Bangladesh J. Bot. **55**(2): 287-293, 2026 (June) DOI: .....

PERFORMANCE AND GENETIC VARIABILITY OF ONION CULTIVARS IN THE COASTAL REGION OF BANGLADESH

MD NOMUN SIDDIKE, MD SABUJ ALI, HANIA BINTA ASLAM, MD SHOHEL TANVIR, NUR MOHAMMAD, JANNATUL FERDOUSE JOTE, MD EKHLASUR RAHMAN, MD BILLAL HOSSAIN, JANNATUL NAYEM AND GAZI MD MOHSIN

Department of Agriculture, Faculty of Science, Noakhali Science and Technology University, Noakhali-3814, Bangladesh

Keywords: Onion, Salinity, Yield, Coastal region

Abstract

Evaluation of the growth and yield attributes of four onion cultivars, in the coastal area were studied. Among the evaluated cultivars, Lal Teer king demonstrated superior performance under saline conditions, recording the highest values for plant height (50.43 cm), number of leaves (10.74), leaf length (37.27 cm), bulb diameter (4.53 cm), bulb length (4.62 cm), individual bulb weight (33.58 g), yield per plot (1410.5 g), and yield per hectare (14.11 t ha^{-1}). Correlation analysis revealed positive associations among key vegetative and yield-related traits. Furthermore, the genetic parameter estimates and principal component analysis (PC1–PC3) indicated substantial genetic variability and the potential for genetic improvement. Therefore, Lal Teer king may be considered a promising cultivar for onion production and future breeding programs aimed at improving salinity tolerance in the coastal region of Bangladesh.

Introduction

Onion (*Allium cepa* L.) is a significant bulb crop cultivated worldwide (Alemu *et al*. 2022). It is usually valued for its biochemical capacity to enhance the flavor of a wide range of foods (Loredana *et al.* 2019). Onion contains vitamins 'B' and 'C', as well as minerals (Kefelegn 2020). Besides, it has many medicinal values that are used to reduce the danger of cancer, cardiovascular diseases, and diabetes (Hassan *et al*. 2014).

One of the major constraints of onion production is soil salinity, particularly in coastal regions Saline soils typically have lower fertility levels, including reduced amounts of organic matter, nitrogen, zinc, and copper (Trina *et al.* 2021) leading to negative effects on crop quality, production, and growth (Rahaman *et al.* 2023, Ali *et al*. 2023, Khatun *et al.* 2023).

Salinity is a major constraint limiting onion production in the coastal region of Bangladesh, resulting in poor growth and reduced yield. Cultivar performance under saline conditions varies due to genetic differences and genotype-environment interactions, making varietal selection essential for stable onion production. The identification of high-yielding and salinity-tolerant cultivars adapted to coastal conditions is therefore important for improving productivity. Moreover, the assessment of genetic variability among cultivars can provide valuable information for selection and future breeding programs. Although varietal evaluations of onion have been reported previously (Alam *et al*. 2023, Chowdhury 2019), limited attention has been given to the performance and genetic variability of locally available cultivars under coastal saline conditions. Therefore, the present study was conducted to evaluate the performance and genetic variability of onion cultivars for suitability in the coastal region of Bangladesh.

*Author for correspondence: <sabuj1412@student.nstu.edu.bd>.

Materials and Methods

The field experiment with four cultivars was carried out during the rabi season from November 2021 to March 2022 at Subarnachar, Noakhali, Bangladesh. The soil was sandy loam with pH 7.5 and soil salinity of 4.51 dSm^{-1}. Four onion cultivars namely, Lal Teer king, Lal Teer hybrid, Lal Teer 20 and Taherpuri were used as a research material to evaluate their growth and yield performance under saline conditions.

