Yield and Quality of Tropical Sugarbeet as Influenced by Spacing

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ABSTRACT

Many agronomic practices may need to be adjusted to maximize yield and quality of sugarbeet. Thus, agronomic package must be always modified. To get higher economic returm from sugarbeet appropriate spacing might be the alternative way to increase total yield and quality. The experiment was conducted in research farm of Agronomy and Farming Systems Division, Bangladesh Sugarcrop Research Institute (BSRI), Ishurdi, Pabna, Bangladesh during the year of 2012-13 cropping season to determine the effect of spacing on yield and quality of tropical sugarbeet which was laid out in a Randomized Complete Block Design with three replications. Nine treatment combination (row to row × plant to plant) viz., 50 cm × 20 cm, 60 cm × 20 cm, 70 cm × 20 cm, 50 cm × 25 cm, 60 cm × 25 cm, 70 cm × 25 cm, 50 cm × 30 cm, 60 cm × 30 cm and 70 cm × 30 cm were used dry sowing method at about 2 cm depth. The yield and quality of tropical sugarbeet was affected by the plant spacing. The effects of spacing were statistically significant on yield and yield contributing components (beet length, beet girth, beet yield, sugar yield) and yield quality characters like total soluble solids (TSS), sucrose percentage etc. The highest beet length (37.70 cm) and beet girth (44.99 cm) were obtained from 50 cm x 20 cm and 70 cm x 30 cm spacing respectively. The highest beet and shoot yields (76.73 t ha^{-1} and 38.54 t ha^{-1}, respectively) were observed in 50 cm x 20 cm spacing. The highest sugar yield (11.99 t ha^{-1}) was found in 50 cm x 20 cm spacing. In case of quality charecters, the highest TSS and sucrose (21.83% and 15.63%, respectively) were derived from 50 cm x 20 cm spacing. Therefore, it may be concluded that closer spacing 50 cm x 20 cm might be recommended for cultivation of tropical sugarbeet in Bangladesh context which produced the highest beet and sugar yield.

Key words: Spacing, beet yield, quality, tropical sugarbeet

INTRODUCTION

Sugarbeet (*Beta vulgaris*) is one of the most important crops in a wide variety of temperate climates (Sohrabi and Heidari, 2008; Abdel-Motagally and Attia, 2009). It ranks the second as sugar crop after sugarcane in the world. Sugarbeet is grown nearly in 40 countries and accounts for up to 40 to 45% of the total world sugar production (Shahl *et al.*, 2000). Sugarbeet is a fleshy root crop processed for sugar production. Sugarbeet matures in five to six months (David and Young, 1981). Sugarbeet has an average sugar content of 14-20% and optimal beet yield of 80 to 100 t ha^{-1} for the tropical climates whereas the values are 15% sugar and 40 to 60 t ha^{-1} beet yield for temperate climates (Syngenta, 2004). At present, total production of

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sugar including *goor* is only 0.63 million tons in Bangladesh, which covers 25% of total national demand. Therefore, there is a big gap of 1.50 million tons of sugar/*goor.* The amount of sugar produced from sugarcane is not sufficient to meet the demand of our country. The total demand is increasing with increasing population whereas supply is decreasing with decreasing acreage of sugarcane. So it is very important for the country to move towards an alternative crop to produce more sugar per year. Sugarbeet is mainly temperate crop, but for tropical region such as India, Pakistan, Bangladesh etc. the international company Syngenta developed and successfully introduced some new sugarbeet genotypes that can be grown under tropical climatic conditions which is known as "tropical sugarbeet".

