Bangladesh J. Sugarcane, **35** : 20-27 June, 2014

Germination and Yield of Tropical Sugarbeet as Influenced by Variety and Fertilizer

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ABSTRACT

An experiment was conducted at Bangladesh Sugarcrop Research Institute farm, Ishurdi during 2013-14 cropping season to investigate the effects of varieties and fertilizer levels on seed germination and yield of tropical sugarbeet. Significant differences were observed in percent germination, yield and brix% of beet. It was found that variety V_2 (Cauvery) produced the highest germination (72.75%) and beet yield (60.8 tha^{-1}) over the variety V_1 (Shubrha) (with 58.53 % and 57.6 tha^{-1}) respectively. In case of fertilizer, the treatment T_3 (MOC_{625} N_{150} P_{25} K_{140} S_{22} Zn_4 $B_{1.5}$ kg ha^{-1}) produced the highest germination (72.79%) and beet yield (101.0 tha^{-1}) among all other treatments. Results from the interaction of variety and fertilizer revealed that, variety V_2 (Cauvery) with the fertilizer level T_3 (MOC_{625} N_{150} P_{25} K_{140} S_{22} Zn_4 $B_{1.5}$ kg ha^{-1}) treatment obtained the highest beet yield (104.67 tha^{-1}) where in every cases Control plot obtained the lowest yield. Therefore, the variety V_2 (Cauvery) and fertilizer level T_3 (MOC_{625} N_{150} P_{25} K_{140} S_{22} Zn_4 $B_{1.5}$ kg ha^{-1}) may be recommended for cultivation of tropical sugarbeet at Ishurdi under AEZ -11 of Bangladesh.

Key words: Sugarbeet, germination, fertilizer dose, brix %, beet yield

INTRODUCTION

Sugarbeet (*Beta vulgaris* L.) ranks the second after sugarcane in terms of world's sugar production. Sugarbeet is a temperate crop, generally grown in Europe, North America and temperate zones of Asia. France, Germany, Russia, USA and Ukraine are the most sugarbeet producing countries of the world (FAO, 2010). Although sugarbeet is a temperate crop, the international company Syngenta developed and successfully introduced a new sugarbeet that can be grown under tropical climatic conditions and hence, the beet is known as tropical sugarbeet. Substantial yield increase of sugarbeet is essential which may vary from variety to variety (Abo-Salama and EL-Sayiad, 2000). So it is crucial to find out a specific variety to obtain maximum beet yield from tropical sugarbeet in Bangladesh. Fertilizer was considered as a limiting factor for obtaining higher yield and superior quality in sugarbeet (Ouda, 2002). Thus, application of nitrogen, phosphorus and potassium fertilizers is immense importance for the production of sugarbeet. O'shea *et al.* (2009) reported that increased the yield and quality of sugarbeet mainly depended on fertilizer, especially in N and K. The increase in beet yield with N fertilizer may be attributed to increased size and number of leaves, which led to increased

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leaf area and photosynthetic activities. An adequate supply of N is essential for optimum yield, but excess of it may result in an increase in yield of roots with lower sucrose content and juice purity. Sugarbeet was found as high potassium (K) requiring crop (Johanson *et al.*, 1971). The role of K fertilization on growth, yield and quality of sugarbeet was emphasized by previous studies conducted by El-Maghraby *et al.* (1998) and El-Shafai (2000). There is a scanty of research in developing a fertilizer recommendation for sugarbeet production in Bangladesh. Considering the above facts, the present study was undertaken to evaluate the suitable variety and estimate optimum doses of fertilization for maximum yield of tropical sugarbeet at Ishurdi in Bangladesh.

