xanthin and lutein. In Bangladesh, vegetable production is not uniform round the year and per capita consumption is much lower than standard requirement. It is cultivated throughout Bangladesh but its average national yield is poor. According to the Bangladesh Bureau of Statistics (BBS) the total production of Okra was about 43000 metric tons produced from 26000 acres of land and the average yield of Okra was 4.1t ha^{-1} in the year 2010-2011 [3]. Sylhet is one of the special AEZs of Bangladesh due to its typical soil characters, as pH of the soil ranges from 4.5-6.5. Production of most of the crops and vegetables are limited here, due to the acidic soil condition. Moreover,adverse climatic conditions such as heavy rainfall, high humidity, seasonal flooding, fog etc. are the other barriers for the vegetable production. Acid soils possess high concentration of Al^{3+}, Fe^{3+}, Mn^{2+}, deficient in P, B and Mo and low availability of bases which together causes reduction in crop yield. Acid soils, especially the Ultisols and Oxisols usually have problems associated with aluminum toxicity, low nutrient status, nutrients imbalance and multiple nutrient deficiencies [4] . Total cultivable land in Sylhet is 1235336 ha. In Sylhet Division Okra is only cultivated in 880 ha of land of which 272 ha belongs to Sylhet District. The total production of Okra in Sylhet District is only about 1904 metric tons [5]. Low production area and lack of suitable variety has resulted in poor production of okra in the region. The

production is too low to meet up the demand and some well suited varieties could improve the situation. Okra variety is able to grow in acidic condition but need to concentrate to increase the production. In view of the above circumstances, expansion of Okra cultivation in acidic soil is necessary. Selection of suitable cultivars are essential to improve the production of Okra to fil the crisis of vegetable in summer, in the region as well as in the country. Considering the aforesaid scopes and constraints the present investigation was undertaken to evaluate potential and suitable okra cultivars having better growth and morphological features in acidic soil conditions in Sylhet region.

II. Material And Methods

Study Location:An experiment was conducted in the field laboratory of Department of Crop Botany and Tea Production Technology of Sylhet Agricultural University, Sylhetwith a view to selecting the superior okra cultivar in relation to growth characters in acidic soil conditions.

Study Duration: From March to October 2014

Experimental materials: Eleven cultivars of Okra of which 4 advanced lines collected from Japan, 4 cultivars collected from India, one collected from Thailand, one from China and a local variety BARI Dherosh-1 were used as experimental materials.

Experimental Design: The individual plot was laid out in a Randomized Complete Block Design 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.

Procedure methodology:

Okra seeds were sown in lines with a spacing of 0.50 m and 0.40 m for row to row and plant to plant, respectively. 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 w started at 20 DAS and continued with an interval of 20 days until final harvest. The total number of germinated plants per plot were counted and then the germination percentage was calculated by using the following formula-

$$\text{Germination (\%)} = \frac{\text{Number of germinated plant per plot}}{\text{Total number of seed sowing per plot}} \times 100$$

Plant height was measured using a ruler between the base of the plant and the shoot tip. The plant height was taken at 20, 40, 60, 80, 100, 120,140 DAS and at final harvesting which was around 190 DAS. The number of branches in the selected plant were counted, leaves were also counted, internodal distance (cm) was recorded and number of days to first flowering was recorded when the first flower appeared in each treatment. This is the number of days required from sowing to first flower opening.

Statistical analysis

The data were analyzed statistically using MSTAT-C [6].

III. Results And Discussion

Results showed that the eleven cultivars did not differ significantly in respect of germination percentage (Fig. 1). It varied from 87.42 to 68.33%. Germination percentage was higher in cultivar JO-1 (87.42%) and lowest was cultivar Durga (68.33%). Variation in germination among cultivars may be due to their inherent characters, seed weight, seed size etc. Germination was greatly influenced by the soil character and weather. It is the main indicators of seed viability. [7] found considerable variation in germination influenced by the cultivar of Okra.[8] observed the dissimilarity in germination due to the inherent genetic divergence among the varieties.

