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SOYBEAN GERMPLASM SHOWS VARIATION IN FARMERS PARTICIPATORY TRIAL IN THE COASTAL REGION OF BANGLADESH

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ABSTRACT

The cultivation of soybean is still concentrated in the coastal region of greater Noakhali District of Bangladesh, where salinity hinders crop production. There is no suitable salt tolerant variety so far. At Bangabandhu Sheikh Mujibur Rahman Agricultural University, 170 soybean genotypes were screened and finally three, namely AGS313 (BU soybean-3), G00028 (BU soybean-4), and BD2330 were found fairly salt tolerant at 5 and 10 dSm^{-1} salinity. In Rabi 2022-23 season the selected three genotypes, G00056 as a high yielding promising genotype, and three varieties namely BU soybean-2, BARI soybean-6 and Binasoybean-2, i.e. altogether seven genotypes were grown in 700 decimals land, both saline and non-saline soils, of 12 farmers in different upazillas of Noakhali, Laksmipur and Bhola districts. The seeds were sown by the last week of January' 23. Salinity of the fields at harvest was found 5- 13 dSm^{-1}, though initially varied from 0 – 4 dSm^{-1}. Yield contributing characters were measured appropriately. Standard error was used for showing the mean differences. Farmers' discussion on the performance of the genotypes were held from time to time. Salinity decreased plant height, maturity duration, number of pods $plant^{-1}$, 1000-seed weight and grain yield ha^{-1}. However, AGS313 and G00028 were affected less than other genotypes. Under non-saline and low saline conditions relatively higher yield was found in BU soybean2 (2657 kg ha^{-1} in Bhola, 3397 $kgha^{-1}$ in Subornachar), G00056 (2341 in Laksmipur sadar, 3390 kg ha^{-1} in Subornachar), AGS313 (2612 in Ramgoti, 3266 kg ha^{-1} in Subornachar) and G00028 (2464 in Bhola sadar, 3374 kg ha^{-1} in Subornachar) compared to other genotypes. The lowest yield was found in BARI soybean6 (1715 kg ha^{-1} in Ramgoti) followed by Binaoybean-2 (1868 kg ha^{-1} in Laksmipur sadar). However, under saline field conditions (5- 8 dSm^{-1}) G00028 (866 kg ha^{-1} in Komolnagar, 1374 kg/ha in Subornachar) and AGS313 (860 kg ha^{-1}in Ramgoti, 1333 kg ha^{-1} in Subornachar) produced substantially higher yield than other genotypes/ varieties. The lowest yield was obtained from G00056 (170 kg ha^{-1}) from Komolnagar. Based on the results of multi-location trials, and discussions with the farmers the genotypes AGS313 and G00028 were registered as BU soybean-3 and BU soybean-4, respectively as relatively salt tolerant varieties from the National Seed Board.

Keywords: *Glycine max,* salinity, variety, yield

Introduction

Among all the cultivated crops soybean (*Glycine max.* L) seeds contain the highest amount of nutrients, especially protein. The dry seeds of soybean contain high amount of protein (30- 50%), vegetable edible oil (18-22%), calcium (277 $mg100g^{-1}$), iron (15.7 $mg100g^{-1}$), magnesium (280 $mg100g^{-1}$), phosphorus (704 $mg100g^{-1}$), potassium (1797 $mg100g^{-1}$), folic acid (375 $\mu 100g^{-1}$), as well as several vitamins including different B vitamins, and minerals, such as molybdenum, copper, manganese etc. (Banaszkiewicz 2011, García-Rebollar *et al.* 2016, USDA 2018). That is why it is called "golden bean" or "miracle bean" in many places. In Bangladesh soybean is mostly used as animal feed. Recently consciousness on its high nutrition as food items is developing among the people in Bangladesh (Mannan *et al*. 2012, Khan *et al.* 2014, Mia 2020, Chowdhury *et al.* 2013, Sultana 2020a, Sultana 2020b).

However, since 2017 the soybean cultivation area and total production in Bangladesh remained more or less unchanged, though the national average yield increased from 1360 kg ha^{-1} in 2010 to 1773 kg ha^{-1}in 2018-19 (BBS

2020). The reasons for not increasing the cultivation of soybean are mainly due to high competition with different winter season crops in the northern Bangladesh, and particularly with maize, sunflower, watermelon, etc. cultivation in the southern part.