The cultivars were evaluated in a Randomized Complete Block Design (RCBD) with three replications. Each replication was further divided into four plots. The distance between blocks and between plots was 0.5m × 0.5m. Seeds of the different cultivars were sown on a seed bed to grow seedlings. After 40 days the seedlings were then transplanted into the well-prepared field. Fertilizers were applied according to the guidelines from the Bangladesh Agricultural Research Institute (BARI) handbook. Weeding and irrigation were done as per requirement of the plant throughout the experiment. Applications of imidacloprid for insect and mancozeb for fungus management were done. Onions were ready for harvest after 70 days of transplanting. Data were collected from nine randomly selected plants from each plot to observe plant height, number of leaves, leaf length, bulb diameter, bulb length, individual bulb weight, yield per plot, and yield per hectare. The data were analyzed statistically by using Minitab 17. Analysis of variance of different parameters was performed by the "F" test. The least significant difference (LSD) test was used to determine the significance of the difference between two means at the 1% probability level. Correlation coefficient, and multivariate analysis, i.e., Principal Component Analysis (PCA) Minitab 19 statistical software package (Minitab Inc., State College, PA, USA). Genetic advance as percent of mean was calculated following the formula proposed by Comstock and Robinson (1952).

Results and Discussion

Plant height showed a significant variability ($p < 0.01$) among the four studied onion cultivars (Table 1). The plant height ranged from 41.67 to 50.43 cm. The maximum plant height was obtained in Lal Teer king (50.43 cm), followed by Lal Teer Hybrid (47.24 cm). A significant variation was observed with respect to leaves number per plant ($p < 0.01$). The leaves count ranged from 8.23 to 10.74 per plant (Table 1). The maximum number was noted in Lal Teer king (10.74) whereas minimum from Taherpuri (8.23). The presented data on Table 1, reflected a considerable variation ($p < 0.01$) in leaf length within the cultivars. The leaf length ranged from 31.01 to 37.27 cm. Lal Teer king showed the highest leaf length (37.27 cm) compared to the other cultivars. These differences indicate superior vegetative vigor of Lal Teer king under saline conditions. Enhanced vegetative growth under stress may be attributed to better osmotic adjustment, efficient water uptake, and maintenance of cell turgor, which are critical physiological traits for salinity tolerance. Similar variations in plant height and leaf traits have been reported by Ibrahim (2010), while Tesfay *et al.* (2011) emphasized the combined role of genetic makeup and environmental factors in determining plant growth. As showed in Table 1, bulb length varied significantly ($p < 0.01$) and ranged from 3.88 cm to 5.54 cm. Lal Teer king showed the bulb length (5.54 cm). Smallest bulb length was recorded from Taherpuri (3.88 cm). Bulb diameter of all the four onion cultivars responded significantly ($p < 0.01$) (Table 1). Lal Teer king produced bulb with the highest diameter (4.53 cm) and the lowest in Taherpuri (3.51 cm). The bulb diameter of Lal Teer Hybrid was 4.01 cm, while Lal Teer 20 had 3.63 cm. Performance of the cultivars differed significantly ($p < 0.01$) ranging from 19.88 to 33.58 g. Lal Teer king obtained highest individual bulb weight (33.58 g), followed by Lal Teer Hybrid (25.60 g). The lowest weights were recorded from Taherpuri (19.88 g). The superior performance of Lal Teer king may be linked to its

ability to maintain ionic balance, enhanced photosynthetic efficiency, and improved assimilate partitioning towards bulb development under saline conditions. Bulb growth was most affected and adapted to stress by shortening the duration of different stages, resulting in faster bulb growth under saline soil (Venancio *et al.* 2022).

Table 1. Vegetative and yield contributing traits of four onion cultivars.

