Site Specific Fertilizer Requirement for Sugarbeet Production

R.C. Kabiraj, G.M.A. Hossain, S. Islam, A.S. Mitu, M.A. Haque and M.S. Islam

Soils and Nutrition Division
Bangladesh Sugarcrop Research Institute, Ishurdi, Pabna, Bangladesh

ABSTRACT

The experiment was conducted at mills zone area of Joypurhat Sugar Mills Ltd., Joypurhat, (AEZ 3) and Rangpur Sugar Mills Ltd., Rangpur (AEZ 3) during 2018-2019 cropping season and was laid out in a RCB design with three replications having six treatments. The treatments of the experiment comprised of T_1- Control (native soil fertility), T_2- Recommended Fertilizer Dose (RFD), T_3- Soil Test Basis Fertilizers (STB), T_4- 75% STB, T_5- 125% of STB and T_6- 150% of STB. The sugar beet variety Shubrah was used in this experiment as the test crop. Results revealed that at Joypurhat and Rangpur site the growth parameters (i.e. germination percent and number of millable beet) and yield of sugar beet showed significant effect over control due to different fertilizer treatments. At Joypurhat and Rangpur site the highest yield of sugarbeet were recorded in treatment T_6 (116.21 and 97.00 t ha^{-1}, respectively) where fertilizers were applied @150% of Soil Test Basis (STB). Treatment T_6 (150% of STB) performed better regarding growth parameters brix percent and yield of sugarbeet at Joypurhat and Rangpur location.

Key words: Site specific, fertilizer, requirement, sugarbeet

INTRODUCTION

Tropical sugar beet (*Beta vulgaris* L.) is a temperate root crop. It remains 5-6 months in the field. During this time it uptakes a lot of nutrients from the soil. Balanced fertilization in sugar beet production is very much crucial for sustaining sugar productivity in Bangladesh. Sugarbeet root contains high concentration of sucrose. Sugarbeet is the second most important sugar crop next to sugarcane that covers 30-40% world sugar production. Recently, some tropical sugarbeet varieties have been developed which can be grown in tropical and subtropical regions of the world. The area under cane cultivation is drastically reduced due to pressure of cereals and other short- duration high value crops, which cause lower amount of sugarcane production. Sugarbeet has got many benefits compared to sugarcane due to short duration with high sucrose contents. In this regard sugarbeet might be an excellent alternative to sugarcane in Bangladesh by enhancing processing facilities in the existing sugar mills. Agronomic practices such as variety, spacing and fertilizer management are important for appreciable root yield and quality of tropical sugarbeet (Paul *et al.*, 2018). Soil health condition in Bangladesh has been

*Corresponding Author: R.C. Kabiraj, Principal Scientific Officer
e-mail: rckabiraj.bsri@yahoo.com

drastically deteriorated in the last couple of decades, in inverse relation with the target of producing more crops from a small amount of land. Fertilizer rate and methods of application are very important in sugar beet cultivation. The growth of the leaves and the root of sugar beet are highly responsive to nitrogen and potash fertilizer. Nitrogen fertilization can improve leaf area, photosynthetic rate and eventually high yield (Cai and Ge, 2004). Phosphorus is the second most important nutrient for sugar beet production. Phosphorus plays an important role in energy transfer within the plants and structural integrity of cell membrane. Application of 120 kg P_2O_5 and 100 kg N ha^{-1} resulted in higher beet and sugar yield (Khan, 2003). Fertilizer is considered as a limiting factor for obtaining high yield and quality of sugarbeet (Ouda, 2002). Many investigators have confirmed the role of N and K in increasing the yield and quality of sugar beet by enhancing the biosynthesis of organic metabolites and improving nutritional status (O'shea *et al.*, 2009). Ibrahim *et al.* (1998) found that the highest sucrose percentage and juice purity were achieved with K application up to 228.5 kg K_2O ha^{-1}.

In Bangladesh no systematic research work in this area has so far been done particularly in sugarbeet cultivation. As a promising sugar crop in Bangladesh, the feasibility study of sugarbeet varieties under various nutrient management in different agro ecological zones (AEZs) are needed to be studied. To get the maximum yield and sugar content, application of N, P, K, S and B fertilizer in optimum dose is very important. Hence, an attempt was made to find out the rates of N, P, K, S and B fertilizers for sugarbeet cultivation in two areas of Bangladesh.