Bangladesh produced around 162,000 MT soybean only from 82,000 ha of land in 2021-22, while imported 2.8 million MT (USDA 2022). The huge demand has been created due to high demand for animal feed production, though soybean is used for both oil extraction and different forms of food consumption worldwide. The cultivation of this crop is still concentrated mostly in the southern coastal part of the country, more specifically in Noakhali and Laksmipur districts where salinity prevails at different degrees. The salinity area is increasing in Bangladesh due to intrusion of seawater to the fresh river water during dry seaon, seepage of salty water due to dryness of the soil, rising of salt through capilary movement and inundation of land due to cyclones (Karim 2015, Mannan *et al*. 2013a, Khan *et al*. 2014, Mondal *et al.* 2013). Many crop fieds in the coastal region remain fallow during Rabi season, after aman rice harvest, just because of rising salinity during Kharif I season. Moreover, many new charlands have been developed which remain fallow for lacking of due attention for bringing under crop cultivation during Rabi and Kharif II seasons.

Soybean is considered as a moderately salt tolerant crop (Maas 1985). Salinity tolerance is linked to maintennance of better water relations, efficient compartmentation of Na^+ into plant organs and balanced nutrition. By selecting tolerant soybean genotypes the yield of the crop can be improved to a great extent in the saline field conditions (Ghassemi-Golezani *et al*. 2009, Mannan *et al*. 2013b, Khan *et al*. 2014, Fujii and Higuchi 2019). Though soybean cultivation in the Bhola district has been increased to some extent, it is still very minimum in the northern part of the country, because of high crop competion in Rabi season and rather long duration requirement due to cooler winter compared to the south. Contrary, in the coastal region the aman rice is harvested in December when it is already late to grow Rabi crops. Moreover, due to delay in drying the land (lacking of ju condition) it is often becomes difficult to sow seeds of Rabi crops timely. However, soybean can be sown untill late January without much affecting the yiled. Unfortunately, there is no salt tolerant soybean variety that can endure rising salinity effect at the reproductive stage in the coastal region. Thus, attempt should be strenthened to increase soybean productivity in the coastal region of Bangladesh by developing high yielding salt tolerant varieties.

The Department of Agronomy of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) has a collection of more than 280 soybean gnotypes from home and abroad, especially from AVRDC, Kyoto University, BARI and farmers fields of greater Noakhali district. Studies on the response of the soybean genotypes to different environmental stresses are going on for more than 17 years. Mannan *et al.* (2012), and Khan *et al.* (2013) selected 13 and 7 salt tolerant genotypes by screening 171 and 41 soybean genotypes, respectively at the Department of Agronomy, BSMRAU. In a study Jinzenji (2020) also reconfirmed the salt tolerance of three genotypes, AGS313, BD2330 and G00028, which are common with the earlier selection of Mannan *et al.* (2012) and Khan *et al.* (2013). Later on, those selected salt tolerant genotypes were again screened in 2019-2020 against 5 and 10 dSm^{-1} salinity in pot culture under vinylhouse conditions (Tareq *et al.* 2022). From that experiment three genotypes namely AGS313, BD2330 and G00028 were extricated as the high salt tolerant ones. Another genotype, G00056 was found as the best yielder compared to the available varieties in pot experiment. In Rabi season of 2022-23, both saline and non-saline fields of 700 decimals of 12 farmers were selected for growing the selected 4 soybean genotypes in the coastal region of different upazillas of Noakhali, Laksmipur and Bhola districts. The objective of growing the selected four soybean genotypes was to get a comprehensive understanding on their performance in the coastal saline soils of Bangladesh in comparison to existing popular varieties. It was hoped that salt tolerant high yielding variety can be developed from the four promising soybean genotypes at the end of the study.