Variety	PH	LNP	LL	BL	BD	IBW	YP	YH
Lal Teer20	42.27c	8.77b	31.01b	4.03bc	3.63bc	20.34c	854.28c	8.54c
Lal Teer Hybrid	47.24b	9.93ab	33.21b	4.62b	4.01b	25.60b	1075.20b	10.75b
Lal Teer king	50.43a	10.74a	37.27a	5.54a	4.53a	33.58a	1410.5a0	14.11a
Taherpuri (check)	41.67c	8.23b	31.17b	3.88c	3.51c	19.88c	835.10c	8.35c
CV (%)	2.17	6.18	2.96	4.39	3.51	6.92	6.92	6.92
LSD	2.98	1.76	2.97	0.60	0.41	5.21	218.72	2.19
Level of significance	**	**	**	**	**	**	**	**

CV: Co-efficient of variation, LSD: Least significant difference; ** : Significant at 1% level of probability, PH: Plant height, LNP: Leaves number per plant, LL: Leaf length, BL: Bulb length, BD: Bulb diameter, IBW: Individual bulb weight, YP: Yield per plot, YH: Yield per hectare

Yield per plot and yield per hectare of the cultivars is presented in Table 1, implied that the Lal Teer king produced the maximum yield whereas minimum from Taherpuri. Yield performance of the plots varied from 1410.5 to 835 g. Lal Teer king out performed other cultivars (1410.5 g), followed by Lal Teer Hybrid (1075.20 g). Contrast to that, Lal Teer 20 and Taherpuri produced lower yields, estimating 854.28 g and 835 g, respectively. Regarding yield per hectare performance ranged from 14.11 t ha^{-1} to 8.35 t ha^{-1}. Among the studied cultivars, Lal Teer king performed superiorly (14.11 t ha^{-1}), while the lowest yield from Taherpuri (8.35 t ha^{-1}). Lal Teer Hybrid and Lal Teer 20 produced 10.75 and 8.54 t ha^{-1}, respectively. The higher yield of Lal Teer king may be attributed to its superior vegetative growth and efficient biomass accumulation under saline conditions. Similar varietal differences in onion performance under salinity were reported by Alam *et al.* (2023). Variations in growth and yield among cultivars may result from salinity levels, varietal potential, agro-ecological adaptation, and genetic differences (Jilani and Ghafoor 2003).

Variability for studied traits among the four onion cultivars was estimated (Table 1). Individual bulb weight, yield per plot and yield per hectare showed the greater coefficient of variation (CV=6.92%), followed by leaves number per plant (CV=6.18%) and bulb length (CV=4.39%), while the lowest coefficient of variation was recorded in leaf length (CV=2.96%) and plant height (CV=2.17%), respectively.

The estimated correlation coefficient of examined traits in Fig. 1 implied that the significant interrelationships among the crucial vegetative and yield contributing traits. Strong and positive correlations were occurred between plant height and leaves number per plant ($r = 0.98$, $p < 0.01$). Notably, bulb diameter had significant and positive correlation with bulb length ($r = 0.95$, $p < 0.01$). Other measured traits, such as individual bulb weight ($r = 0.90$, $p < 0.01$) and yield ($r = 0.95$, $p < 0.01$). Additionally, individual bulb weight demonstrated good positive correlations with yield per plot ($r = 0.98$**,** $p < 0.01$) and yield per hectare ($r = 0.90$**,** $p < 0.01$). From a biological perspective, the observed associations reflect the integrated nature of growth and yield formation under salinity stress. Greater plant height and leaf number enhance the photosynthetic surface, supporting higher assimilate production. Cultivars maintaining better leaf growth under salinity

likely possess improved osmotic regulation and ion homeostasis. Similar positive correlations between yield and traits such as plant height, bulb diameter, leaf number, and bulb weight have been reported at both phenotypic and genotypic levels (Lakshmi 2015, Singh *et al.* 2010).