Sugarbeet yield is influenced by various agronomic practices such as the suitable variety, spacing, fertilizer management and date of sowing. The optimum spacing in sugarbeet is necessary to achieve higher beet yields. Sugarbeet leaves comprise the main light receptor organ. Early leaf area development during the growing season results in more efficient use of sunlight, since it is important for the formation and expansion of canopy (Sarmadnia and Koocheki, 1997). There is a close relationship between yield and production of leaf area. Yield is affected by the amount of radiation received by the leaves (Fortune *et al.*, 1999). Sadre *et al.* (2012) showed that many factors influence the optimum plant population for a crop: availability of water, nutrients and sunlight, length of growing season, potential plant size and the plant's capacity to change its form in response to varying environmental conditions. Plant density has been recognized as a major factor in determining the degree of competition between plants. They found plant density had significant influence on beet yield and white sugar yield. Root yield is also affected by plant spacings. Many researchers have conducted experiments to determine the optimum plant population density for obtaining high beet yield. Kashem (2014) found that for optimum growth, yield and quality of tropical sugarbeet in Bangladesh, the crop might be sown in early November with a spacing of 50 cm x 20 cm. Jafarnia *et al.* (2013) observed that 90,000 plants ha^{-1} density gave the desired quality of sugarbeet with the minimum impurities and the maximum sugar yield. The highest beet and sugar yields were found from 70,000-110,000 plants ha^{-1} (Ramazan, 2002). Mahmoud *et al.* (1999) also found that widening the distance between plants from 15 cm to 20 cm in row width of 60 cm significantly increased weight of individual beet, beet yield. The aim of the present investigation is to determine the optimum spacing for high root yield and quality of tropical sugarbeet under Bangladesh condition.

MATERIALS AND METHODS

This investigation was laid out in a Randomized Complete Block Design with three replications during the year of 2012-2013 cropping season at BSRI farm, Ishurdi, Pabna, Bangladesh. Each plot size was 4.0 m x 4.0 m i.e. 16 m^2. The adjacent replications were separated from one another by keeping 2m space and distance between two adjacent plots was 1.0 m. Sugarbeet has been sown on 06

November 2012. Nine treatments combination (row to row × plant to plant) viz., 50 cm × 20 cm, 60 cm × 20 cm, 70 cm × 20 cm, 50 cm × 25 cm, 60 cm × 25 cm, 70 cm × 25 cm, 50 cm × 30 cm, 60 cm × 30 cm and 70 cm × 30 cm were used dry sowing method at about 2 cm depth. The land was uniformly fertilized with 260 kg Urea, 100 kg Triple Super Phosphate (TSP), 225 kg Muriate of Potash (MoP), 100 kg Gypsum, 10 kg Zinc Sulphate and 7 kg Boric Acid ha^{-1} as per BSRI suggestions (BSRI, 2011). Three weedings were done at 30, 50 and 70 DAS for the study. Plants were thinned at the age of 35 days after sowing to obtain one plant $hill^{-1}$. Earthing-up was done to cover the root base and to facilitate drainage operation. Construction and re-construction was performed during each time of weeding. The experimental field was irrigated 3 times at 45, 90 and 125 DAS. The experimental crops were harvested separately at full maturity after 5.5 month of sowing. Plants were infected by sclerotium root rot disease which was controlled by spraying fungicide named Tilt @ 1 ml L^{-1} of water followed by raking of soil. At later stage i.e., around 120 DAS, both beet and leaves were also attacked by sugarbeet caterpillar (*Spodoptera litura*), which was controlled by applying Nitro 505 EC @ 4.0 L ha^{-1} of water at 15 days interval. Data collection for yield and yield components (beet length, beet girth, beet yield, sugar yield and yield quality characters (total soluble solids, sucrose percentage and apparent purity percentage) were done. All data were statistically analyzed according to the technique of analysis of variance (ANOVA) by means of "STATISTIX-10" Computer software package for windows version (Statistix-10, 2013) and treatment means were compared at 5% level of probability using the least significant difference (LSD) method.

RESULTS AND DISCUSSION

Beet length (cm) and beet girth (cm)

There was a significant influence by spacing on beet length and beet girth of tropical sugarbeet at harvest (Figure 1 and Figure 2). General trend was an increase in beet length with decrease of spacing and increase in beet girth with increase of spacing. The maximum beet length and beet girth (37.70 cm and 44.99 cm, respectively) were obtained from 50 cm x 20 cm and 70 cm x 30 cm spacing but the lowest (31.83 cm and 36.87 cm, respectively) were recorded in 70 cm x 30 cm and 50 cm x 20 cm spacing, respectively. This may be happened due to inadequate number of plants in wider spacing and over population in closer spacing. Pospisil *et al.* (2000) reported that increasing plant population in closer spacing resulted in leaf surface reduction in each plant.

