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EFFECT OF SOWING DATE AND SPACING ON DRY MATTER PRODUCTION AND YIELD IN TROPICAL SUGAR BEET

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ABSTRACT

Kashem MN, Khaliq QA, Karim MA, Karim AJMS, Ahmed MM (2015) Effect of sowing date and spacing on dry matter production and yield in tropical sugar beet. *Int. J. Sustain. Crop Prod.* 10(2), 1-5.

A field experiment was conducted at the research farm of the Department of Agronomy, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh from November 2011 to May 2012 with four sowing dates *viz*. 01 November, 15 November, 01 December and 15 December 2011 following four plant spacings *viz.* 50 × 25 cm, 50 × 20 cm, 40 × 20 cm and 40 × 18 cm to find out the optimum sowing date and spacing of sugar beet. Total dry matter production of sugar beet and its partitioning into root, petiole and leaf blade decreased with delay in sowing after 01 November. The highest total dry matter and root dry matter were recorded at the spacing of 50 × 20 cm, and petiole and leaf blade dry matter were recorded at the closest spacing of 40 × 18 cm when the plants were sown on 01 November. The individual root weight and root yield in sugar beet significantly decreased with delay in sowing after 15 November. The highest root weight (1154 g) and root yield (91.2 t ha^{-1}) per plant were recorded at 165 days after emergence (DAE) from 01 November sowing at the spacing of 50 × 20 cm. Therefore, for optimum yield of tropical sugar beet in Bangladesh, the crop might be sown in early November with a spacing of 50 × 20 cm.

Key words: *tropical sugar beet, sowing date, spacing, dry matter, yield*

INTRODUCTION

Sugar beet (*Beta vulgaris* L.) ranks second next to sugarcane in terms of world's sugar production. Sugar beet provides about 40% of sugar production in the world. Planting sugar beet at proper time with optimum population plays a vital role in sugar beet production. It has been suggested that November to April is the best time for growing tropical sugar beet in Bangladesh (BSRI 2011). Abd EL-Gawad *et al.* (2000) found that early planting dates produced thicker and heavier sugar beet root and top yield as well as sugar yield. It was hypothesized that optimum plant spacing will ensure the tropical sugar beet to grow properly through efficient utilization of space, nutrients, light and moisture and thus would contribute to maximize the yield of sugar beet. Research work on spacing of the tropical sugar beet genotypes has not been taken yet and as a consequence the optimum plant density was not determined for the production of tropical sugar beet. In Bangladesh farmers as well as extension personnel are asking for a package of production technology with a clear recommendation of optimum plant population per unit area.

The composition of sugar beet is mainly affected by cultivation methods like planting date and population density (Märländer 1992). Root yield was affected by plant spacing, sowing dates and interaction effect of plant spacing and sowing date in a field experiment (Söğüt and Arıoğlu, 2004). Root yield was also affected by plant spacing and sowing date.

Since tropical sugar beet is a recently introduced sugar crop in Bangladesh, not much information on its cultivation; particularly optimum sowing dates and spacing is available under agro climatic conditions of Bangladesh. Therefore, the present study has been undertaken to determine the sowing time and optimum spacing of tropical sugar beet for higher beet yield under Bangladesh agro-ecological condition.

MATERIALS AND METHODS

Experimental site

The experiment was conducted in the experimental field of the Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur from November 2011 to May 2012 on an upland soil. The experimental site was about 40 km North to Dhaka city with 24.09' North latitude and 90.26° East longitude and an elevation of 8.40 m above the sea level.

Planting materials

Tropical sugar beet variety 'Shubhra' was used as a test crop. Seeds of this variety were collected from Syngenta, Bangladesh.

Cultivation procedures

The experimental land was prepared thoroughly. As sugar beet prefers alkaline soil dolomite was applied @ 1500 kg ha^{-1} (Islam *et al*. 2010). The experiment was laid out in a strip plot design with three replications. The unit plot size was 3 m × 2 m. During final land preparation cow dung @ 15 t ha^{-1} was incorporated into the soil. A fertilizer dose @ 120 kg N, 105 kg P, 150 kg K, 18 kg S, 3.5 kg Zn and 1.2 kg B ha^{-1} was applied in the form of urea, triple super phosphate, muriate of potass, gypsum, $ZnSO_4$ and boric acid, respectively. All fertilizers and one third of urea were applied during final land preparation. The remaining amount of urea was applied as