MATERIALS AND METHODS

The experiment was conducted at mills zone area of Joypurhat Sugar Mills Ltd., Joypurhat, (AEZ 3) and Rangpur Sugar Mills Ltd., Rangpur (AEZ 3) during 2018-2019 cropping season and was laid out in a RCB design with three replications having six treatments. The treatments of the experiment comprised of T_1- Control (native soil fertility), T_2- recommended fertilizer dose (RFD), T_3- Soil test basis fertilizers (STB), T_4- 75% STB, T_5- 125% of STB and T_6- 150% of STB.. The experimental plot size was 4m × 5m and line to line and plant to plat spacing were 60 cm × 20 cm, respectively. The sugarbeet variety Shuvra was used as test crop in this experiment. The distances between two adjacent plots were 0.5 m and that between two blocks was 1m. At the time of final land preparation, respective unit plots were fertilized with different levels of cow dung and poultry manure according to treatments. The manures were thoroughly mixed with the soil. nitrogen, phosphorus, potassium, sulphur, zinc and boron were applied in the form of urea, triple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid, respectively. Whole amount of triple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid were applied at final land preparation as specified in the treatments. Urea was applied in three equal splits at 30, 50 and 70 days after sowing (DAS). Seeds were sown in rows on the ridge with 50 cm x 20 cm spacing @ two seeds $hill^{-1}$ on 30 November 2016. Thinning was done at 35 DAS leaving one healthy plant $hill^{-1}$. Gap filling was also done at 30 DAS from the out strips extra seedlings of the same age to have optimum population. Three hand weedings were done at 15, 30, 45 and 60 DAS. The crop was irrigated four times at 45, 70, 95 and 120 DAS. Earthing up was done at 60 DAS to facilitate soil moisture to the root for its maximum growth. The fungicide named "Score" was sprayed @ 3ml L^{-1} of water by hand sprayer. The insect pest like Sugarbeet caterpillar was controlled by spraying Nitro- 505EC @ (4 L ha^{-1}) in 15 days intervals.

Brix (%) measurement

Percent brix was measured by hand refractometer (ATAGO, Japan) at maturity stage beginning from 120 DAS at 15-day intervals up to 150 DAS (at harvest). Five beets of each plot were randomly collected. A sharp knife was used to remove the outer skin of sugarbeet root and sliced into small pieces as well as to extract a drop of juice by using mortar and pestle. Then the juice was transferred into the prism of the refractometer and also closed the day light plate to get the accurate measurement of brix (%) observed by eyepiece and then averaged to get mean data $plot^{-1}$.

Yield components and yield

After harvesting, plants were washed and cleaned by removing dead and dried leaves and soil adhering to beets. Data on plant characters and yield components were recorded from ten randomly selected plants from each plot. Beet yield was recorded from the whole plot harvest and converted to t ha^{-1}. Necessary intercultural operations were done throughout the cropping season for proper growth and development of the crop. Collected data were compiled and tabulated in proper form and were subjected to statistical analysis by using the computer package Statistix 10 program for Windows Version. Computation was done by the use of Microsoft Excel 2003 program.

RESULTS AND DISCUSSION

Results presented in Table 1 show that germination percent of sugarbeet responded significantly due to different fertilizer treatments. At Joypurhat site Germination percent ranged from 79.27 to 89.67 due to different fertilizer treatments. The highest germination was recorded in treatment T_3 (89.67%) where fertilizer was applied as per soil test basis (STB) which was statistically at par with all other treatments except T_6 (150% of STB). The lowest germination was recorded in treatment T_6 (79.27%). It was found that application of STB fertilizers increased germination percent of tropical sugarbeet (Anonymous 2018). This might be due to proper nutrient availability in soil with soil test basis fertilizer which may led higher germination of sugarbeet. Number of millable beet ranged from 56.50 x 10^3 ha^{-1} to 94.83 x 10^3 ha^{-1} due to different fertilizer treatments. The highest number of millable beet was recorded in treatment T_6 (94.83 x 10^3 ha^{-1}) where fertilizer was applied as per 150% of Soil Test Basis (STB) fertilizer which was followed by treatment