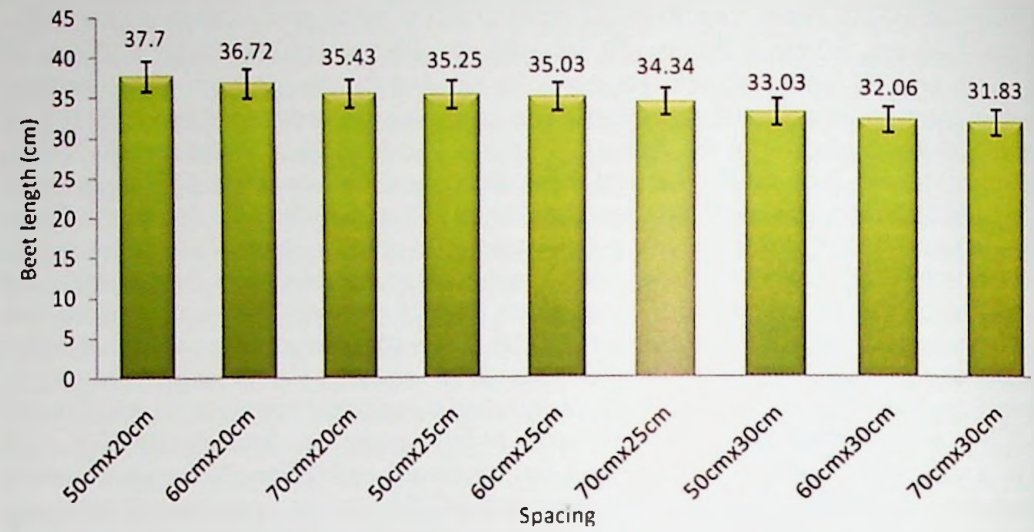

Figure 1. Beet length (cm) as affected by spacing at harvest

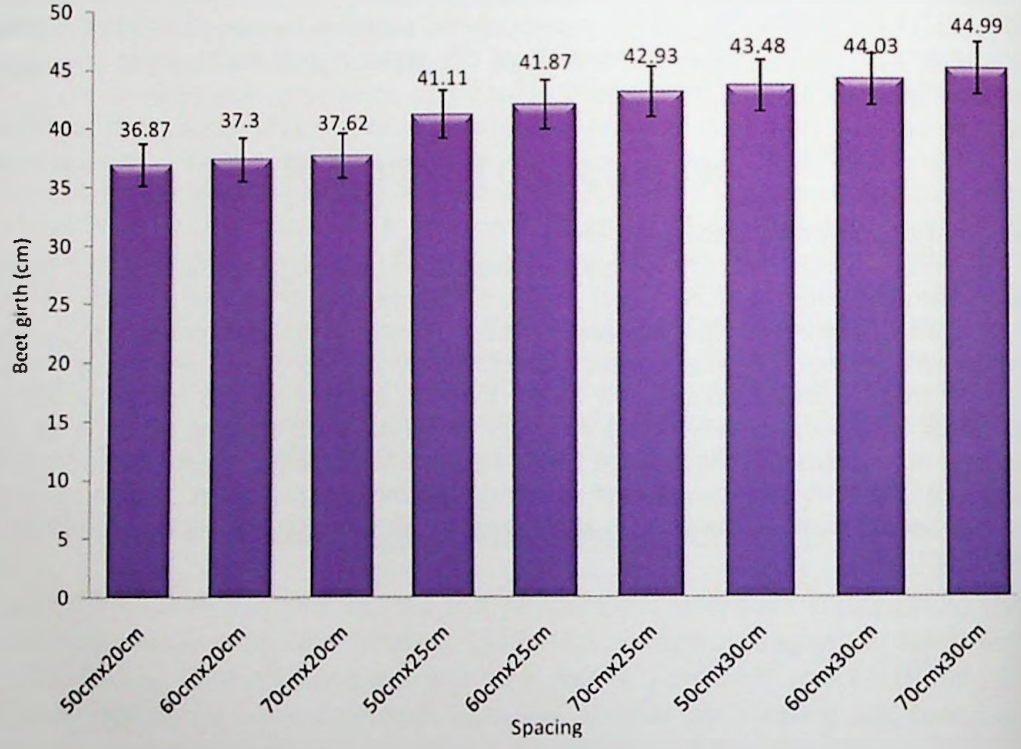

Figure 2. Beet girth (cm) as affected by spacing at harvest

Beet and shoot yields (t ha^{-1})