MATERIALS AND METHODS

The experiment was conducted at BSRI farm, Ishurdi under High Ganges River Flood Plain Soils (AEZ 11) during 2013-14 cropping season. The experiment was laid out randomized complete block in factorial design with three replications. There were four fertilizer levels viz., T_1- Control (No fertilizer), T_2- Mustard Oil Cake $(MOC)_{500}$ Nitrogen $(N)_{120}$ Phosphorus $(P)_{20}$ Potassium $(K)_{112.5}$ Sulphur $(S)_{18}$ Zinc $(Zn)_{3.5}$ Boron $(B)_{1.2}$ kgha^{-1}, T_3- MOC_{625} N_{150} P_{25} K_{140} S_{22} Zn_4 $B_{1.5}$ kgha^{-1} and T_4- MOC_{375} N_{90} P_{15} $K_{84.38}$ $S_{13.5}$ $Zn_{2.63}$ $B_{0.9}$ kgha^{-1} in combination with two sugarbeet varieties viz., V_1 - Shubrha, V_2 - Cauvery. Sugarbeet seeds were sown on 05 November, 2013 at 50cm × 20cm spacing in 5m × 4m sized plots. Grined MOC was incorporated in the plots of the respective treatments at 6 days before seeds sowing. Full amount of PKSZnB and one third of N were applied in soil as basal and thoroughly mixed with soil. The rest amount of N was applied in two equal splits at 30 and 60 DAS. The cultural operations such as irrigation, weeding, earthing up and pest control were done as and when necessary. The crop was harvested on 03 May, 2014. Data on seed germination, beet yield and brix % were collected and analyzed by statistix-10 software.

RESULTS AND DISCUSSION

Germination percent of tropical sugarbeet

Effect of variety

Figure 1 represents percent germination of sugarbeet varieties. The highest germination percent was found in Cauvery (72.75%) over V_1 Shubhra (58.53%). This result was supported by Arshadi and Asgharipour (2011) where they reported that there had a significant difference between the germination percent in different genotypes of sugarbeet.

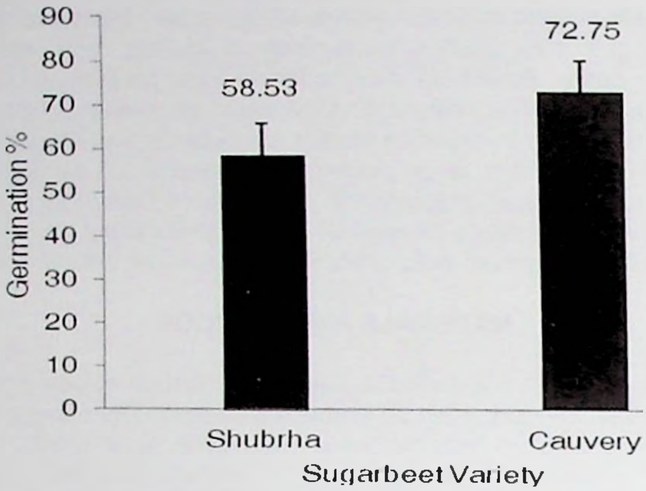

Figure 1. Effect of variety on seed germination of tropical sugarbeet varieties

Effect of fertilizer

Results revealed that the germination percentages were significantly influenced by different fertilization levels Table 1. The treatment T_3 (MOC_{625} N_{150} P_{25} K_{140} S_{22} Zn_4 $B_{1.5}$ $kgha^{-1}$) produced the highest germination (72.79%), but the effect was statistically similar with T_2 (MOC_{500} N_{120} P_{20} $K_{112.5}$ S_{18} $Zn_{3.5}$ $B_{1.2}$ $kgha^{-1}$), and the lowest percentage was obtained by the T_1 (Control) treatment (56.83%). Stevens *et al.* (2011) reported that fertilizer in band placement between 7.5 and 12.5 cm deep (5 to 10 cm below the seed) resulted with the best combination of N uptake and seedling emergence.

Interaction effect of variety and fertilizer

Interaction effect of variety and fertilizer had significantly influenced on germination percentages Table 1. The highest germination (80.92%) was found from the variety V_2 (Cauvery) with fertilizer level T_3 (MOC_{625} N_{150} P_{25} K_{140} S_{22} Zn_4 $B_{1.5}$ $kgha^{-1}$), which was statistically similar to the same variety with T_2 (MOC_{500} N_{120} P_{20} $K_{112.5}$ S_{18} $Zn_{3.5}$ $B_{1.2}$ $kgha^{-1}$) treatment, and the lowest germination (51.08%) was produced by the variety V_1 (Shubhra) with T_1 (Control) treatment.