Materials and Methods

Before going for the main study in Rabi season 2022-23, the seeds were multiplied in the coastal region in the farmers' field. In Kharif 2 of 2022, a total 450 decimals of land involving 11 farmers in Ramgoti and Komolnagar Upazillas of Laksmipur district were cultivated for seeds production of four soybean advanced lines/ genotypes

namely AGS313 (BU soybean-3), G00028 (BU soybean-4), BD2330, and G00056. The farmers were selected with the support of the Solidaridad Asia Network with whom BSMRAU has formal LoA and Department of Agricultural Extension. The farmers were given training on Good Agricultural Practices (GAP) for soybean cultivation. The land size ranges from 20 decimal to 80 decimal. However, due to cyclone "Sitrang" during 22-25 October 2022 crops in many fields were damaged, though in some fields the crop survived to some extent. Seeds in some fields were re-sown. Crops in about 150 decimals of land were grown satisfactorily. By the 2nd week of January' 23 all the crops were harvested. A total of 750 kg seeds of the 4 genotypes were obtained.

Soybean fields of 700 decimal of 12 farmers, both saline and non-saline, were selected for growing the selected 4 soybean genotypes during Rabi 2022-23 season in the coastal region, covering 150 decimals in Subarnachar upazilla of Noakhali district, 150 decimals in Komolnagar, 100 decimals in Laksmipur sadar, 100 decimals in Raipur, 100 decimals in Ramgoti upazillas of Laksmipur district, 100 decimals in Bhola sadar upazilla of Bhola district (Table 1). Each field was 50 decimals in area. The seeds were sown by the last week of January' 23. Salinity was measured before sowing the seeds and at harvest. The salinity level was less than 3 dSm^{-1}, except a few having 4 dSm^{-1}, though increased to 5- 13 dSm^{-1} at the pod development stage. At and over 10 dSm^{-1} none of the genotypes produced seeds. Farmers' discussion on the performance were held time to time. Finally KGF monitoring team led by the Executive Director visited and discussed with farmers on selection of the best and relatively salt tolerant soybean genotypes.

At harvest each field of each genotype was divided into three sub-plots and yield of 2m X 3m was measured. Each field of each upazilla was considered as a replication under randomized complete block design, though each field was sub-divided into two repetitions for each crop for better data collection. Data on yield and yield contributing characters were recorded. Mean values was calculated and the standard error was used to show the mean differences.

Results and Discussion

Selected four soybean genotypes namely AGS313 (BU Soybean-3), G00028 (BU soybean-4), BD2330 and G00056 along with three popular varieties such as BU soybean-2, BARI soybean6 and Binasoybean-2 were grown in 700 decimals land in the coastal region in Rabi 2022-23 season in both saline and non-saline soils. The salinity level was less than 3 dSm^{-1}, except a few having 4 dSm^{-1} during sowing, though increased to 5- 13 dS m^{-1} at harvest. At and over 10 dSm^{-1} none of the genotypes produced seeds.

Table 1. List of farmers selected for growing soybean in different upazillas of the coastal region in rabi 2022-23 season

Sl. no.	Name of PG Member	Father/Husband Name	Soybean Land (dec.)	Cluster/Union	Upazila	District
1	Md.Dilder Hossain	Md.Sekandor Hossain	100	Char Amanullah	Subarnachar	Noakhali
2	Sohodeb Chandra Das	Nitis Chandra Das	50	Char Bata	Subarnachar	Noakhali
3	Mohon Lal Roy	Late Mahendra Kumar Roy	50	Char Gazi	Ramgati	Laxmipur
4	Md Dildar Hossain	Late Md Jahangir Alam	50	Char Algi	Ramgati	Laxmipur
5	Abul Kalam	Amin Ullah	50	Char Lawrence	Kamalnagar	Laxmipur
6	Nuruddin	Sayed Hawladar	100	patarir Hat	Kamalnagar	Laxmipur
7	Md Soykhot Hossin	Hossin Miya	50	Char kadira	Kamalnagar	Laxmipur
8	Md Abdur Rahman	Md Ibrahim kholil	50	kushakhali	Sadar Laxmipur	Laxmipur
9	Md Riad Hossin	Md Abdul hilim	50	kushakhali	Sadar Laxmipur	Laxmipur
10	Jamal Bapary	Billal bapary	50	Charkachia	Raipur	Laxmipur
11	Md. Anwar	Md. Alauddin	50	Sibpur, Bhola Sadar	Bhola sadar	Bhola
12	Md. Hasnain	Jakir Hossain	50	Char Shyamiya	Bhola sadar	Bhola
	Total land area (decimal)= 700					