Spacing had significant influence on beet and shoot yields of tropical sugarbeet (Figure 3). Results of the study show that the highest beet and shoot yields (76.73 t ha^{-1} and 38.54 t ha^{-1}, respectively) were observed in 50 cm x 20 cm spacing which was supported by higher LAI and optimum plant population per unit area. This also might be due to better exploitation of environmental factors that facilitates the higher production and translocation of photosynthates from the source to sink. On the contrary, the lowest beet and shoot yields (58.28 t ha^{-1} and 29.06 t ha^{-1}, respectively) were obtained from 70 cm x 30 cm spacing.

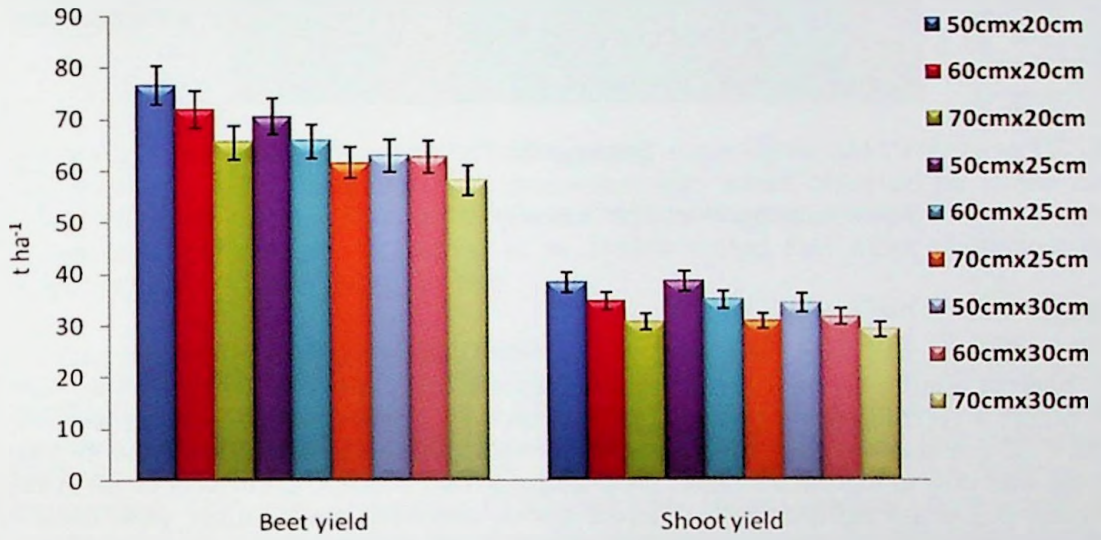

Figure 3. Beet and shoot yield (t ha^{-1}) as affected by spacing at harvest

Hozayn *et al.* (2013) and El-Sarag (2009) reported that increasing plant density positively affected yield of sugarbeet. Khaiti (2012) mentioned that use of high population increases interplant competition for light, water and nutrients, which may be detrimental to final yield. These results suggest that 50 cm x 20 cm spacing is the best for higher beet and shoot yield in tropical sugarbeet.