Table 1. Seed germination influenced by fertilizer and interaction effect of variety and fertilizer

Treatment	Germination %
Fertilizer levels:	
T_1	56.83 c
T_2	68.75 ab
T_3	72.79 a
T_4	64.18 b
LSD (0.05)	5.07
Fertilizer xVariety:	
T_1V_1	51.08 d
T_2V_1	59.92 c
T_3V_1	64.67 bc
T_4V_1	58.43 c
T_1V_2	62.58 c
T_2V_2	77.58 a
T_3V_2	80.92 a
T_4V_2	69.92 b
LSD (0.05)	7.18

T_1- Control (No fertilizer), T_2- MOC500 N120 P20 K112.5 S18 Zn3.5 B1.2 kg ha ,
T_3- MOC625 N150 P25 K140 S22 Zn4 B1.5 kg ha^{-1}, T_4- MOC375 N90 P15 K84.38 S13.5 Zn2.63 B0.9 kg ha^{-1}, V_1 - Shubrha, V_2 - Cauvery

Beet yield

Effect of variety

Data on beet yield showed that, there were significant differences among the varieties Table 2. The highest beet yield (60.80 t ha^{-1}) was obtained in Cauvery and the lower yield (57.6 t ha^{-1}) produced in Shubrha. Nenadi? *et al.* (2003) reported that the Swedish cultivar Dorotea (tolerant to both rhizoctonia and cercospora) was found as the highest yielding crop. The lowest yielding crop (susceptible to both rhizoctionia and cercospora) was the domestic cultivar Dana. However, planting sugarbeet V_2 (Cauvery) was observed more favorable for higher sugar yield at the study location at Ishurdi in Bangladesh.

Effect of Fertilizer

Sugarbeet yield was significantly influenced by fertilizer levels was observed in Table 2. The highest beet yield (101.0 t ha^{-1}) was found from the treatment T_3 (MOC_{625} N_{150} P_{25} K_{140} S_{22} Zn_4 $B_{1.5}$ kgha^{-1}) and the lowest was obtained from T_1: treatment (3.1 t ha^{-1}). Kashem (2014) stated that increasing nitrogen levels from 0 to 50 kg or from 50 to100 kg N ha^{-1} caused increase in beet yield by 26.80 and 29.03%, respectively. Similar findings were reported by Abd EL-Moneim (2000); EL-Shahawy *et al.* (2002) and Ramadan *et al.* (2003) in their study. In New Zealand, sugarbeet root and sugar yields were optimal when nitrogen was applied @ 240 and 200 kg ha^{-1}, respectively (Smit *et al.*, 1995). They further reported that fresh top weight increased with increasing nitrogen availability, while sugar content was reduced.

Table 2. Effect of variety and fertilizers on yield and brix% of tropical sugarbeet

Treatment	Yield (t ha^{-1})	Brix (%)
Variety:		
V_1	57.6 b	17.15 b
V_2	60.8 a	18.35 a
LSD (0.05)	2.0257	0.30
Fertilizer levels:		
T_1	3.1d	18.57 a
T_2	72.6 b	17.53 b
T_3	101.0 a	16.97 c
T_4	60.5 c	17.92 b
LSD (0.05)	2.8648	0.42

T_1- Control (No fertilizer), T_2- MOC500 N120 P20 K112.5 S18 Zn3.5 B1.2 kg ha ,
T_3- MOC625 N150 P25 K140 S22 Zn4 B1.5 kg ha^{-1}, T_4- MOC375 N90 P15 K84.38 S13.5 Zn2.63 B0.9 kg ha^{-1}, V_1 - Shubrha, V_2 - Cauvery

Interaction effect of variety and fertilizer

Beet yield was significantly influenced by interaction between variety and fertilizer Table 3. The highest beet yield (104.67 t ha^{-1}) was produced in interaction between the variety Cauvery and $MOC_{625}\ N_{150}\ P_{25}\ K_{140}\ S_{22}\ Zn_4\ B_{1.5}$ $kgha^{-1}$ fertilizer dose, and the lowest beet yield (2.9 t ha^{-1}) was recorded with the interaction between Cauvery variety and Control (No fertilizer) treatment. These results indicated that sugar beet variety Cauvery should be grown with the fertilizer dose $MOC_{625}\ N_{150}\ P_{25}\ K_{140}\ S_{22}\ Zn_4\ B_{1.5}$ $kgha^{-1}$ in High Ganges River Flood Plain Soils (AEZ 11) for achieving higher sugar yield.

Brix % of beet

Effect of variety

Significant differences were recorded for brix % among the varieties Table 2. The highest brix % (18.35%) was recorded from V_2 (Cauvery) and the lowest (17.15) from the V_1 (Shubrha) treatment.