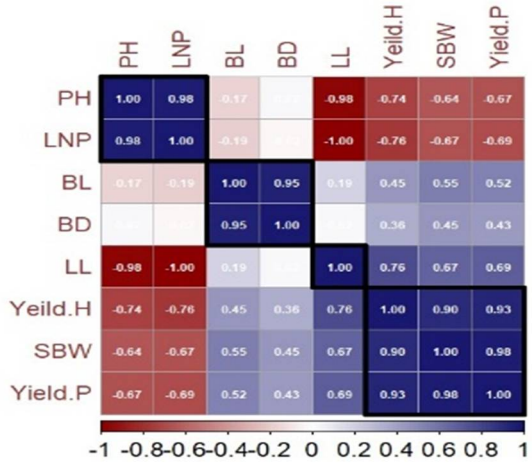

Fig. 1. Estimation of Pearson's correlation coefficients among different traits of onion cultivars

In this study, all the variables showed greater heritability (Table 2). Most traits show minor differences between the genetic coefficient of variation (GCV) and the phenotypic coefficient of variation (PCV), which suggests that the attributes are primarily influenced by genetic factors rather than environmental ones. Individual shoot weight (62.38%), yield per plot (62.37%), yield per hectare (62.37%), and bulb length (40.41%) showed high genetic advance. Meanwhile, leaf number/plant (29.81%), bulb diameter (26.43%), plant height (22.60%), and leaf length (20.96%) recorded moderate genetic advance. Singh *et al.* (2010) recorded high heritability and genetic advance in gross yield. Lakshmi (2015) observed high heritability, moderate to high GCV for the traits like bulb weight, diameter and yield.

Table 2. Estimation of genetic parameters of eight traits in onion cultivars.

Traits	σ^2g	σ^2e	σ^2p	GCV	ECV	PCV	h^2b	GA (5%)	GA (%mean)
PH	25.748	0.966	26.715	11.177	2.165	11.385	96.383	10.262	22.604
LNP	1.899	0.042	1.942	14.633	2.188	14.796	97.813	2.808	29.812
LL	12.278	0.963	13.240	10.565	2.958	10.972	92.729	6.951	20.958
BL	0.823	0.039	0.862	20.078	4.387	20.552	95.443	1.826	40.408
BD	0.268	0.019	0.287	13.271	3.510	13.727	93.461	1.032	26.429
IBW	59.441	2.959	62.400	31.025	6.922	31.788	95.258	15.501	62.378
Yield P	0.105	0.005	0.110	31.022	6.922	31.785	95.257	0.651	62.372
Yield H	10.485	0.522	11.007	31.022	6.922	31.785	95.257	6.510	62.372

σ^2g: Genotypic variance, σ^2P: Phenotypic variance, GCV: Genotypic co-efficient of variation, PCV: Phenotypic coefficient of variation, h^2b: Heritability, GA: Genetic advance, GA (%): Genetic advance. PH: Plant height, LNP: Leaves number per plant, LL: Leaf length, BL: Bulb length, BD: Bulb diameter, IBW: Individual bulb weight, YP: Yield per plot, YH: Yield per hectare

Principal components analysis is a multivariate effective approach that may be used to reduce data and estimate the genetic variety of onion breeding materials (Hanci and Gokce 2016). Considering the PCA of 8 traits of four onion cultivars ((PC1-PC3) indicated remarkable variation among the cultivars for different morphological and yield contributing traits, especially Lal Teer king and Lal Teer Hybrid (Table 3 and Fig. 2). PC1, indicating the most variation (98.57%), with an eigenvalue of 7.886, was dominated by characteristics such as plant height, leaf number per plant, leaf length, bulb length, bulb diameter, shoot bulk weight, yield per plot, and yield per hectare, emphasizing the significance of overall plant production. PC2 and PC3 contributed minimally, accounting for 1.29% and 0.14% of the variance, respectively. Bulb diameter, bulb length and leaves number per plant showed negative contribution in PC3, while other traits showed positive loadings. Similarly, Hanci and Gokce (2016) used PCA to assess genetic variability in onion based on morphological traits. The strong contribution of PC1 suggests that salinity tolerance is associated with integrated growth and biomass maintenance. Cultivars such as Lal Teer king and Lal Teer Hybrid, which loaded highly on PC1, likely possess efficient physiological mechanisms including ion regulation, sustained photosynthesis, and assimilate partitioning under stress. Negative loadings in PC2 and PC3 indicate possible trade-offs among growth traits under salinity. From a breeding perspective, bulb diameter, bulb length, and individual bulb weight showing strong correlation with yield and high heritability are effective selection criteria.