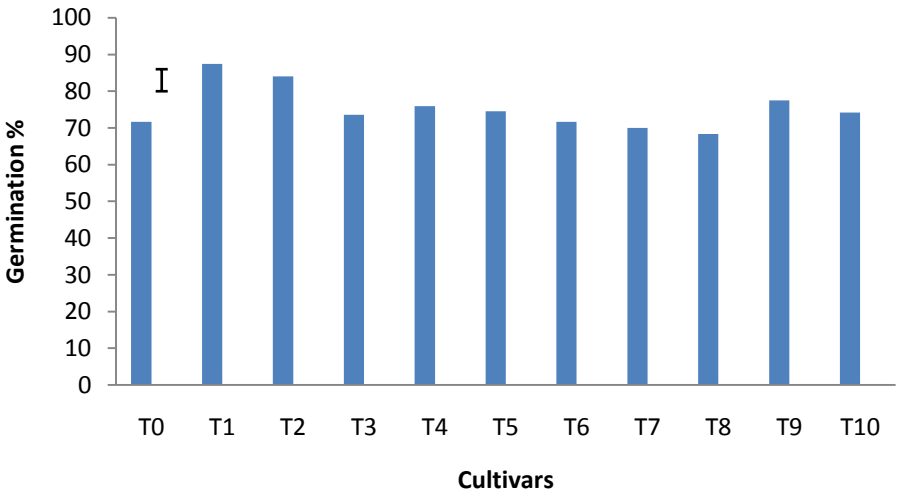

Fig 1. Variation in germination percentage of different Okra cultivars. Vertical bar represents standard error. T_0 = BARI Dherosh-1 (Control), T_1 = JO-1, T_2 = JO-2, T_3 = JO-3, T_4 = JO-4, T_5 = Indian, T_6 = Orka Onamika, T_7 = Bankim, T_8 = Durga, T_9 = China and T_{10} = Thai.

Plant height were found among different cultivars (Table 1). Plant height increased in all the cultivars with the advancement of growth. At 20 DAS plant height found lofty (10.37 cm) in cultivar Indian while at 40 DAS (32.30 cm) Durga had longest plant among the cultivars**.** During maturation viz. 60 to 140 DAS, BARI Dherosh-1 produced tallest plant than the rest of the varieties. At the final stage Bankim was tallest (139.9 cm) but BARI Dherosh-1, Orka Onamika & Durga were also statistically similar. On the other hand, in 20 DAS BARI Dherosh-1 and China and 40 DAS, JO-2 and Bankim produced shortest plants (6.067 and 12.70 cm). [9] find out significant variation among eight cultivars of Okra ranges between 75.50 and 137.9 cm at final stage. [10] also found variation in plant height among three genotypes of Okra.]8] reported that plant height unfolded significant unlikeness among seven cultivars of Okra.[11] presented the resembling variation in plant height at final harvest ranged from 81.80 to 196.17 cm among 121 genotypes of Okra which is more or less similar with our current study.

Table 1 Variation in plant height (cm) of different Okra cultivars (DAS)

Plant height (cm)

Treatment	20 DAS	40 DAS	60 DAS	80 DAS	100 DAS	120 DAS	140 DAS	Final harvest
T_0	6.06 d	20.30 bcd	47.87 a	71.87 a	113.9 a	122.8 a	131.0 a	137.6 a
T_1	9.03 ab	24.83 b	40.17 abc	60.50 abc	71.23 cde	83.80 de	90.27 ef	101.8 c
T_2	6.46 d	12.70 e	37.40 cde	61.63 abc	66.53 ef	76.86 ef	84.80 f	90.80 d
T_3	8.26 bc	16.47 de	38.50 cd	66.47 ab	76.73 b-e	86.77 cd	94.27 e	112.5 b
T_4	6.26 d	23.40 bc	39.53 bcd	58.03 abc	62.30 ef	68.63 fg	73.33 g	82.27 e
T_5	10.37 a	24.73 b	42.20 abc	64.20 abc	86.77 bc	100.4 b	118.7 c	135.3 a
T_6	6.73 cd	19.47 cd	39.70 bc	69.60 a	89.03 b	102.1 b	125.1 ab	137.1a
T_7	6.43 d	12.70 e	31.83 def	49.80 cd	69.90 de	100.2 b	121.6 bc	139.9 a
T_8	6.50 cd	32.30 a	46.73 ab	70.13 a	84.47 bcd	95.50 bc	108.5 d	114.8 b
T_9	6.06 d	19.07 cd	25.80 f	42.30 d	51.17 f	60.13 g	68.13 g	77.53 e
T_{10}	7.16 cd	13.50 e	30.27 ef	53.77 bcd	69.53 de	83.50 de	95.70 e	110.1b