two top dressings 55 and 90 days after sowing (DAS). Sugar beet seeds were sown in lines on four sowing date (01 Nov. 15 Nov, 01 Dec and 15 Dec) following four different spacing's such as 50×25 cm, 50 × 20 cm, 40 × 20 cm and 40 × 18 cm which were corresponded to plant population of 80000 ha^{-1}, 100000 ha^{-1}, 125000 ha^{-1} and 138888 ha^{-1}, respectively. Light irrigation was done immediately after sowing to ensure uniform emergence. To ensure optimum soil moisture irrigation was done twice in a week up to maturity till April. Intercultural operations were done uniformly in each plot to ensure normal growth of the crop. Weeding and mulching were done simultaneously in the experimental plots at 20, 40 and 60 DAS. Plant was thinned out keeping one plant per hill during the second weeding. Earthling up was done at 55 and 90 DAS after top dressing of nitrogen. Dithane M 45 @ 2.2 kg ha^{-1}, Tilt 1 ml/L of water and Score 250 EC 0.5 ml/L of water were used to control damping off, sclerotium root rot and cercospora leaf spot diseases. Durshban @ 2.5 ml/L of water was applied for controlling cut warm, tobacco caterpillar and army warm.

Data collection

Data regarding yield and yield attributes like dry mater partitioning into root, leaf blade and petiole, Root and Shoot fresh weight, Root:Shoot ratio at 120 DAE to 165 DAE and
Root yield per m^2 and per ha were collected, analyzed and interpreted.

Statistical analysis

The crop was harvested on 15 April and collected data were statistically analyzed with the help of MSTAT-C program with LSD test at 5% level of significance.

RESULTS AND DISCUSSION

Effect of sowing dates and plant spacing on total dry matter production of sugar beet

The production of economic yield is greatly determined by the production of total dry matter and its partitioning to the economic part (Singh *et al*. 1998). Different sowing dates and spacings showed a significant influence on the total dry matter (TDM) production and dry matter accumulation into roots of tropical sugar beet over time (Fig. 1a & 1b). At 165 DAE, the highest total dry matter of 2916.6 gm^{-2} was recorded in the spacing of 50 × 20 cm sown on 01 November and which was statistically similar to that of 15 November sowing with same spacing. After 60 DAE the roots accumulated dry matter more rapidly up to 150 DAE and thereafter slowly till final harvest at 165 DAE. The highest root dry matter (2530.28 gm^{-2}) was found at 165 DAE in 01 November sowing with 50 × 20 cm spacing, followed by that of 15 November sowing with 50 × 20 cm spacing.

These results suggest that sowing of sugar beet in between 01 November and 15 November with 50 × 20 cm spacing is the best for higher dry matter yield in the tested environmental conditions.

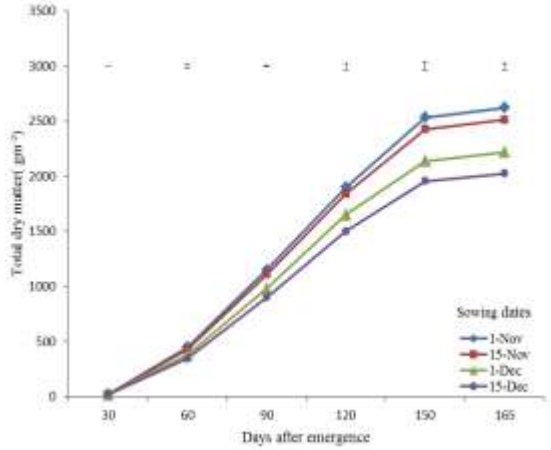

Fig. 1a. Total dry mater production in tropical sugar beet (g m^{-2}) over time as influenced by sowing dates. Vertical bar indicates LSD 0.05

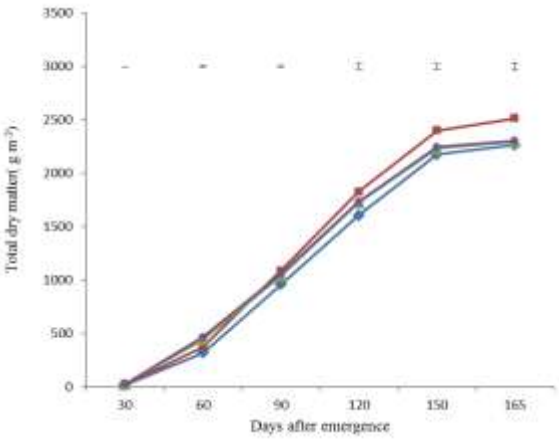

Fig. 1b. Total dry mater production in tropical sugar beet (gm^{-2}) over time as influenced by spacings. Vertical bar indicates LSD 0.05