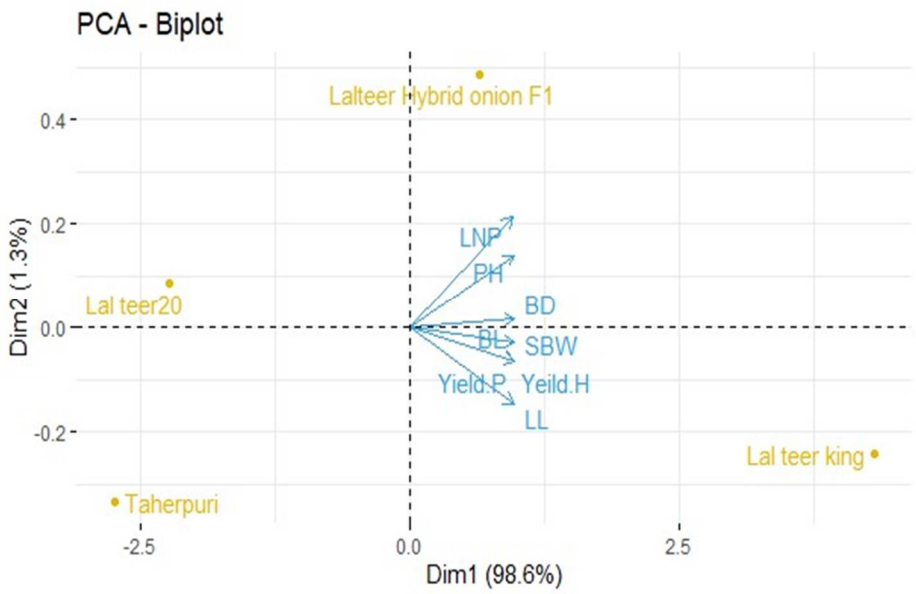

Fig. 2. Principal component analysis (PCA) biplot showing relationship between vegetative and yield-contributing traits in four onion cultivars.

Based on the present findings, the studied onion cultivars can be differentiated by their morphological traits and performance under saline conditions. Lal Teer king and Lal Teer Hybrid showed superior vegetative growth and yield, indicating their suitability for cultivation in coastal saline regions. These cultivars are recommended for adoption to enhance productivity in such areas. However, multi-location trials across diverse agro-ecological zones are needed to confirm their stability. Incorporating these cultivars into breeding programs may facilitate the development of salt-tolerant varieties and support food security in Bangladesh.

Table 3. Principal component analysis (PCA) of growth and yield traits in onion cultivars.

Variables	PC1	PC2	PC3
PH	0.987	0.143	0.079
LNP	0.976	0.217	-0.037
LL	0.989	-0.149	0.019
BL	0.999	-0.029	-0.036
BD	0.999	0.018	-0.039
IBW	0.998	-0.065	0.005
Yield P	0.998	-0.065	0.005
Yield H	0.998	-0.065	0.005
Eigenvalues	7.886	0.103	0.011
% of var.	98.573	1.291	0.136

References

Alam MA, Rahman MA, Rahman MM, Hasan MM, Naher S, Fahim AHF, Mottalib MA, Roy S, Islam MR, Mozumder SN, Alsuhaibani AM, Gaber A and Hossain A 2023. Performance valuation of onion (*Allium cepa* L.) genotypes under different levels of salinity for the development of cultivars suitable for saline regions. Front. Plant Sci. **14**: 1154051

Alemu D, Kitila C, Garedew W, Jule L, Badassa B, Nagaprasad N, Seenivasan V, Saka A and Ramaswamy K 2022. Growth, yield, and yield variables of onion (*Allium cepa* L.) varieties as influenced by plant spacing at DambiDollo, Western Ethiopia. Sci. Rep. **12**(1): 20563.