T_0 = BARI Dherosh-1 (Control), T_1 = JO-1, T_2 = JO-2, T_3 = JO-3, T_4 = JO-4, T_5 =Indian, T_6 = Orka Onamika, T_7 = Bankim, T_8 = Durga, T_9 = China and T_{10} = Thai.

Like the plant height, the number of branches plant^{-1} also varied significantly among the cultivars (Table 2). The cultivar China produced maximum branches plant^{-1} at 40, 60, 80 and 100 DAS (1.93, 3.26, 5.13 and 6.33, respectively) but at 120, 140 DAS and final stage JO-3 had acute branch plant^{-1} (7.13,6.23 and 4.86 chronologically). In 40 DAS Orka Onamika had lowest number of branches plant^{-1} (0.66). The cultivar JO-2

produced lower number of branches plant^{-1} at 60, 80, & 100 DAS (1.76, 2.40 & 3.00, respectively) but rest of the period China showed the vulgar position. The result indicates that JO-3 cultivar has vigorous growth habit than other cultivars. In respect of number of branches [8], [9] and [10] also reported plant-1 similar. The results showed that no. of leaves plant^{-1} varied significantly among the cultivars at all growth stages except at 120 DAS (Table 3). For all cultivars, the number of leaves increased with the ages of plants, found maximum at 120 DAS, and then declined.

Table 2 Variation in number of branches plant^{-1} of different Okra cultivars (DAS)

	No. of branches plant^{-1}						
Treatment	40 DAS	60 DAS	80 DAS	100 DAS	120 DAS	140 DAS	Final harvest
T_0	1.33 b	2.03 bcd	2.90 cde	4.96 bcd	6.50 abc	5.00 b	3.53 bc
T_1	1.40 b	2.13 bcd	2.80 de	5.06 bcd	6.56 abc	4.70 bc	3.60 b
T_2	1.30 b	1.76 d	2.40 e	3.00 f	5.43 d	3.83 de	3.03 bcd
T_3	1.40 b	2.36 b	3.46 bc	5.20 bc	7.13 a	6.23 a	4.86 a
T_4	1.33 b	2.26 bc	4.00 b	5.70 ab	7.00 ab	5.70 a	4.40 a
T_5	1.36 b	2.30 bc	3.13 cd	4.30 de	6.30 bc	4.90 b	3.16 bcd
T_6	0.66 c	2.30 bc	3.00 cde	4.56 cde	5.80 cd	3.96 de	3.00 bcd
T_7	1.36 b	1.90 cd	2.40 e	3.86 ef	4.60 ef	3.53 de	2.90 cd
T_8	1.40 b	2.26 bc	3.26 cd	3.70 ef	4.46 ef	3.70 de	2.83 d
T_9	1.93 a	3.26 a	5.13 a	6.33 a	4.10 f	3.46 e	2.80 d
T_{10}	1.23 b	2.23 bc	2.80 de	3.86 ef	5.13 de	4.20 cd	3.20 bcd

T_0 = BARI Dherosh-1 (Control), T_1 = JO-1, T_2 = JO-2, T_3 = JO-3, T_4 = JO-4, T_5 =Indian, T_6 = Orka Onamika, T_7 = Bankim, T_8 = Durga, T_9 = China and T_{10} = Thai.

