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Effect of Plant Spacing and Varieties on Growth, Yield and Quality of Zero-Till Potato in the Coastal Ganges Delta

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Increasing soil salinity, late harvest of *Aman* rice, shorter cool weather duration, difficulties in crop establishment, shortage of fresh irrigation water and other factors contribute to low crop productivity in the coastal saline zone of Bangladesh during the *Rabi* season. An innovative technique for the saline regions is zero tillage potato cultivation using mulching. The low potato yield is still a disadvantage to the farmers in salty regions not using the best agronomic procedures for growing potatoes without tilling the soil. When growing zero tillage potatoes, proper spacing is crucial for both yield and quality. In order to find out the appropriate spacing at which the potato varieties should be planted in salty soil using the zero tillage technique, a field experiment was carried out in Tildanga, Dacope Upazila, Khulna in 2018-2019 and 2019-2020, following the harvest of transplanted *Aman* rice. The experiment was designed using a factorial randomized complete block layout with three replications. The combination effect of 25 cm x 15 cm spacing with BARI Alu 41 produced the highest emergence (98.34%), crop growth rate (20.24 g m^{-2} d^{-1}), maximum yield (20.30 t ha^{-1}) and highest A size (28-40 mm) tubers (8.56 t ha^{-1}) according to results from two years of experimentation. The maximum BCR (2.56) were was observed in the interaction effect of 25 cm x 15 cm spacing with BARI Alu 41. Therefore, in regions with high levels of salt, the zero tillage method may be suggested using close spacing (25 cm x 15 cm) and salt tolarent variety BARI Alu 41 for a higher potato production, economic considerations and to meet farmers' demands for agriculture.

(***Key words:*** *Potato varieties, Saline soils, Spacing, Yield, Zero tillage*)

To boost food security and to increase land use intensity, zero-tillage potato cultivation (ZTPC) derived as a promising technology for sustainable intensification in rice-based cropping systems, exhibits considerable potential in the saline belt of Bangladesh (Ramirez *et al.,* 2022; Sarangi *et al.,* 2021). Through the adoption of zero-tillage potato technology, mono-cropping in saline soils of the coastal region of the Ganges Delta with rice can be converted into double and triple cropping (Sarangi *et al.,* 2021). However, due to the lack of optimised technology and dependency on conventional agriculture, the production of potato is still very low compared to the attainable yield and yield of the neighboring countries like India and China. During 2019-2020, the total potato production area was 461,317 ha where total production was 9,605,624 M tonnes with an average yield of 20.8 t ha^{-1} (BBS, 2020). One of the major ecological threats to global agriculture is salinity of soils (Zhang *et al.,* 2007). In extreme saline environments, few crops/cultivar can achieve economic yield (Shrivastava and Kumar, 2015). Soil salinity is a seasonal problem in the saline belt of Bangladesh that severely spoils crop production especially in the *Rabi* season, but soil salinity declines in the *Kharif* season and does not significantly hamper production (Khan *et al.,* 2008). During the *Rabi* season, most of the saline areas remain fallow. Therefore, salinity-tolerant high-yielding potato varieties are crucial for this area.

Medium to long duration transplanted *Aman* rice (wet season rice) is the predominant crop in the region. The slow drying process after harvest of T. *Aman* rice

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delays soil drainage and drying for ploughing the land for dry season winter (*Rabi*) and pre-mosoon crops. The cultivation of dry season crops in such conditions requires suitable crops and agronomic options for early planting in the excess moist soil, where ploughing is not feasible. Plant spacing is an influential factor that can significantly affect the quality and yield of potato. Planting density strongly affects yield since more tubers and yield per square meter are expected at higher planting densities. Bussan *et al.* (2007) argued that optimizing plant density was one of the most important practices in potato production management, as it affects seed cost, plant development, yield and the quality of the crop. The possibility of securing high yield depends on proper consideration of optimum number of plants per unit area (Gebre and Giorgis, 2001). Gulluoglu and Arıoglu (2009) noted that the optimal planting density differed depending on environmental conditions and cultivars. Closer spacing (10 to 15 cm hill to hill and 30 to 35 cm row to row) has been recommended for cultivation of zero tillage potato in the coastal saline soils (Sarangi *et al.,* 2018). We hypothesized that closer spacing would be suitable for zero-tillage potato than conventional planting since not space will be needed for ridging, and also maximizing soil cover would help to decrease surface soil drying. However, the optimum spacing may vary among cultivars depending on their phenology and salt tolerance. Hence, the experiment was carried out to determine the optimum plant spacing of three potato varieties under the zero-tillage method in salinity-affected coastal area of Ganges Delta.