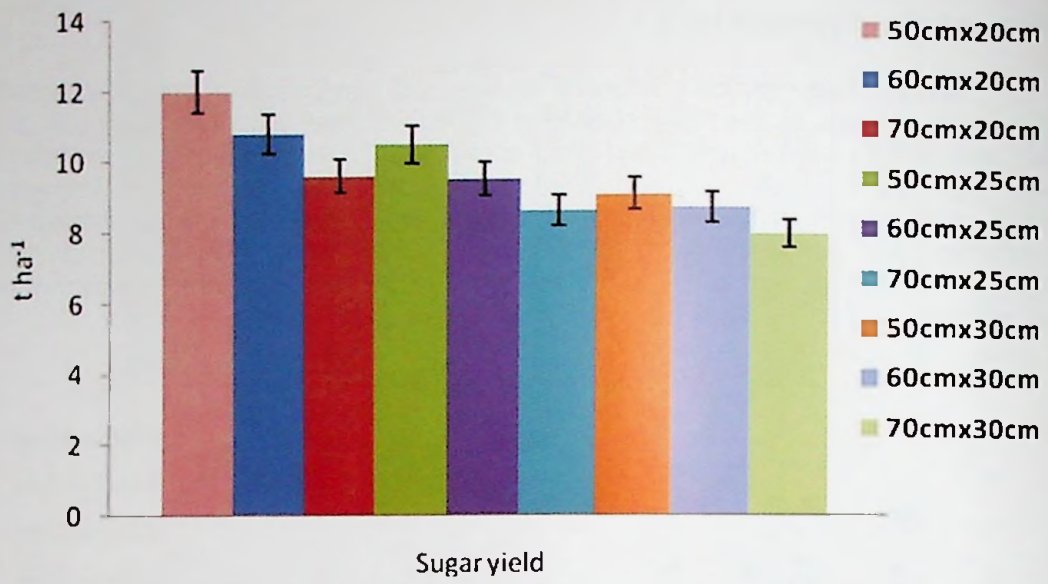

Figure 4. Sugar yield (t ha^{-1}) as affected by spacing at harvest

Sugar yield (t ha^{-1})

Spacing had significant effect on sugar yield and harvest index of tropical sugarbeet at harvest (Figure 4). Data reveal that the highest sugar yield (11.99 t ha^{-1}) was found in 50 cm x 20 cm spacing due to optimum number of plants per unit area, whereas 70 cm x 30 cm spacing gave the lowest sugar yield (7.98 t ha^{-1}). The increase in sugar yield was due to increase in beet yield and sucrose content. Cakmakci *et al.* (1998) stated that when plant density reached above optimum levels, sugar yield declined due to reduction in root yield. Almost similar type of results was found by Heidari *et al.* (2008) in sugarbeet.

Total soluble solids (TSS%), sucrose (%) and apparent purity (%)

Spacing had significant effect on total soluble solids (TSS%) and sucrose percentage (%) but non-significant effect on apparent purity percentage of tropical sugarbeet (Table 1). The general trends of TSS and sucrose percentage were little bit higher with closer spacing or lower with wider spacing. It was found that the highest TSS and sucrose (21.83% and 15.63%, respectively) were derived from 50 cm x 20 cm spacing while the lowest (18.89% and 13.70%, respectively) were found in 70 cm x 30 cm spacing.

Table 1. Total soluble solids (TSS%), sucrose percentage (%) and apparent purity percentage (%) of sugarbeet as affected by spacing at harvest

Spacing (r-r) x (p-p)	Total soluble solids Brix (%)	Sucrose percentage (%)	Apparent purity percentage (%)
T_1 = 50 cm x 20 cm	21.83	15.63	71.62
T_2 = 60 cm x 20 cm	20.92	15.00	71.71
T_3 = 70 cm x 20 cm	20.50	14.63	71.39
T_4 = 50 cm x 25 cm	20.71	14.88	71.86
T_5 = 60 cm x 25 cm	20.31	14.47	71.24
T_6 = 70 cm x 25 cm	19.78	14.00	70.80
T_7 = 50 cm x 30 cm	20.28	14.40	71.02
T_8 = 60 cm x 30 cm	19.05	13.87	72.79
T_9 = 70 cm x 30 cm	18.89	13.70	72.55
CV (%)	1.21	1.21	2.38
LSD (0.05)	0.43	0.30	NS

Generally, it can be concluded that closer spacing show significant increase in TSS % and sucrose %. This observation is consistent with those obtained by Ismail and Allam (2007) and Masri (2008), who reported that sowing sugarbeet at closer spacing enhanced sugar content. Cakmakci *et al.* (1998) stated that wider plant spacing always resulted in lower sugar content.

The spacing 50 cm x 20 cm produced the highest beet (76.73 t ha^{-1}) and sugar yield (11.99 t ha^{-1}). These results suggest that 50 cm x 20 cm spacing is the best for higher beet and sugar yield in tropical sugarbeet. The increase in sugar yield was due to increase in beet yield and sucrose content. It was found that the highest TSS and sucrose (21.83% and 15.63%, respectively) were derived from 50 cm x 20 cm spacing. Generally, it can be concluded that closer spacing show significant increase in TSS % and sucrose %. From the observation it may be concluded that the spacing 50 cm x 20 cm is optimum for yield and quality of tropical sugarbeet in context of Bangladesh.

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