Effect of sowing dates and plant spacing on root dry matter of sugar beet

Root dry matter production of tropical sugar beet was significantly influenced by sowing dates and spacings (Fig. 2a & 2b). Irrespective of sowing dates and spacings, during the first few weeks of growth the rate of root dry matter accumulation was very slow, and from 60 DAE the roots began to accumulate dry matter more rapidly up to 150 DAE and thereafter slowly till final harvest at 165 DAE. Similar results were also reported by Theurer (1979) in sugar beet. The highest root dry matter (2530.28 g m^{-2}) was found at 165 DAE with 01 November sowing and 50 × 20 cm spacing followed by 15 November sowing and 50 × 20 cm spacing, while the interaction between 15 December and 50 × 25 sown plants gave the lowest root dry matter (1682.78 g m^{-2}). This might be due to prevailing high temperature during root formation stages of later sown plants compare to early

sown plants or because of in wider spacing inadequate number of plants and in closer spacing over population. These results indicate that sowing dates of sugar beet should be in between 01 November and 15 November with 50 × 20 cm spacing for higher root dry matter yield in Gazipur agro climatic conditions.

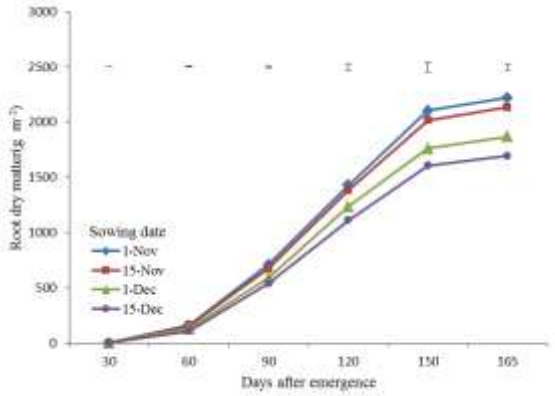

Fig. 2a. Root dry matter (g m^{-2}) in tropical sugar beet over time as influenced by sowing dates. Vertical bar indicates LSD 0.05

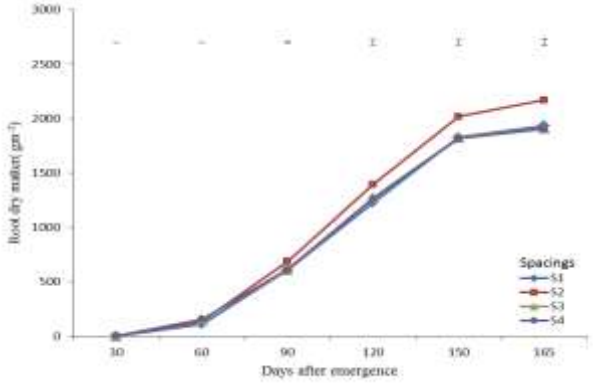

Fig. 2b. Root dry matter (g m^{-2}) in tropical sugar beet over time as influenced by four spacings (S1 = 50 × 25 cm, S2 = 50 × 20 cm, S3 = 40 × 20 cm, S4 = 40 × 18 cm). Vertical bar indicates LSD 0.05

Effect of sowing dates and plant spacing on plant weight, root and shoot fresh weight of sugar beet

Whole plant fresh weight, root fresh weight and shoot fresh weight per plant of tropical sugar beet were significantly affected by the sowing dates and spacings (Table 1 and 2). The whole plant fresh weight production (1565.9 g $plant^{-1}$) was significantly higher in November sowings with a spacing of 50 × 25 cm than in December sowings (1303.7 g $plant^{-1}$). It might be due to increased photosynthesis resulted by higher leaf area and thereby increased individual plant fresh weight production.