MATERIALS AND METHODS

The field experiment was conducted at Tildanga, Dacope Upazila, Khulna, Bangladesh in 2018-2019 and 2019-2020 during the *Rabi* season after harvest of T. *Aman* rice. It is situated at 22°34′20″ North and 89°30′40″ East. The treatments of the 1st year experiment were Factor A: Variety: BARI Alu 8, BARI Alu 41, BARI Alu 72 and Factor B: Spacing: 55 cm x 25 cm, 55 cm x 15 cm, 50 cm x 20 cm, 50 cm x 25 cm, 45 cm x 25 cm. On the basis of the first year experiment, 55 cm x 15 cm spacing (gave the highest yield) was selected for 2nd year experiment and other four close spacing (25 cm x 15 cm, 30 cm x 15 cm, 35 cm x 15 cm and 45 cm x 15 cm) were also applied in the 2nd year. The treatments were laid out in randomized complete block design with three replications. The experimental areas are slight to moderately drought, non-alluvial soils and saline prone, and face salinity at later part of winter season and beginning of summer. The soil texture of the experimental site are silty clay (0-15 and 15-30 cm) overlying clay (30-45 and 45-60 cm). Planting was done 15 December in the moist soil immediately following the harvest of *Kharif* T. *Aman* rice (BR10) in accordance with the zero tillage method. The field was drained two weeks before to rice harvest in order to make seeding properly. The dimensions of each plot in the studies were 6 m × 4 m. For the experiment, 45 plots were utilized. Before planting, seed potatoes were treated with Provex @ 2.5 g L^{-1} of water for 30 minutes. Seed tubers were first allowed to germinate and then large sized tubers were cut into pieces (40 - 50 g in weight) with at least two germinating eyes. All piece of tubers were mixed with ash for protecting diseases. Tubers with sprouts of about 1cm long at the sowing were considered suitable for early growth of plants above the paddy straw. Whole and pieces potato seeds were sown by hand and giving a little pressure on muddy soil. After sowing, the tubers were covered with dry cowdung. Higher yield and maintainence of soil fertility in saline belt areas for potato production require application of more organic fertilizers. The most common organic fertilizer in saline belt areas is cattle manure. Over the compost a thick layer (20-30 cm) of paddy straw (available in plenty in the coastal area) was laid to cover the entire area. Proper covering of the tuber with paddy-straw is the most important practice in this technology. Sub-optimum thickness exposes the growing tubers to sunshine, which results in the formation of solanine (green colour potato). To avoid this, care should be taken to use optimum quantity and pre-used paddy-straw so that this packs well and there is no exposure to sunshine. All of the triple superphosphate (150 kg ha^{-1}), muriate of potash (250 kg ha^{-1}), gypsum (130 kg ha^{-1}), zinc sulphate (16 kg ha^{-1}), boric acid (10 kg ha^{-1}) and half of the urea (250 kg ha^{-1}) as well as dry cowdung were applied during sowing by broadcasting between rows. The remaining 50% of urea was applied at 30 days after planting followed by irrigation. In 2018-2019, the average maximum and minimum temperature ranged from 24.73 to 33.91 and 12.10 to 25.14°C, respectively (Fig.1). Maximum and minimum relative humidity (RH) % for this period ranged from 93.24% - 99.41% and 36.23% - 57.10% where maximum RH 99.41% was recorded in February and it was minimum 36.23% in January. During the study period (sowing date,15 December), there was only 3 mm rainfall but after 22 February at maturity stage about 342 mm of rain was recorded (Fig. 1). About half of the total seasonal rainfall occurred in the last week of February. The total six months rainfall for this period (2018-2019) was 345.00 mm where maximum rainfall (166.00 mm) was recorded in February and it was minimum 3.00 mm in December.