T_2 (90.00 x 10^3 ha^{-1}) and T_5 (87.67 x 10^3 ha^{-1}) regarding number of millable beet. The effect of treatment T_5 was however statistically at par with treatment T_4 but ranked second in position regarding number of millable beet production. The lowest number of millable beet (56.50 x 10^3 ha^{-1}) was recorded in control treatment (no fertilizer). It was reported that application of 150% STB fertilizers increased number of millable beet of tropical sugarbeet at Ishurdi and Thakurgoan site (Anonymous, 2018). This might be due to proper nutrient availability in soil with soil test basis fertilizer which may led higher number of millable beet of sugarbeet. The brix percent and yield of sugar beet did not differed significantly due to different fertilizer treatments at Joypurhat. The highest yield of sugarbeet was obtained in treatment T_6 (116.21 tha^{-1}) where fertilizer was applied @ 150% of Soil Test Basis (STB). The effect of treatment T_6 was statistically followed by treatment T_5 (106.27 t ha^{-1}) and T_2 (101.42 t ha^{-1}) but superior to all other treatments. The lowest beet yield was obtained in control (24.38 tha^{-1}). It was reported that highest yield of sugarbeet was recorded with the application of 150% of soil test basis fertilizer application (Anonymous, 2018). This might be due to proper nutrient availability in soil with 150% STB fertilizer application which may led higher yield of sugarbeet.

Table 1. Effect of fertilizer management on yield and brix (%) of sugarbeet at Joypurhat site, 2018-2019

Treatment	Germination (%)	Number of millable Beet (x 10^3 ha^{-1})	Yield (tha^{-1})	Brix (%)
T_1- Control (native soil fertility)	86.92 a	56.50 c	24.38 c	15.33
T_2- Recommended Fertilizer Dose	89.67 a	92.00 a	101.42 a	16.00
T_3- Soil Test Basis fertilizer dose (STB)	86.92 a	60.00 c	61.08 b	15.16
T_4- 75% of STB	83.75 ab	82.67 b	55.95 b	15.66
T_5- 125% of STB	84.92 ab	87.67 ab	106.27 a	16.50
T_6- 150% STB	79.27 b	94.83 a	116.21 a	15.33
LSD (0.05)	3.28	3.28	8.15	NS

In a column, figures with similar letters do not differ significantly at 5% level.

Initial and post harvest nutrient status of soil at Joypurhat site are presented in Table 2. Soil nutrient status were slightly changed over initial soil nutrient status due to different fertilizer treatments of sugarbeet.

Table 2. Initial and post harvest soil nutrient status at Joypurhat

Treatment	pH	OC (%)	N (%)	P (ppm)	K (meq%)	S (ppm)
Initial soil	5.56	0.67	0.070	19.0	0.18	14.0
Post harvest Soil						
T_1	5.50	0.65	0.060	18.0	0.17	12.5
T_2	5.50	0.66	0.065	18.5	0.17	13.0
T_3	5.55	0.65	0.065	18.0	0.18	13.0
T_4	5.59	0.62	0.060	17.5	0.16	12.0
T_5	5.55	0.61	0.065	18.0	0.17	13.0
T_6	5.55	0.66	0.070	18.5	0.18	13.5
Critical level value	-	-	0.12	10.0	0.12	10.0

Results presented in Table 3 showed that at Rangpur percent of sugarbeet responded significantly due to different fertilizer treatments. Germination percent ranged from 52.67 to 59.16 percent due to different fertilizer treatment. The highest germination percent was recorded in treatment Twhere fertilizer were applied as per 150% of Soil Test Basis (STB) effect of treatment T_6 were superior to all other treatments percent. All other treatments except control showed statistically similar effect regarding germination percent. The lowest germination was recorded in (52.67%). It was found that application of 150 % of Soil Test Basis fertilizers increased germination percent of tropical sugarbeet (Anonymous, 2018). This might be due to proper nutrient availability in soil with soil test basis fertilizer which may led higher germination of sugarbeet. Number of millable beet ranged from 1 to 61.25 x 10^3 ha^{-1} due to different fertilizer treatment. The highest number of millable beet was recorded from treatment T_6 (61.25 x 10^3 ha^{-1}) where fertilizer were applied as per 150% of Soil Test Basis (STB) which was followed by treatment T_2 (60 x 10^3 ha^{-1}), T_3 (56.67 x 10^3 ha^{-1}) and T_4 (47.50 x 10^3 ha^{-1}). The lowest number of millable beet (recorded in control treatment. It was found that application of 150% Soil Test Basis fertilizers increased number of millable beet of tropical sugarbeet at Joypurhat site (Anonymous, 2018). This might be due to proper nutrient availability in soil with soil test basis fertilizer which may led higher number of millable beet of sugarbeet. The Brix percent and yield of sugar beet responded significantly due to different fertilizer treatments. The highest yield of sugar beet was obtained in treatment T_6 (97.00 tha^{-1}) where fertilizer were applied @ 150% of soil test basis (STB). The effect of treatment T_6 was statistically followed by treatment T_3 (88.33 t ha^{-1}) and T_2 (81.33 t ha^{-1}) but superior to all other treatments. The lowest beet yield was obtained in control (15.67 tha^{-1}). It was found that highest Brix percent and yield of sugarbeet was recorded with the application of 150% of soil test basis fertilizer application (Anonymous, 2018). This might be due to proper nutrient availability in soil with 150% soil test basis fertilizer application which may led higher Brix percent and yield of sugarbeet.