The highest root fresh weight per plant (1154 g $plant^{-1}$) was found at 165 DAE with the interaction between 01 November sowing and 50 × 25 cm spacing, followed by the interaction between 15 November sowing and 50 × 25 cm spacing which were statistically identical. While the interaction between 15 December sowing and 40 × 18 cm spacing plants gave the lowest root fresh weight per plant (630 g $plant^{-1}$). This might be possible due to the prevailing high temperature during root development in the plants of 15 December sowing than in the plants of 01 November and 15 November sowings. This high temperature might cause less translocation of assimilates to the developing roots and more respiratory loss of assimilates. Tsialtas (2008) also found high respiratory loss in sugar beet at high temperature.

Table 1. Individual plant fresh weight in tropical sugar beet shubhra under different sowing dates and spacings

Treatment		Plant fresh weight (g $plant^{-1}$)			
Sowing date	Spacing	120 DAE	135 DAE	150 DAE	165 DAE
01 November	50 × 25 cm	1194.42	1379.71	1549.51	1565.96
	50 × 20 cm	1161.96	1342.53	1497.39	1510.6
	40 × 20 cm	872.70	914.64	1018.94	1024.24
	40 × 18 cm	757.18	817.88	937.46	958.63
15 November	50 × 25 cm	1185.01	1368.19	1528.48	1552.78
	50 × 20 cm	1144.37	1314.64	1448.16	1469.87
	40 × 20 cm	842.59	908.89	1000.77	1013.53
	40 × 18 cm	737.64	814.07	938.32	966.81
01 December	50 × 25 cm	1135.40	1289.86	1397.56	1433.12
	50 × 20 cm	1016.44	1194.99	1291.08	1323.87
	40 × 20 cm	761.92	877.74	971.95	988.86
	40 × 18 cm	727.86	798.77	910.53	932.81
15 December	50 × 25 cm	1097.37	1240.26	1274.56	1303.71
	50 × 20 cm	972.77	1153.25	1218.62	1240.84
	40 × 20 cm	755.40	850.30	902.65	908.72
	40 × 18 cm	723.02	790.70	854.61	865.64
LSD (0.05)		23.98	21.39	33.01	44.38
CV (%)		2.48	3.17	4.64	5.17

Table 2. Root fresh weight per plant of tropical sugar beet shubhra under different sowing dates and spacings

Treatment		Root fresh weight (g plant^{-1})			
Sowing date	Spacing	120 DAE	135 DAE	150 DAE	165 DAE
01 November	50 × 25 cm	739.7	933.7	1109.2	1154.1
	50 × 20 cm	718.0	911.3	1077.4	1111.3
	40 × 20 cm	538.3	612.7	728.3	753.0
	40 × 18 cm	466.7	547.0	669.0	700.7
15 November	50 × 25 cm	732.7	926.3	1093.3	1136.4
	50 × 20 cm	705.7	888.7	1031.4	1073.2
	40 × 20 cm	519.7	613.3	715.0	747.30
	40 × 18 cm	452.7	545.7	672.0	709.7
01 December	50 × 25 cm	701.0	875.0	993.3	1046.5
	50 × 20 cm	627.0	814.0	917.0	964.3
	40 × 20 cm	470.0	597.7	696.0	730.3
	40 × 18 cm	449.0	534.0	649.0	684.7
15 December	50 × 25 cm	677.3	840.0	893.3	947.3
	50 × 20 cm	594.7	782.3	858.0	904.7
	40 × 20 cm	466.0	572.7	636.3	663.7
	40 × 18 cm	446.0	530.7	602.7	629.7
LSD (0.05)		17.43	11.17	36.67	39.38
CV (%)		4.75	3.99	5.56	5.63

Effect of sowing dates and plant spacing on root weight of sugar beet per square meter and root yield of sugar beet

Root weight per plant or individual root weight is the most important yield contributing character of sugar beet. Effects of sowing date and spacing also had significant influence on root fresh weight per square meter. The highest root fresh weight per square meter (9.13 kg m^{-2}) was found at 165 DAE with 01 November sowing and 50 × 20 cm spacing, followed by 15 November sowing and 50 × 20 cm spacing (8.85 kg m^{-2}), which were statistically identical. These results indicate that sowing date and spacing of tropical sugar beet should be in between 01-15 November with 50 × 20 cm spacing.