Effect of Fertilizer

Fertilizer levels significantly influenced brix % in sugarbeet Table 2. The highest brix % (18.57 %) was found from the treatment T_1: Control plot and the lowest (16.97 %) was obtained from the treatment T_3 ($MOC_{625}\ N_{150}\ P_{25}\ K_{140}\ S_{22}\ Zn_4\ B_{1.5}kgha^{-1}$). Kashem (2014) reported that increasing nitrogen levels from 100 to 150 kg N ha^{-1} led to decrease in brix % content by 2.25 %. Similar findings were reported by Attia *et al.* (1999); Mahasen (1999) and Nemeat Alla *et al.* (2002).

Table 3. Interaction effect of variety and fertilizers on yield and brix % of tropical sugarbeet

Variety × Fertilizer	Yield (t ha^{-1})	Brix (%)
T_1V_1	3.23 f	17.95 c
T_2V_1	69.50 d	17.00 d
T_3V_1	97.33 b	16.36 e
T_4V_1	60.13 e	17.29 d
T_1V_2	2.90 f	19.19 a
T_2V_2	76.00 c	18.06 bc
T_3V_2	104.67 a	17.58 cd
T_4V_2	61.20 e	18.56 b
LSD (0.05)	4.0514	0.59

T_1- Control (No fertilizer), T_2- MOC500 N120 P20 K112.5 S18 Zn3.5 B1.2 kg ha^{-1}, T_3- MOC625 N150 P25 K140 S22 Zn4 B1.5 kg ha^{-1}, T_4- MOC375 N90 P15 K84.38 S13.5 Zn2.63 B0.9 kg ha^{-1}, V_1 - Shubrha, V_2 - Cauvery

Interaction effect of variety and fertilizer

Brix percentage was significantly influenced by interaction between variety and fertilizer Table 3. The highest brix (19.19 %) in sugarbeet was produced by interaction between Cauvery variety and Control (No fertilizer) fertilizer dose, and the lowest brix % (16.36 %) of sugarbeet was recorded with the interaction between Shubrha variety and T_3 (MOC_{625} N_{150} P_{25} K_{140} S_{22} Zn_4 $B_{1.5}$kgha^{-1}) fertilizer dose.

Economic performance

The economic performance of different levels of variety and fertilizer doses on sugarbeet (AEZ 11) is presented in Table 4. The highest Marginal Benefit Cost Ratio (MBCR) 6.27 was obtained in interaction between the variety Cauvery and T_2 MOC_{625} N_{150} P_{25} K_{140} S_{22} Zn_4 $B_{1.5}$ kgha^{-1} fertilizer dose. Hence, application of MOC_{625} N_{150} P_{25} K_{140} S_{22} Zn_4 $B_{1.5}$ kgha^{-1} fertilizer in cultivation of sugarbeet variety Cauvery at Ishurdi (AEZ 11) was found the most economically profitable.

Table 4. Economic performance of sugarbeet varieties at different fertilizers level at BSRI, Ishurdi.

Treatment	Fertilizer cost (Tk. ha^{-1})	Yield (tha^{-1})	Gross return	Net Benefit	MBCR [(1)]
			(Tk.ha^{-1})		
T_1V_1	0	3.23	9,690	9,690	-
T_2V_1	34,548	69.50	2,08,500	1,73,952	5.03
T_3V_1	43,175	97.33	2,91,990	2,48,815	5.76
T_4V_1	25,911	60.13	1,80,390	1,54,479	5.96
T_1V_2	0	2.90	8,700	8,700	-
T_2V_2	34,548	76.00	2,28,000	1,93,452	5.59
T_3V_2	43,175	104.67	3,14,010	2,70,835	6.27
T_4V_2	25,911	61.20	1,83,600	1,57,689	6.08

Input Price: Urea= Tk. 16.00 kg^{-1}. TSP= Tk. 22.00 kg^{-1}, MOP= Tk. 15.00 kg^{-1}, Gypsum= Tk. 15.00 kg^{-1}, Zinc Sulphate Mono: Tk. 120 kg^{-1}, Boric Acid= 240 kg^{-1}, Mustard Oil Cake: Tk. 40 kg^{-1}.

Variable cost includes fertilizer cost only

Output Price: Sugarbeet: Tk. 3000.00 t^{-1}

From the present findings, it may be concluded that the variety Cauvery and the fertilizer rate of MOC_{625} N_{150} P_{25} K_{140} S_{22} Zn_4 $B_{1.5}$ $kgha^{-1}$ were found appropriate for achieving higher yield of tropical sugarbeet at the study location of BSRI, Ishurdi under High Ganges River Flood Plain Soils (AEZ 11).

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