Table 3. Effect of fertilizer management on yield and brix (%) of sugarbeet at Rangpur site, 2018-2019

Treatment	Germination (%)	Number of Millable Beet (10^3 ha^{-1})	Yield (tha^{-1})	Brix (%)
T_1- Control (Native soil fertility)	52.67 c	44.16 bc	15.67 c	15.50 ab
T_2- Recommended Fertilizer Dose	54.67 bc	60.00 ab	81.33 ab	15.50 ab
T_3- Soil Test Basis fertilizer dose (STB)	55.83 b	56.67 abc	88.33 ab	14.83 b
T_4- 75% of STB	56.50 b	47.50 abc	68.00 b	15.83 a
T_5- 125% of STB	56.50 b	42.16 c	71.00 b	15.50 ab
T_6- 150% STB	59.16 a	61.25 a	97.00 a	15.83 a
LSD (0.05)	1.16	7.16	10.46	0.40

In a column, figures with similar letters do not differ significantly at 5% level.

Initial and post harvest nutrient status of soil at Rangpur site are presented in Table 4. Soil nutrient status were slightly changed over initial soil nutrient status due to different fertilizer treatments of sugarbeet.

Table 4. Initial and post harvest soil nutrient status at Rangpur

Treatment	pH	OC (%)	N (%)	P (ppm)	K (meq%)	S (ppm)
Initial soil	5.58	0.72	0.075	10.0	0.19	15.0
Post harvest Soil						
T_1	5.53	0.70	0.070	9.0	0.18	14.5
T_2	5.56	0.71	0.070	9.5	0.18	14.5
T_3	5.58	0.71	0.065	9.0	0.17	14.0
T_4	5.59	0.70	0.060	8.5	0.17	13.5
T_5	5.56	0.71	0.070	9.0	0.18	14.0
T_6	5.57	0.72	0.075	9.5	0.19	15.5
Critical level value	-	-	0.12	10.0	0.12	10.0

From the above discussion it may be concluded that at Joypurhat and Rangpur site the growth parameters and yield of sugar beet showed significant effect over control due to different fertilizer treatments. Whereas Brix percent at Rangpur site differed significantly but at Joypurhat site it was insignificant due to different fertilizer treatments. The highest yield at Joypurhat and Rangpur was recorded in treatment T_6 (116.21 t ha^{-1} and 97.00 t ha^{-1}, respectively) where fertilizers were applied @150% of soil test basis.

REFERENCES

Annonymous, 2018. Annual Report-2014-2015, Bangladesh Sugarcrop Research Institute, Ishurdi-6620, Pabna.

Cai, B. and Ge, J. 2004. The effect of nitrogen amount on photosynthetic rate of sugar beet, *Nature Sci.,* **2** (2): 60-63.

Ibrahim, M.F.M. 1998. The effect of some fertilization elements on the yield and quality of sugar beet. Ph. D. Thesis, Fac. of Agric., Zagazig University.

Jagtap, S.M.; Jadhav, M.B. and Kulkarm, R.V. 2006.Effect of levels of NPK on yield and quality of suru sugarcane (cv. Co. 7527). *Indian Sugar.*, **56**:35-40.

Khan, D. 2003.The effect of application methodology and doses of nitrogen and phosphorus on sugar beet husbandry. *Annu. Tech. Rep. S.C.R.I., Mardan*, pp. 72-73.

O'shea, C.J.; Lynch, B.; Lynch, M.B.; Callan, J.J. and O'Doherty, J.V. 2009. Ammonia emissions and dry matter of separated pig manure fractions as affected by crude protein concentration and sugar beet pulp inclusion of finishing pig diets. *Agric. Ecosyst. Environ.*, **131**: 154-160.

Ouda, M.M.S.; 2002. Effect of nitrogen and sulphur fertilizers levels on sugar beet in newly cultivated sandy soil. *Zagazig J. Agric. Res.*, **29**: 33-50.

Paul, S.K.; Paul, U.; Sarkar, M.A.R. and Hossain, M.S. 2018.Yield and quality of tropical sugarbeet as influenced by variety, spacing and fertilizer application. *Sugar Tech*, **20**(2):175-181.