Salinity decreased plant height, maturity duration, number of pods plant^{-1}, 1000-seed weight, and grain yield ha dSm^{-1}. Under both saline and non-saline conditions, the plant height was the highest in AGS313, while the lowest was in Binasoybean2 in all the study sites (Table 2). The reduction in plant height was minimum in AGS313 in all the upazillas compared to other genotypes. Salinity affected little the days to flowering of the genotypes though days to maturity enhanced in all the genotypes in all upazillas (Table 3 and 4). Under non-saline conditions AGS313 matured earlier (±90 days) than other genotypes. Under saline conditions the variation in maturity time was very high due to differences in salinity level (72 – 86 days across the genotypes). Salinity decreased seriously the number of pods plant^{-1} in all the genotypes and in all the locations (Table 5). In the saline field the highest number of pods were produced by G00028 (29 – 36 plant^{-1}) followed by AGS313 (31 – 34 plant^{-1}). The number of pods plant^{-1}varied noticeably in all the genotypes under saline field conditions as because of high variation in salinity levels (5-8 dSm^{-1}) from field to field. Salinity did not affect number of seeds per pod irrespective of locations and genotypes. The number of seeds were almost 3/pod irrespective of locations except in G00056 in some locations (Table 6). Salinity lowered the 1000-seed weight (Table 7). Under both non-saline and saline conditions G00056, AGS313, G00028 and BU soybean2 had the larger seeds (>200 g/1000-seeds under non-saline and > 1600 g/1000-seed under 5-8 dSm^{-1} saline conditions) irrespective of locations than other tested genotypes. Grain yield was decreased remarkably by the salinity and the salinity effects varied with the intensity of salinity in the field of different upazillas (Table 8). Under non-saline conditions the higher grain yield was found in G00056 (2342 – 3391 kg/ha), AGS313 (2612 – 3267 kg ha^{-1}), G00028 (2582 – 3374 kg ha^{-1}) and BU soybean2 (2333 – 3397 kg ha^{-1}). However, under saline conditions the substantially higher grain yield was produced by G00028 (866 – 1375 kg ha^{-1}) followed by AGS313 (860 – 3267 kg ha^{-1}) irrespective of locations. Other genotypes including the popular varieties produced very low yield compared to G00028 and AGS313. Even the same genotypes showed much variation in grain yield across the locations, especially under saline conditions. The variation was due to differences in salinity levels even in the same field.

Table 2. Plant height of soybean genotypes grown in different upazillas of the coastal region

Name of genotypes	Suborna char, Noakhali		Komolnagar, Laksmipur		Raipur, Laksmipur		Laksmipur Sadar upazilla		Ramgoti, Laksmipur		Bhola Sadar upazilla
	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline
AGS313 (BU soybean-3)	76.3±6.4	31.3±1.2	67.5±5.5	30.3±1.2			55.7±2.3	39.0±2.1	66.5±3.9	35.7±3.2	
G00028 (BU soybean-4)	45.9±2.2	15.0±0.6	48.7±0.9	20.0±3.1	50.7±2.7	25.7±5.6	45.7±2.2	21.0±3.0	44.2±1.9	27.7±1.8	48.7±0.9
G00056	46.0±4.6	29.8±2.9	51.0±0.0	17.3±2.3	49.3±4.5	28.7±5.2	49.0±3.5	19.3±3.8	51.0±4.4	28.3±5.2	46.0±4.6
BD2330	40.3±1.5	19.7±3.3	54.3±4.5	18.0±6.1					42.5±5.4	23.7±2.3	
BU soybean2	45.2±4.9	23.0±3.6	52.0±1.5	17.7±2.9	48.7±3.2	30.0±6.0	51.0±3.6	24.0±4.6	49.7±1.2	23.6±3.9	52.0±1.5
BARI soybean6	49.7±3.2	25.5±6.7	49.7±4.3	20.3±4.4	55.3±3.2	19.7±5.8	51.7±6.0	28.7±3.5	50.0±3.6	27.9±5.7	51.7±6.0
Binasoybean-2	31.7±4.4	22.7±4.8	38.7±3.0	16.3±3.3	40.3±2.2	22.3±2.0	43.3±2.6	17.3±4.1	43.0±2.9	17.8±4.2	43.3±2.6

