# INFLUENCE OF INTEGRATED NUTRIENT MANAGEMENT ON THE GROWTH, YIELD AND SUGAR CONTENT OF TROPICAL SUGARBEET (*Beta vulgaris* L.)

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**ABSTRACT**

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during November 2016 to April 2017 to find out the influence of integrated nutrient management on the growth, yield and sugar content of tropical sugarbeet. The experiment comprised two tropical sugarbeet varieties viz.PAC-60008 and SV-887and nine nutrient managements viz. Cowdung @ 10 t $ha^{-1}$, Poultry manure @ 5 t $ha^{-1}$, Recommended dose of chemical fertilizer (NPKSZnB @ 135-25-133-18-3.5-1.2 kg $ha^{-1}$), 75% NPK and other inorganic fertilizers + cowdung @ 10 t $ha^{-1}$, 75% NPK and other inorganic fertilizers + poultry manure @ 5 t $ha^{-1}$, 50% NPK and other inorganic fertilizers + cowdung @ 10 t $ha^{-1}$, 50% NPK and other inorganic fertilizers + poultry manure @ 5 t $ha^{-1}$, 75% NPK and other inorganic fertilizers + cowdung @ 5 t $ha^{-1}$ and 75% NPK and other inorganic fertilizers + poultry manure @ 2.5 t $ha^{-1}$.The experiment was laid out in a randomized complete block design with three replications. The tallest plant (57.25 cm, at 100 DAS) was recorded in PAC-60008 fertilized with NPKSZnB @ 135-25-133-18-3.5-1.2 kg $ha^{-1}$ while the highest number of leaves $plant^{-1}$(36.83, at 100DAS ) was found in SV-887 with 75% NPK and other inorganic fertilizers + poultry manure @ 5 t $ha^{-1}$and the highest SPAD value (87.20, at 80 DAS) was recorded in SV-887 fertilized with 75% NPK and other inorganic fertilizers + cowdung @ 10 t $ha^{-1}$. The highest top length (50.33 cm) and top yield (38.67 t $ha^{-1}$) at harvest were recorded in SV-887 fertilized with NPKSZnB @ 135-25-133-18-3.5-1.2 kg $ha^{-1}$and PAC-60008 fertilized with 75% NPK and other inorganic fertilizers + poultry manure @ 2.5 t $ha^{-1}$, respectively. The highest beet girth (38.58 cm), average beet weight (0.98 kg) and beet yield (98.18 t $ha^{-1}$) were recorded in PAC-60008 fertilized with 75% NPK and other inorganic fertilizers + poultry manure @5 t $ha^{-1}$. The highest values of beet girth, average beet weight and beet yield were at par in PAC-60008 fertilized with NPKSZnB @ 135-25-133-18-3.5-1.2 kg $ha^{-1}$and PAC-60008 fertilized with 75% NPK and other inorganic fertilizers + poultry manure @ 2.5 t $ha^{-1}$while the lowest beet yield (22.10 t $ha^{-1}$) was recorded in SV-887 fertilized with cowdung @ 10 t $ha^{-1}$. The highest brix (18 %) was recorded at harvest (150 DAS) in PAC-60008 fertilized with 50% NPK and other inorganic fertilizers + poultry manure @ 5 t $ha^{-1}$while the lowest brix (14.67%) was obtained in SV-887 with poultry manure @ 5 t $ha^{-1}$, and 75% NPK and other inorganic fertilizers + cowdung @ 5 t $ha^{-1}$. Therefore, variety PAC-60008 fertilized with 75% recommended dose of NPK and other inorganic fertilizers + poultry manure @ 2.5 appears as the promising combination in terms of beet yield.

**Key words:** Sugarbee**t,** nutrient management, growth, yield, sugar content

## INTRODUCTION

Sugarbeet (*Beta vulgaris*L.), is a temperate crop and its root contains high concentration of sucrose. Sugarbeet is the second most important sugar crop next to sugarcane that covers 30-40 % world sugar. Recently, some tropical sugarbeet varieties have been