The tubers were covered with dry compost at 5 t ha^{-1}. Over the compost and seed potato, a

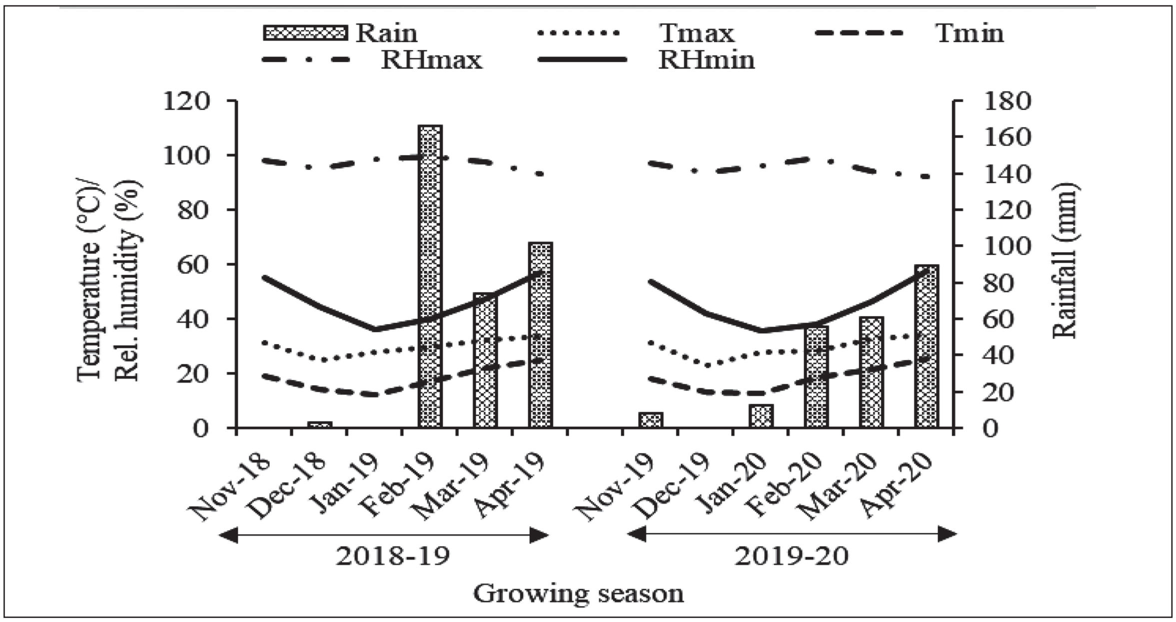

Fig. 1. *Weather details (monthly total rainfal, maximum and minimum average temperature) and maximum and minimum RH (%) for 2018-2019 and 2019-2020 growing season at Tildanga, Dacope, Khulna Bangladesh*