±: standard error

Table 3. Days to flowering of soybean genotypes grown in different upazillas of the coastal region

Name of genotypes	Suborna char, Noakhali		Komolnagar, Laksmipur		Raipur, Laksmipur		Laksmipur Sadar upazilla		Ramgoti, Laksmipur		Bhola Sadar upazilla
	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline
AGS313 (BU soy-bean-3)	40.0±1.2	40.0±0.6	45.7±1.8	42.2±0.4			42.7±1.5	42.0±0.6	41.3±0.9	40.3±1.2	
G00028 (BU soybean-4)	42.2±0.2	41.0±0.6	51.0±1.2	46.7±0.9	41.7±0.3	41.7±0.3	47.3±1.2	43.0±0.6	40.7±0.6	42.0±0.6	42.0±0.6
G00056	40.0±1.2	40.7±0.9	49.3±0.3	44.0±1.0	42.3±0.3	42.3±0.3	42.7±2.2	42.7±0.9	41.2±0.4	41.0±0.6	41.7±0.9
BD2330	41.8±0.6	41.0±0.6							41.0±0.6	38.3±1.8	
BU soy-bean2	42.3±0.7	41.0±0.6	51.3±0.9	41.0±0.6		42.3±0.7	47.3±2.7	42.0±0.6	42.0±0.6	41.3±0.3	
BARI soy-bean6	42.0±0.6	41.3±0.9	42.0±0.6	48.5±2.3	41.3±0.3	41.3±0.9	42.3±0.7	47.0±3.0	42.3±1.5	42.2±0.4	41.0±0.6
Binasoy-bean-2	42.0±0.6	40.7±0.9	41.7±0.3	41.3±0.7	41.7±0.9	42.3±1.5	43.0±0.6	44.3±0.7	41.0±0.6	40.7±0.7	40.3±0.9

±: standard error

Table 4. Days to maturity of soybean genotypes grown in different upazillas of the coastal region

Name of geno-types	Suborna char, Noakhali		Komolnagar, Laksmipur		Raipur, Laksmipur		Laksmipur Sadar upazilla		Ramgoti, Laksmipur		Bhola Sadar upazilla
	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline
AGS313 (BU soybean-3)	90.7±0.9	79.0±1.5	90.3±2.4	83.7±1.8			92.7±1.5	84.0±2.6	90.0±1.5	81.3±1.5	
G00028 (BU soybean-4)	96.7±0.9	85.3±1.2	95.7±0.9	82.0±3.8			95.7±0.9	84.0±2.1	92.2±2.4	83.3±1.8	104.7±2.3
G00056	95.7±1.2	73.3±2.7	95.0±1.5	78.7±1.5	96.3±0.3	85.0±2.1	96.0±0.6	83.3±2.3	98.5±0.3	85.3±2.2	104.3±0.7
BD2330	96.5±1.5	80.3±3.2	97.3±0.3	81.0±2.9					98.0±1.0	85.7±2.4	
BU soybean2	99.0±2.1	82.0±3.5	97.7±1.8	86.3±1.8	99.3±1.8	86.7±3.2	97.7±0.3	85.7±1.8	98.0±1.5	85.3±2.0	107.7±2.3
BARI soybean6	95.7±2.6	72.3±1.9	99.0±2.6	86.0±2.5	98.7±2.4	86.0±1.5	94.7±2.4	86.0±1.0	98.7±1.3	84.7±0.9	106.0±1.0
Binasoybean-2	91.0±2.6	75.0±5.0	92.7±1.8	82.7±2.2	94.0±1.2	82.0±1.5	95.0±1.0	83.0±3.1	98.0±1.0	83.7±1.8	92.0±2.0

±: standard error

Table 5. Number of pods/ plant of soybean genotypes grown in different upazillas of the coastal region