Ali MS, Majumder D, Talukder SK, Zahid ZH, Datta P, Rahman MJR and Hossen K 2023. Effect of nitrogen, phosphorus and potassium on the growth and yield performance of garlic (*Allium sativum* L.) in coastal zone of Bangladesh. Res. Agric. Livest. Fish. **10**(1): 53-60

Chowdhury MNA 2019. Research and Development of Onion: Bangladesh perspective, Bangladesh Agricultural Research Institute, Dhaka. pp. 45-58.

Comstock RE and Robinson HF 1952. Genetic parameters, their estimation and significance. *In*: Proceedings of the 6th International Grassland Congress. Vol. 1. Washington, DC, USA: National Publishing Company, pp. 248-291.

Hanci F and Gokce A 2016. Genetic diversity evaluations in Turkish onion (*Allium cepa* L.) genotypes: Principal component analyses (PCA) for breeding strategies. Acta Hortic. **1143**: 227-234.

Hassan LEA, Ahamed MBK, Majid ASA, Baharetha HM, Muslim NS, Nassar ZD and Majid AMA 2014. Correlation of antiangiogenic, antioxidant and cytotoxic activities of some Sudanese medicinal plants with phenolic and flavonoid contents. BMC. Complement. Altern. Med. **14**(1): 401-406.

Ibrahim N 2010. Growth and yield of onion (*Allium cepa* L.) in Sokoto, Nigeria. Agric. Biol. J. N.Am. **1**:556-564.

Jilani MS and Ghafoor A 2003. Screening of local onion varieties for bulb formation. Int. J. Agric. Biol. **5**(2):129-133.

Khatun R, Ali MS, Islam DR, Rahaman S, Islam T, Mohammad N, Rahman MJ, Siddike MN and Mohsin GM 2023. Influence of vermicompost on growth and yield of okra (*Abelmoschus esculentus*) in coastal area of Bangladesh. Res. Agric. Livest. Fish. **10**(2):165-173.

Kefelegn GA 2020. Review on mineral nutrition of onion (*Allium cepa* L). Open Biotech. J. **14**: 134-144.

Lakshmi R 2015. Studies on genetic variability, correlation, and path analysis of yield and yield components in onion. J. Hortic. Sci. **10**: 237-241.

Loredana L, Giuseppina A, Filomena N, Florinda F, Marisa DM and Donatella A 2019. Biochemical, antioxidant properties and antimicrobial activity of different onion varieties in the Mediterranean area. J. Food Meas. Charact. **13**(2): 1232-1241.

Rahaman S, Ali MS, Mohammad N, Rahman ME, Rahman MT, Nahid SFTZA, Mohsin GM, Hossen K and Ahmed R 2023. Effect of biochar on growth and yield of yard long bean (*Vigna unguiculata*) under salinity stress. J. Agrofor. Environ. **16**(2): 63-68.

Singh RK, Dubey BK, Bhonde SR and Gupta RP 2010. Estimates of genetic variability and correlation in red onion (*Allium cepa*) advance lines. Indian J. Agric. Sci. **80**(2): 160-163.

Tesfay SZ, Bertling I, Odindo AO, Greenfield P and Workneh TS 2011. Growth responses of tropical onion cultivars to photoperiod and temperature based on growing degree days. African. J. Biotechnol. **10**: 15875-15882.

Trina F, Ahmed R, Aftab Ruhi R, Joy MI, Binta M and Maliha J 2021. Morphological performances of BINA soybean 6 (*Glycine max*) at several salinity stress concentrations in coastal region of Bangladesh. J. Biosci. Agric. Res. **27**: 2287-2295.

Venancio JB, Dias Nda S, de Medeiros JF, de Morais PLD, do Nascimento CWA and Neto ON de S 2022. Yield and morphophysiology of onion grown under salinity and fertilization with silicon. Sci. Hortic. **301**: 111095.

(Manuscript received on 30 September, 2024; revised on 25 May, 2026)