In first 80 DAS minimum no. of leaves plant^{-1} found in the cultivar Bankim whereas China (41.83) at 100 DAS and JO-2 (22.33) at final stage also notable for that they showed least no. of leaves. These differences between the cultivars depend upon inherent character of the respective cultivars. Leaf number is the most important part of field crop. It is directly related with photosynthesis which influences other morphological and physiological traits also. [12] and [9] also observed in there experiment that number of leaves differed with different cultivars. The cultivars differed significantly at 90 DAS from one another in respect of number of internodes and node to node distance (Table 4). Highest degree of internodes obtained from the cultivar BARI Dherosh-1 (19.19), whereas minimum number of internodes observed in China (14.08) which was statistically similar with the cultivars JO-2, JO-4 and Durga.

Table 3 Variation in number of leaves plant^{-1} of different Okra cultivar (DAS)

	No. of leaves plant^{-1}							
Treatment	20 DAS	40 DAS	60 DAS	80 DAS	100 DAS	120 DAS	140 DAS	Final harvest
T_0	5.40 bc	8.83 bc	19.43 abc	33.53 ab	52.57 abc	63.37 a	43.93 a	31.77 ab
T_1	5.96 ab	10.63 b	17.83 bcd	30.00 abc	53.00 ab	62.70 a	42.70 a	24.07 de
T_2	4.50 cd	7.567 cd	16.90 cd	27.27 bc	42.03 cd	53.13 a	34.70 b	22.33 e
T_3	4.86 bcd	9.967 b	21.60 a	31.67 abc	47.47 a-d	53.30 a	38.67 ab	29.17 bc
T_4	7.13 a	13.40 a	19.40 abc	29.50 abc	47.23 a-d	59.17 a	43.00 a	32.80 ab
T_5	6.03 ab	13.13 a	20.17 ab	29.40 abc	44.00 bcd	52.90 a	40.77 a	29.57 bc
T_6	5.06 bcd	10.00 b	19.70 abc	30.37 abc	46.60 a-d	58.63 a	44.00 a	35.13 a
T_7	3.96 d	6.567 d	15.27 d	25.33 c	44.00 bcd	57.07 a	42.77 a	26.77 cd
T_8	6.13 ab	14.80 a	20.87 ab	35.07 a	53.53 ab	60.80 a	44.37 a	27.50 cd

T_9	5.93 ab	14.87 a	18.67 abc	31.23 abc	41.83 d	52.37 a	40.07 ab	25.93 cde
T_{10}	5.03 bcd	9.00 bc	20.13 ab	32.73 ab	55.07 a	62.47 a	41.90 a	33.90 a

T_0 = BARI Dherosh-1 (Control), T_1 = JO-1, T_2 = JO-2, T_3 = JO-3, T_4 = JO-4, T_5 =Indian, T_6 = Orka Onamika, T_7 = Bankim, T_8 = Durga, $T_{9\,s}$= China and T_{10} = Thai.

The longest (5.52 cm) internode found in BARI Dherosh-1 cultivar and shortest internode (2.75 cm) observed in China which is statistically similar with JO-4. Number of internodes and node to node distance is an important parameter in case of Okra because every single node bears flower which produced fruits. [9] Saha (2013) oriented as like dissimilarity in both cases among 8 cultivars of Okra which was 13.44 to 18.78 and 2.73 to 5.63 in number and length, respectively.

IV. Conclusion

There were significant differences among the cultivars. None of the cultivars explained all rounding performance in all parameters studied. They are well fit in a cropping pattern that would increase the cropping intensity as well as net crop in the region. Among the eleven cultivars, the highest germination ability was found in variety JO-1 and lowest in Durga. The highest number of branches plant^{-1} obtained from the cultivars China at first half and rest half both in JO-3 and JO-4. The highest number of leaves plant^{-1} were observed in Thai, BARI Dherosh-1 and Orka Onamika, respectively at final stage. BARI Dherosh-1 represents the longest and highest number of internodes whereas the shortest and minimum number of internodes observed in cultivar China. Based on overall morphological performance, comparatively JO-3 proved to be promising cultivar in acid soil conditions of Sylhet.

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