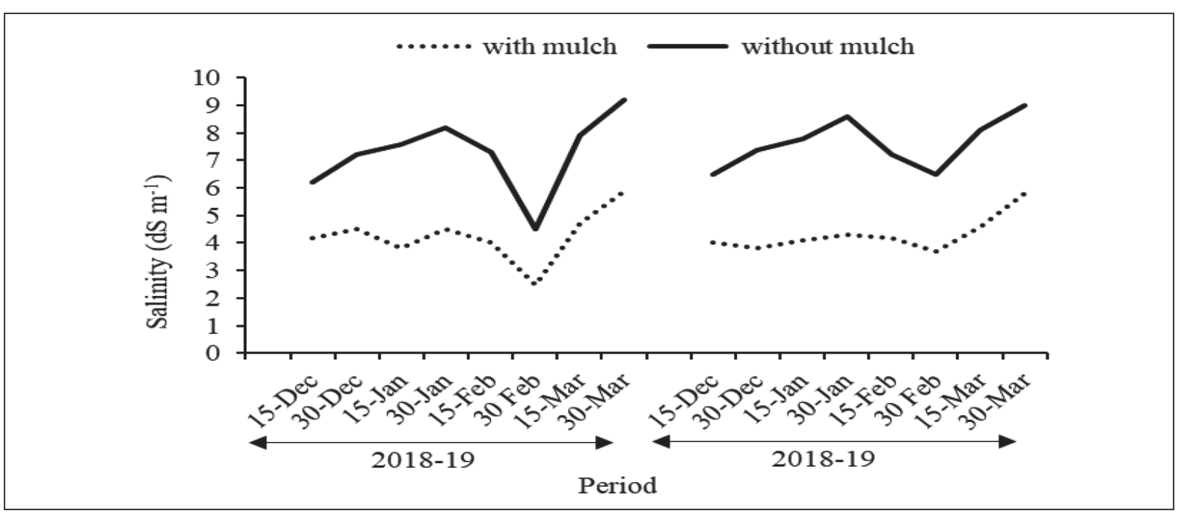

Fig. 2. *Soil salinity during crop growing period 2018-2019 and 2019-2020 at Tildanga, Dacope, Khulna*

thick layer (20-30 cm) of paddy straw (available in plentiful supply in the coastal area) was laid to cover the entire area (as per the package of practices recommended by Sarangi *et al.,* 2021). The residual soil moisture was sufficient for shoot and root emergence from tubers, but irrigation was applied from canal water at three times (25 DAS, 45 DAS and 65 DAS). Fungicide (Dithane M-45) was applied for preventing late blight disease of potato. Soil salinity was monitored throughout the growing season (Fig. 2). The potato crops were harvested when the tubers reached physiological maturity stages and all data from sowing to maturity stage of potato were recorded. All the experimental data were analyzed statistically using R software (Ver. 3.5.0).

RESULTS AND DISCUSSION

Interaction effect of variety and spacing on growth parameters of potato

Plant emergence

The plant emergence recorded after 30 days of planting was significantly affected by the treatments (Table 1). Seedling emergence was greater in close spacing in both years. In 2018-2019, the highest emergence (96.85%) was observed in the combination effect of spacing 55 cm x 15 cm with BARI Alu-41 and lowest (87.36%) was recorded from 55 x 25 cm spacing with BARI Alu-8. In 2019-20, the highest emergence (98.34%) was observed in the combination effect of spacing 25 cm x 15 cm with BARI Alu-41 and lowest (92.87%) was recorded from 55 cm x 15 cm spacing with BARI Alu-8.

Plant height (cm)

Varieties and different spacing of potato resulted significant difference in plant height for both years (Table 1). The combination effect of spacing 55 cm x 15 cm with BARI Alu-41 gave highest plant height (60.74 cm) and lowest (46.25 cm) was recorded from 55 cm x 25 cm spacing with BARI Alu-8 during 2018-2019. In 2019-20, the highest plant height (54.34 cm) was observed in the combination effect of spacing 25 cm x 15 cm with BARI Alu-41 and lowest (42.47 cm) was recorded from 55 cm x 15 cm spacing with BARI Alu-8.

Average number of leaves

BARI Alu 41 and BARI Alu 72 gave statistically similar average number of leaves. At 75 days after planting (DAP), the highest average number of leaves at (75 DAS) (56.32) were observed in from the interaction effect of BARI Alu 41 with 55 cm × 15 cm spacing followed by interaction of BARI Alu 72 with 55 cm × 15 cm spacing and lowest average number of leaves (75 DAP) (46.89) were obtained from the interaction effect of BARI Alu 8 with 55 cm × 25 cm spacing during 2018-2019 (Table 1). At 75 DAP, the highest average number of leaves (60.68) were observed in from the interaction effect of BARI Alu 41 with 25 cm x 15 cm spacing followed by interaction of BARI Alu 72 with 25 cm x 15 cm spacing. The lowest average number of leaves (75 DAP) (50.18) were obtained from the interaction effect of BARI Alu 8 with 55 cm x 15 cm spacing during 2019-2020 (Table 1).