Name of genotypes	Suborna char, Noakhali		Komolnagar, Laksmipur		Raipur, Laksmipur		Laksmipur Sadar upazilla		Ramgoti, Laksmipur		Bhola Sadar upazilla
	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline
AGS313 (BU soybean-3)	58.3±4.4	34.3±4.8	64.3±2.3	31.7±1.8			61.3±2.7	31.7±2.0	58.7±2.7	31.3±1.5	
G00028 (BU soybean-4)	54.3±6.7	36.7±3.9	50.0±5.9	28.3±6.9	48.7±4.5	27.3±2.7	54.0±4.5	29.3±2.4	46.2±3.9	30.7±2.4	
G00056	48.0±3.0	27.0±3.1	59.3±0.9	27.7±2.4	48.7±1.5	19.0±1.0	51.0±3.1	13.7±2.0	49.7±2.6	23.3±1.5	72.3±4.3
BD2330	54.3±1.8	17.3±3.5							53.7±1.9	23.3±1.3	
BU soybean2	58.7±5.4	26.8±4.3	67.3±1.2	23.3±3.9	53.7±7.3	24.7±3.0	50.7±7.2	29.0±3.0	58.3±3.4	27.0±1.0	75.0±2.8
BARI soybean6	53.5±6.0	23.3±1.5	53.7±6.7	26.0±2.5	43.7±2.3	24.7±2.0	64.3±1.8	26.0±2.5	66.0±5.1	27.5±5.5	81.0±12.7
Binasoybean-2	47.7±1.8	24.0±2.1	47.7±2.4	26.7±3.2	52.0±2.3	25.3±3.4	41.3±2.2	22.7±0.9	41.0±2.1	22.2±0.6	63.5±2.3

±: standard error

Table 6. Number of seeds/pod of soybean genotypes grown in different upazillas of the coastal region

Name of genotypes	Suborna char, Noakhali		Komolnagar, Laksmipur		Raipur, Laksmipur		Laksmipur Sadar upazilla		Ramgoti, Laksmipur		Bhola Sadar upazilla
	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline
AGS313 (BU soybean-3)	3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0			3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0	
G00028 (BU soybean-4)	3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0
G00056	3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0	2.7±0.3	2.7±0.3	2.7±0.3	3.0±0.0	3.0±0.0	3.0±0.0
BD2330	3.0±0.0	3.0±0.0							3.0±0.0	3.0±0.0	
BU soybean2	3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0	2.7±0.3	2.7±0.3	2.7±0.3	3.0±0.0	3.0±0.0	3.0±0.0
BARI soybean6	3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0	2.7±0.3	2.7±0.3	2.7±0.3	3.0±0.0	3.0±0.0	3.0±0.0
Binasoybean-2	3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0

±: standard error

Table 7. 1000-seed weight of soybean genotypes grown in different upazillas of the coastal region

Name of genotypes	Suborna char, Noakhali		Komolnagar, Laksmipur		Raipur, Laksmipur		Laksmipur Sadar upazilla		Ramgoti, Laksmipur		Bhola Sadar upazilla
	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline
AGS313 (BU soybean-3)	220±0.6	160±1.2	180±0.6	161±0.6			210±1.5	151±1.2	201±1.7	180±0.3	
G00028 (BU soybean-4)	191±1.4	160±0.9	200±0.3	160±1.9	210±0.6	150±0.3	230±0.6	160±0.9	220±1.8	171±0.3	230±0.5
G00056	231±0.7	160±1.7	250±0.2	150±1.2	230±1.7	151±0.7	270±0.7	170±0.6	170±4.1	161±1.3	270±0.6
BD2330	170±0.6	150±1.5	140±0.9	140±0.9					151±0.5	130±0.6	
BU soybean2	211±0.4	170±0.6	240±0.3	180±0.6	230±0.6		221±0.9	151±0.9	220±1.5	180±0.6	240±0.4
BARI soybean6	150±0.4	131± 0.9	150±0.6	121±0.5	160±0.6	130±0.6	141±0.7	111±0.3	150±2.1	120±0.6	141±0.3
Binasoyean-2	140±0.9	120±0.6	141±0.9	120±0.6	141±0.9	111±0.3	140±0.3	110±0.3	121±1.8	110±0.6	150±0.6

±: standard error

Table 8. Yield (kg/ha) of soybean genotypes grown in different upazillas of the coastal region