A significant variation in root yield was also observed due to effect of sowing dates and spacings (Table 3). It appears that the highest root yield (91.26 t ha^{-1}) was obtained in 01 November sowing followed by 15 November sowing (88.53 t ha^{-1}) with 50 × 20 cm spacing. The spacing of 50 × 25 cm gave identical root yield when sown on 01 November and 15 November and their root yield significantly decreased with delay in sowing. The spacing of 50 × 20 cm gave the highest root yield and closer spacings of 40 × 20 cm and 40x18 cm produced lower root yield at all sowing dates. These findings indicate that sowing of tropical sugar beet in between 01 November to 15 November with 50 × 20 cm spacing is the best for higher root yield in the tested environmental conditions. The results revealed that root yield of tropical sugar beet significantly decreased with delay in sowing. Similar result was obtained in case of sugar beet by Rahman (2011) at Bangladesh Sugarcane Research Institute farm Ishurdi, Pabna, Bangladesh; Rahman *et al*. (2006); BRAC (2010) in Gazipur, Dinajpur, Rajshahi, Thakurgaon, Patuakhali; BSRI (2005) in Pabna, Bangladesh.

Table 3. Root yield in tropical sugar beet shubhra under different sowing dates and spacings at harvest(165 DAE)

Treatments		Root weight (kg m^{-2})	Root yield (t ha^{-1})
Sowing date	Spacing		
01 November	50 × 25 cm	8.27	82.63
	50 × 20 cm	9.13	91.26
	40 × 20 cm	7.81	78.08
	40 × 18 cm	7.78	77.75
15 November	50 × 25 cm	8.20	81.99
	50 × 20 cm	8.85	88.53
	40 × 20 cm	7.56	75.58
	40 × 18 cm	7.49	74.86
01 December	50 × 25 cm	7.05	70.52
	50 × 20 cm	7.91	79.14
	40 × 20 cm	7.08	70.75
	40 × 18 cm	7.04	70.35
15 December	50 × 25 cm	6.37	63.67
	50 × 20 cm	7.41	74.05
	40 × 20 cm	6.54	65.38
	40 × 18 cm	6.57	65.73
LSD (0.05)			3.58
CV (%)			5.76

Functional relationships between individual root weight and root yield, shoot weight and root yield have been shown in Figures 3a and 3b, respectively. In both the cases respective figure shows a positive linear relationship. Therefore, for getting maximum yield optimum sowing date for tropical sugar beet in Bangladesh condition seems to be early November and appropriate spacing seems to be 50×20 cm. The crop should be harvested at around 165 DAE if sown in early November.

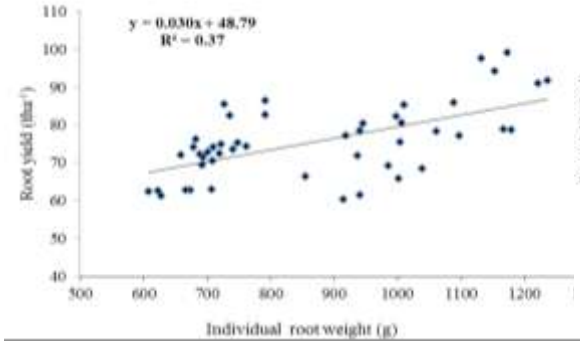

Fig. 3a. Relationship between individual root weight and root yield in tropical sugar beet genotype Shubhra

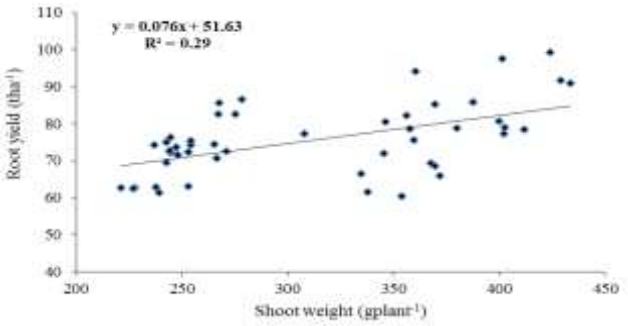

Fig. 3b. Relationship between individual shoot weight and root yield in tropical sugar beet genotype Shubhra

CONCLUSION

Experimental result revealed that the optimum sowing date under Bangladesh condition seems to be early November for getting optimum growth, yield and quality of tropical sugar beet *var.* Shubhra. For high root and sugar yield the appropriate spacing for tropical sugar beet in Bangladesh seems to be 50 × 20 cm. For high root and sugar yield the crop should be harvested at around 165 DAE if sown in early November.

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