Crop growth rate

Crop growth rate (50-60 DAP) of BARI Alu 41 and BARI Alu 72 were statistically similar. The highest crop growth rate (50-60 DAP) (17.62 g m^{-2} d^{-1}) were obtained from the interaction effect of BARI Alu 72 with 55 cm × 15 cm spacing and the lowest crop growth rate (50-60 DAP) (15.42 g m^{-2} d^{-1}) were obtained from the interaction effect of BARI Alu 8 with 55 cm × 25 cm spacing during 2018-2019 (Table 1). The highest crop growth rate (50-60 DAP) (20.24 g m^{-2} d^{-1}) were obtained from the interaction effect of BARI Alu 41 with 25 cm x 15 cm spacing and the lowest crop growth rate (50-60 DAP) (16.67 g m^{-2} d^{-1}) were obtained from the interaction effect of BARI Alu 8 with 55 cm x 15 cm spacing during 2019-2020 (Table 1).

Morphological characteristics of potato varieties

In their morphological characteristics, the tubers of three potato varieties under study showed great diversity (Table 2). BARI Alu 8 was short-oval, oval, long-oval shape and medium to large size. Tuber colour was red. Skin of tuber was smooth and tuber flesh colour was cream. BARI Alu 41 was round, short-oval, round to flat round in shape and medium to large sized. Tuber colour was purplish red. Skin

Table 1. *Interaction effect of varieties and spacing on growth parameters of potato during 2018-2019 and 2019-2020*

Varieties	2018-2019					2019-2020				
	Spacing	Emergence % (30 DAS)	Plant height (cm)	Average number of leaves (75 DAS)	CGR (50-60 DAS) (g m^{-2} d^{-1})	Spacing	Emergence % (30 DAS)	Plant height (cm)	Average number of leaves (75 DAS)	CGR (50-60 DAS) (g m^{-2} d^{-1})
BARI Alu 8	55 cm x 25 cm	87.36	46.25	46.89	15.42	25 cm x 15 cm	96.23	47.37	57.25	19.74
	55 cm x 15 cm	92.78	52.17	50.58	16.95	30 cm x 15 cm	95.45	45.24	56.57	19.35
	50 cm x 20 cm	89.24	48.67	47.34	16.17	35 cm x 15 cm	95.27	44.12	55.34	18.76
	50 cm x 25 cm	87.45	47.35	45.28	15.76	45 cm x 15 cm	94.65	42.37	52.25	17.25
	45 cm x 25 cm	90.31	50.35	54.62	16.63	55 cm x 15 cm	92.87	42.87	50.18	16.67
BARI Alu 41	55 cm x 25 cm	92.13	54.36	48.72	16.32	25 cm x 15 cm	98.34	52.34	60.31	20.24
	55 cm x 15 cm	96.85	60.74	56.32	17.62	30 cm x 15 cm	97.25	50.66	58.76	19.86
	50 cm x 20 cm	95.47	57.68	54.17	17.20	35 cm x 15 cm	97.12	49.24	58.27	19.23
	50 cm x 25 cm	94.12	55.62	52.78	16.77	45 cm x 15 cm	96.57	47.79	57.63	18.34
	45 cm x 25 cm	96.65	58.47	55.92	17.23	55 cm x 15 cm	96.14	47.34	56.82	17.67
BARI Alu 72	55 cm x 25 cm	90.13	53.78	50.15	15.85	25 cm x 15 cm	97.69	50.75	59.31	19.95
	55 cm x 15 cm	96.15	60.25	55.32	17.15	30 cm x 15 cm	97.18	48.17	57.67	19.68
	50 cm x 20 cm	95.34	56.36	52.67	16.55	35 cm x 15 cm	96.72	46.85	57.22	19.15
	50 cm x 25 cm	93.12	55.16	51.28	16.15	45 cm x 15 cm	96.24	45.34	56.87	18.20
	45 cm x 25 cm	95.85	57.82	54.62	16.78	55 cm x 15 cm	95.97	42.22	56.12	17.53
CV (%)		9.34	12.67	11.23	12.34		10.27	10.34	14.12	14.23
LSD		2.45	2.18	3.42	2.15		2.79	1.90	3.85	2.67