Name of genotypes	Suborna char, Noakhali		Komolnagar, Laksmipur		Raipur, Laksmipur		Laksmipur Sadar upazilla		Ramgoti, Laksmipur		Bhola Sadar upazilla
	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline	Saline (5-8 dSm^{-1})	Non-saline
AGS313 (BU soybean-3)	3266.6±91.1	1333.3± 88.2	3091.7± 213.9	998.0± 260.7			2921.3±61.6	1190.7±171.0	2612.0±311.3	860.0±70.2	
G00028 (BU soybean-4)	3374.1±144.4	1374.5± 138.1	3169.8± 41.2	866.3± 77.2	3266.7± 176.4	1309.7± 217.5	2582.0±360.1	1133.3±176.4	2832.3±119.9	1077.3±282.3	2464.3±117.8
G00056	3390.8±95.7	217.7± 31.5	3087.5± 0.0	172.9± 26.5	2692.0± 368.3	206.7± 52.1	2341.6±280	193.3±28.5	2786.0±221.7	405.7±198.7	2703.3±60.1
BD2330	2266.7±88.2	567.8± 222.2	2266.7± 88.2	391.8± 36.4					1746.2±305.1	319.2 ±61.9	
BU soybean2	3397.8±97.8	388.0± 107.0	3005.2± 41.2	301.9± 128.9	2866.7± 88.2	183.3± 60.1	2333.4±284.7	180.0±25.2	3001.2±115.5	259.4±39.7	2656.7±97.7
BARI soybean6	2603.6±112.4	231.2± 33.8	2533.3± 88.2	343.5± 94.9	2094.0± 351.6	176.0± 14.5	2474.3±125.7	196.7±43.3	1715.8±159.7	265.4±52.7	2414.5±93.8
Binasoybean-2	2796.9±26.2	181.8± 10.0	2726.7± 63.6	457.6± 71.6	2433.3± 120.2	966.7± 145.3	1868.7±67.2	426.7±93.3	2363.2±148.5	420.0±111.3	2414.5±93.8

±: standard error

Based on the yield ha^{-1} and yield contributing characters under saline conditions in different upazillas G00028 and AGS313 were found relatively salt tolerant genotypes.

It was estimated that about 1.056 million ha out of a total 2.86 M ha in the coastal and offshore area of Bangladesh are affected by varying degrees of salinity, where the cropping intensity is much lower than the average of the country (SRDI 2010; Karim *et al.* 2017). In the present study the genotypes AGS313 and G00028, which are already registered as BU soybean-3 and BU soybean-4 respectively, produced substantially higher grain yield than the popular varieties under saline conditions. Since the demand of soybean is significantly higher than that is produced in Bangladesh (USDA, 2022; DAE, 2022) the new varieties will presumably be supportive for increasing the soybean production in the coastal saline soils.

Conclusion

Three genotypes, AGS313, G00028 and BD2330, along with another high yielding genotype G00056 and three popular varieties namely BARI soybean6, BU soybean-2 and BINAsoybean-2 were grown in different upazillas of coastal districts, namely Noakhali, Laksmipur and Bhola under both saline and non-saline conditions. Farmers were given training on Good Agricultural Practices for soybean cultivation, quality seeds were supplied to them and time to time visited the fields. Based on the field performance, farmers' perception and on-station trial the genotypes AGS313 and G00028 were selected as the bold seeded, high yielding and fairly salt tolerant genotypes. Finally, AGS313 and G00028 have been registered as BU soybean-3 and BU soybean-4 from the National Seed Board, Ministry of Agriculture.

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References

Banaszkiewicz T. 2011. Nutritional Value of Soybean. *In:* Soybean and Nutrition, Hany A. El-Shemy (ed). Published by In: Tech Janeza Trdine 9, 51000 Rijeka, Croatia ISBN 978-953-307-536-5 free online editions of In: Tech Books and Journals, www.intechopen.com

BBS (Bangladesh Bureau of Statistics) 2020. Yearbook of Agricultural Statistics-2019. Ministry of Planning, Government of the People's Republic of Bangladesh. www.bbs.gov.bd.

Chowdhury MMU, Sarker MJU, Choudhury AK, Farhad ISM, Bhowal SK and Hossain KMF. 2013. Soybean cultivation in coastal area of Noakhali. On-Farm Research Division, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh.

Department of Agricultural Extension (DAE). 2022. Crop Statistics of DAE (unpublished data, personal communication), Dhaka.

Fujii K and Higuchi H. 2019. The saline-tolerant mechanism of the Bangladesh soybean variety AGS313. Tropical Agriculture and Development, *63*: 186-191.