Table 2. *Morphological characteristics of potato varieties*

Variety	Shape and size of tuber	Eye depth	Tuber color	Tuber skin	Tuber flesh colour
BARI Alu 8	Short-oval, oval,long-val shape and medium to large size	Medium	Red	Smooth	Cream
BARI Alu 41	Round, short-oval, round to flat round shape and medium to large size	Medium shallow	Purplish red	Smooth	Light yellow
BARI Alu 72	Short oval shape and medium to large size	Shallow	Red	Smooth	Yellow

of tuber was smooth and tuber flesh colour was light yellow. BARI Alu 72 was short oval shape and medium to large in size. Tuber colour was red. Skin of tuber was smooth and tuber flesh colour was yellow. Alom *et al.* (2003) found out different colors and shape in different varieties of potatoes. Skin of tuber of three varieties were smooth. Tuber flesh colour of BARI Alu 41 was light yellow, yellow for BARI Alu 72 and cream for BARI Alu 8. The size of tubers of all three varieties were medium to large.

Variety and spacing effects on yield and yield contributing characters of potato

Tuber number

Tuber number was significant by the treatments. The highest tuber number (88.78 m^{-2}) was observed from the combination effect of 55 cm x 15 cm with BARI Alu-41 and lowest (65.42 m^{-2}) was recorded from 55 cm x 25 cm spacing with BARI Alu-8 during 2018-2019 (Table 3). In 2019-20, the highest tuber number per (112.25 m^{-2}) was observed in the combination effect of spacing 25 cm x 15 cm with BARI Alu-41 and lowest (80.42 m^{-2}) was recorded from 55 cm x 15 cm spacing with BARI Alu-8 (Table 3). Similar finding was observed by Harnet *et al.* (2014) who indicated that the maximum number of tubers at closer intra-row spacing is due to the high number of plants per unit area.

Tuber yield

From the Table 3, it was revealed that significantly the highest yield (17.45 t ha^{-1}) were obtained from the interaction effect of BARI Alu 41 with 55 cm × 15 cm spacing followed by interaction of BARI Alu 72 with 55 cm × 15 cm spacing and the lowest yield (11.75 t ha^{-1}) was observed in the interaction effect of BARI Alu 8 with 55 cm × 25 cm spacing during 2018-2019. In the second year (2019-2020), the interaction effect of BARI Alu 41 with 25 cm x 15 cm gave maximum yield (20.30 t ha^{-1}) and lowest yield was observed in BARI Alu 8 with 55cm x 15cm spacing (15.14 t ha^{-1}) (Table 3). The result of the present study was also similar with the findings of Masarirambi *et al.* (2012) who indicated that reducing the intra-row spacing from 45 to 30 cm significantly increased plant population and subsequently increased the total tuber yield.

Tuber size distribution

In general, the higher planting densities resulted in smaller tubers across all varieties. This is in agreement with Getachew *et al.* (2013) who concluded that tuber bulking of individuals at close spacing was reduced and resulted in small tubers. Khalafalla (2001) and Mutetwa (2010) found closer spacing to result in smaller tuber sizes. Therefore, different varieties have different capacities of producing different tuber sizes based on number of tubers that a particular variety can set. In 2018-2019, the interaction effect of BARI Alu 41 with 55 cm × 15 cm spacing gave 9.13 t ha^{-1} grade B (40-55 mm) size tubers (Table 3). Again, the interaction effect of BARI Alu 41 with 55 cm × 25 cm spacing gave highest (3.12 t ha^{-1}) over grade < 55 mm size tubers than other interaction effects. The highest under grade tuber > 28 mm (1.65 t ha^{-1}) was observed in the interaction effect of BARI Alu 8 with 50 cm × 20 cm spacing. In 2019-2020, the interaction effect of BARI Alu 41 with 55 cm × 15 cm spacing gave 9.13 t ha^{-1} grade B (40-55) mm size tubers (Table 5). Again, the interaction effect of BARI Alu 41 with 25 cm x 15

Table 3. *. Interaction effect of varieties and spacing on yield and yield contributing characters of potato during 2018-2019 and 2019-2020*

Varieties	Spacing	2018-2019						2019-2020					
		Tuber no. m^{-2}	Total yield (t ha^{-1})	Tuber size (t ha^{-1})				Tuber no. m^{-2}	Total yield (t ha^{-1})	Tuber size (t ha^{-1})			
				Under grade > 28mm	Grade A (28-40) mm	Grade B (40-55) mm	Over grade <55 mm			Under grade > 28mm	Grade A (28-40) mm	Grade B (40-55) mm	Over grade <55 mm
BARI Alu 8	55 cm x 25 cm	65.42	11.75	0.60	1.14	7.13	2.88	108.36	19.84	5.64	7.57	6.00	0.63
	55 cm x 15 cm	84.87	16.45	1.25	4.53	8.36	2.31	104.45	18.75	3.34	7.36	7.00	1.05
	50 cm x 20 cm	70.66	15.10	1.65	4.02	7.56	1.87	98.13	17.85	2.40	4.87	8.45	2.13
	50 cm x 25 cm	68.57	13.52	1.36	3.34	6.77	2.05	90.96	17.15	0.75	4.10	9.15	3.15
	45 cm x 25 cm	80.14	15.26	1.45	5.67	6.03	2.11	80.42	15.14	0.32	2.42	9.22	3.18
BARI Alu 41	55 cm x 25 cm	70.23	12.81	0.45	1.70	7.54	3.12	112.25	20.30	3.43	8.56	7.41	0.85
	55 cm x 15 cm	88.78	17.45	0.63	5.13	9.13	2.56	107.56	19.45	2.15	8.15	8.01	1.14
	50 cm x 20 cm	75.45	15.79	1.23	3.65	8.47	2.44	101.15	18.57	1.27	5.36	9.50	2.44
	50 cm x 25 cm	72.45	14.38	1.25	3.50	7.44	2.19	95.56	17.79	0.43	4.33	9.58	3.45
	45 cm x 25 cm	82.23	16.27	1.05	6.30	6.47	2.45	86.36	16.45	0.19	2.64	10.12	3.50
BARI Alu 72	55 cm x 25 cm	69.66	12.77	0.55	1.67	7.45	3.10	110.89	20.12	4.50	8.34	6.50	0.78
	55 cm x 15 cm	86.56	16.88	0.75	4.77	9.02	2.34	105.45	19.15	3.20	7.89	6.96	1.10
	50 cm x 20 cm	73.58	15.42	1.20	3.56	8.30	2.36	100.87	18.23	2.36	5.10	8.37	2.40
	50 cm x 25 cm	71.64	14.27	1.30	3.47	7.36	2.14	94.13	17.68	0.65	4.25	9.52	3.26
	45 cm x 25 cm	82.18	15.85	1.10	6.23	6.20	2.32	84.24	16.14	0.29	2.72	9.65	3.48
CV%		14.13	10.86	6.75	10.57	11.92	7.81	15.32	12.25	8.25	11.17	13.23	9.45
LSD		3.87	2.83	1.02	5.17	5.12	1.68	4.87	3.47	2.78	6.81	7.62	2.32

Table 4. *Economic performance of potato in respect to combined effects of varieties and spacing during 2018-2019 and 2019-2020*

Varieties	Spacing	2018-2019				2019-2020			
		Gross return (Tk ha^{-1})	Total variable cost (Tk ha^{-1})	Gross margin (Tk ha^{-1})	Benefit cost ratio (Tk ha^{-1})	Gross return	Total variable cost (Tk ha^{-1})	Gross margin (Tk ha^{-1})	Benefit cost ratio
BARI Alu 8	55 cm x 25 cm	235000	155200	79800	1.52	396800	158400	238400	2.51
	55 cm x 15 cm	329000	158300	170700	2.08	375000	158200	216800	2.37
	50 cm x 20 cm	302000	158600	143400	1.91	357000	157700	199300	2.27
	50 cm x 25 cm	270400	158400	112000	1.71	343000	156700	186300	2.19
	45 cm x 25 cm	305200	159200	146000	1.92	302800	156100	146700	1.94
BARI Alu 41	55 cm x 25 cm	256200	155200	101000	1.65	405000	158400	246600	2.56
	55 cm x 15 cm	349000	158300	190700	2.21	389000	158200	230800	2.46
	50 cm x 20 cm	315800	158600	157200	2.00	370800	157700	213100	2.36
	50 cm x 25 cm	287600	158400	129200	1.82	355800	156700	199100	2.27
	45 cm x 25cm	325400	159200	166200	2.05	329000	156100	172900	2.11
BARI Alu 72	55 cm x 25 cm	255400	155200	100200	1.65	402400	158400	244200	2.54
	55 cm x 15 cm	337600	158300	179300	2.14	383000	158200	225100	2.42
	50 cm x 20 cm	308400	158600	149800	1.95	364600	157700	206900	2.31
	50 cm x 25 cm	285400	158400	127000	1.81	353600	156700	196900	2.26
	45 cm x 25 cm	317000	159200	157800	2.0	322800	156100	166700	2.07