García-Rebollar P, Cámara L, Lázaro RP. Dapoza C, Pérez-Maldonado R and Mateos GG. 2016. Influence of the origin of the beans on the chemical composition and nutritive value of commercial soybean meals. Animal Feed Science and Technology, *221*: 245-261

Ghassemi-Golezani K, Taifeh-Noori M, Oustan S and Moghaddam M. 2009. Response of soybean cultivars to salinity stress. Journal of Food Agriculture and Environment, *7:* 401-404.

Jinzenji Y. 2020. Differences for salt stress between soybean varieties which are cultivated in the coastal area in Bangladesh. MS dissertation, Faculty of Agriculture, Kyoto University.

Karim MA. 2015. The Challenge of Increasing Climatic Variability to Climate Smart Agriculture in Bangladesh. Proceedings of the Annual Conference of the Bangladesh Society of Agronomy, BARC, Dhaka.

Karim MA, Quayuum MA, Samsuzzaman S, Higuchi H and Nawata E. 2017. Challenges and opportunities in crop production in different types of char lands of Bangladesh: Diversity in crops and cropping. Tropical Agriculture and Development, *61*: 77-93.

Khan MSA, Karim MA, Haque MM, Karim AJMS and Mian MAK. 2013. Screening of soybean genotypes for salt tolerance in hydroponics. Bangladesh Agronomy Journal, *16*: 95-104

Khan MSA, Karim MA, Haque MM, Karim AJMS and Mian MAK. 2014. Variations in agronomic traits of soybean genotypes. SAARC Journal of Agriculture, *12:* 90-100.

Maas EV. 1985. Crop tolerance to saline sprinkling water. Plant and Soil, *89:* 273-284.

Mannan MA, Karim MA, Haque MM, Khaliq QA, Higuchi H and Nawata E. 2012. Response of soybean to salinity: I. Genotypic variations in salt tolernce at the vegetative stage. Tropical Agrculture and Developoment, *56*: 117-122

Mannan MA, Karim MA, Haque MM, Khaliq Q.A, Higuchi H and Nawata E. 2013a. Response of soybean to salinity: ii. Growth and yield of some selected genotypes. Tropical Agriculture and Development, *57*: 31-40.

Mannan MA, Karim MA, Haque MM, Khaliq Q.A, Higuchi H and Nawata E. 2013b. Response of soybean to salinity: III. Water Status and Accumulation of Mineral Ions. Tropical Agriculture and Development, *57*:41-48.

Miah AA, Karim MA, Mamun MAA, Khan MAR, Akter N and Haque MM. 2020. Planting time effects on phenology and yield of early maturing dwarf soybean genotypes, Bangladesh Journal of Ecology, *2:* 19-24.

Mondal MS, Jalal MR, Khan MSA, Kumar U, Rahman R and Huq H. 2013. Hydro-Meteorological Trends in Southwest Coastal Bangladesh: Perspectives of Climate Change and Human Interventions. American Journal of Climate Change, *2*: 62-70. http://dx.doi.org/10.4236/ajcc.2013.21007

SRDI. 2010. Saline Soils of Bangladesh. Soil Resource Development Institute (SRDI). SRMAF project, Ministry of Agriculture, Govt. Peoples Republic of Bangladesh.

Sultana D, Bari MN, Mamun MAA, Higuchi H and Karim MA. 2020a. Grain growth and seed quality of some soybean genotypes, Bangladesh Journal of Ecology, *2*: 47-52.

Sultana D, Bari MN, Mamun MAA, Higuchi H and Karim MA. 2020b. Genotypic difference in phenology and dry matter distribution pattern in soybean, Bangladesh Journal of Ecology, *2*: 13-18.

Tareq MS, Mannan MA, Rahman MM, Mamun MAA and Karim MA. 2022. Salinity-induced changes in growth, physiology and yield of soybean genotypes. Annals of Bangladesh Agriculture, *26* (press).

The United States Department of Agriculture (USDA). 2018. USDA-ARS Nutrient Data Laboratory, USDA Nutrient Lists from Standard Reference Legacy.

The United States Department of Agriculture (USDA). 2022. Global Agricultural Information Network. Report Number: BG2021-0011. Date: April 04, 2021. *https:// www.newagebd.net*