cm spacing gave highest A (28-40) mm size tubers than other interaction effects (Table 3). Grade A and Grade B type tubers demand in market are higher and more economically profitable.

Cost and return analysis

Cost and return analysis is an important tool to evaluate the economic feasibility of crop cultivation. Benefit cost analysis of potato production as influenced by interaction effect of varieties and spacing has been presented in Table 4. In 2018-2019, among the treatments, the maximum gross return (Tk. 349000 ha^{-1}), gross margin (Tk. 190700 ha^{-1}) and maximum benefit cost ratio (BCR of 2.21) were observed in the interaction effect of BARI Alu 41 with 55 cm × 15 cm spacing followed by interaction of BARI Alu 72 with 55 cm × 15 cm spacing. The lowest gross return (Tk. 235000 ha^{-1}), gross margin (Tk. 79800 ha^{-1}) and BCR (1.52) were observed in the interaction effect of BARI Alu 8 with 55 cm × 25 cm spacing. In 2019-2020, the maximum gross return (Tk. 405000 ha^{-1}), gross margin (Tk. 246600 ha^{-1}) and maximum BCR (2.56) were observed in the interaction effect of BARI Alu 8 with 25 cm x 15 cm spacing followed by interaction of BARI Alu 72 with 25 cm x 15 cm spacing and the lowest gross return (Tk. 302800 ha^{-1}), gross margin (Tk. 146700 ha^{-1}) and BCR (1.94) were observed in the interaction effect of BARI Alu 8 with 55 cm x 15 cm spacing.

CONCLUSION

Crop production in coastal saline zones especially during the *Rabi* season (dry season) is very poor due to the increase in soil salinity and shortage of fresh irrigation water. In this study, during 2018-2019, the highest yield (17.45 t ha^{-1}) was obtained from the interaction effect of BARI Alu 41 with 55 cm × 15 cm spacing and the lowest yield (11.75 t ha^{-1}) was observed in the interaction effect of BARI Alu 8 with 55 cm × 25 cm spacing.

But in 2019-2020, the highest tuber number (112.25 m^{-2}) and maximum yield (20.25 t ha^{-1}) were observed in the combination effect of variety BARI Alu 41 with 25 cm x 15 cm close spacing and lowest yield was observed in BARI Alu 8 with 55 cm x 15 cm spacing (15.14 t ha^{-1}). The maximum gross return (Tk. 405000 ha^{-1}), gross margin (Tk. 246600 ha^{-1}) and maximum BCR (2.56) were observed in the interaction effect of 25 cm x 15 cm spacing with BARI Alu 41. Hence, on the basis of maximum yield and highest benifit cost ratio (BCR) of potato, close spacing (25 cm x 15 cm) and BARI Alu 41 can be recommended for zero tillage method in the saline prone areas. In saline areas using the zero-tillage method, close spacing is needed because of less vigorous growth (emergence %, average number of leaves, plant height, etc) and lower yield of potato varieties (stressed environment) than other potato growing areas of Bangladesh. However, yield of the salt-tolerant potato varietiy BARI Alu 41 was high enough to be profitable in the coastal region of Bangladesh under saline stress conditions. As BARI Alu 41 has red tuber color, they possibly contain a high concentrations of phytonutrients with antioxidant activity that are health-promoting attributes. For successful potato cultivation in coastal saline soils, zero tillage planting and optimal spacing (25 cm x 15 cm) should be followed. Further investigation is needed in other parts of the saline belt of Bangladesh in order to confirm the present findings.

CONFLICTS OF INTEREST

There is no conflict of interest among all the authors.

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