developed which can be grown in tropical and subtropical regions of the world. The current production of sugar in Bangladesh is meeting about 5% of total demand and 20% of total requirement covers with jaggery mainly from sugarcane and rest 75% sugar demand is fulfilled by importation (Rahman *et al*., 2016). The main causes of lower sugar production include less supply of sugarcane in the factories and very poor sugar recovery. In Bangladesh, due to acute shortage of sugarcane as raw materials most of the sugar mills remain inoperative for longer period of time in every year. The area under cane cultivation is drastically reduced due to pressure of cereals and other short-duration 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. The Government of Bangladesh is emphasizing the attainment of self-sufficiency in sugar and jaggery production by introducing sugarbeet in the country and boosting up the sugarcane production. Feasibility of sugarbeet cultivation in Bangladesh is under trial although some people are growing low sucrose containing genotype as salad and vegetable purposes. 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 drastically deteriorated in the last couple of decades, in inverse relation with the target of producing more crops from a small amount of land. 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). Although enhanced dosage of sole N fertilizer increases growth and yield of sugar crops, it raises the sugar losses to molasses and ultimately lower sugar recovery (Salami and Saadat, 2013). Balanced crop nutrition could enhance crop and sugar yields significantly (30–60%) as 1 kg of macronutrients produces about 114 kg of stripped sugarcane (Soomro *et al.,* 2014). A crop having yield of 100 tons per hectare uptakes 207 kg N, 30 kg $P_2O_5$ and 233 kg $K_2O$ from the soil (Jagtap *et al*., 2006). Manure is also important for sugarbeet yield because of containing all macro and micro nutrients required for plant growth but in small amount. Farm yard manure increased the sugar yield by 10% when applied at the rate of 20 t $ha^{-1}$ compared to control plots (Javaheri*et al.*, 2005). Hergert and Nielsen (2011) reported that of manure increased sugar yield significantly with no significant effect on sugar loss to molasses. So, manure could be a valuable source of nutrients for sugarbeet because it mineralizes slowly which can affect sugar content and impurities. Topcuoğlu and Önal (2005) reported that application of poultry manure @ 10 t $ha^{-1}$ increased yields and sugar content of sugarbeet. There is no denying the need of using chemical fertilizers and adopting multiple cropping to meet the growing demand of food, but the farmers should at the same time be encouraged to use more organic fertilizer along with the chemical ones to recover the soil health. Now-a-day, attention has been directed towards organic manure because of the rising cost of inorganic fertilizers coupled with their inability to give the soil the desired sound health. Combined application of manure with inorganic fertilizers increased yield and quality of various crops were reported elsewhere (Oyedeji*et al*., 2014; Pal *et al*., 2016; Ahmad *et al*., 2016). Cowdung and poultry manure are the excellent soil amendment that provides nutrients for growing crops and also improves soil health when applied wisely because of organic matter content combined with available nutrients for plant growth and development. 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 are needed to be studied. Therefore, the present study was undertaken with a view to delineating the performance of sugarbeet varieties with variable nutrient management practices.

## MATERIALS AND METHODS

### Experimental sites and experimentation

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during November 2016 to April 2017. The experimental field is located at $24^0$75'N latitude and $90^0$50'E longitude at an altitude of 18 m. The field belonging to the Sonatala series of Old Brahmaputra Floodplain Agro ecological Zone (AEZ-9) was a medium high land with well drained silt loam texture and non-calcareous dark grey floodplain soils having pH 6.5 and low in organic matter (1.67 %) content (UNDP and FAO, 1988). The experiment comprised two tropical sugarbeet varieties viz. PAC-60008 ($V_1$) and SV-887 ($V_2$) and nine nutrient management viz. Cowdung @ 10 t $ha^{-1}$ ($F_1$), Poultry manure @ 5 t $ha^{-1}$ ($F_2$), Recommended dose of chemical fertilizer (NPKSZnB @ 135-25-133-18-3.5-1.2 kg $ha^{-1}$) ($F_3$), 75% NPK and other inorganic fertilizers + cowdung @ 10 t $ha^{-1}$ ($F_4$), 75% NPK and other inorganic fertilizers + poultry manure @ 5 t $ha^{-1}$ ($F_5$), 50% NPK and other inorganic fertilizers + cowdung @ 10 t $ha^{-1}$ ($F_6$), and 50% NPK and other inorganic fertilizers + poultry manure @ 5 t $ha^{-1}$ ($F_7$), 75% NPK and other inorganic fertilizers + cowdung @ 5 t ha-1 ($F_8$), 75% NPK and other inorganic fertilizers + poultry manure @ 2.5 t ha-1 ($F_9$). The experiment was laid out in a randomized complete block design with 3 replications. The size of each unit plot was 2.5 m × 2.0 m. 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 × 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 pests (Sugarbeet caterpillar, red beetle) were controlled by spraying Nitro-505EC @ 2 ml $L^{-1}$ (5 L $ha^{-1}$).

### Plant height and leaf number $plant^{-1}$

Five plants were randomly selected immediately after emergence and marked with bamboo sticks in each plot excluding border rows to record the data on plant height and number of leaves $plant^{-1}$at 20-day intervals beginning 40 up to 100 DAS.

### Measurement of leaf chlorophyll content

Chlorophyll meter values (SPAD) were recorded using a portable SPAD meter (Model SPAD-502, Minolta crop, Ramsey, NJ) at 20-day intervals, beginning 40 DAS upto 100 DAS. The instrument measures transmission of red light at 650 nm, at which chlorophyll absorbs light, and transmission of infrared light at 940 nm, at which no absorption occurs. The chlorophyll meter readings have been found to be positively correlated with destructive chlorophyll measurements in many crop species (Zhu *et al*., 2012) and considered as a useful indicator of the need of N top

dressing during the crop growth. On the basis of these two transmission values, the instrument calculates a SPAD value that is well correlated with chlorophyll content (Paul *et al*., 2018).

**Brix (%) measurement**

Percent brix were 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$^{-1}$.

**Statistical Analysis**

All the recorded data were analyzed using analysis of variance (ANOVA) using a computer package MSTAT-C program. The treatment mean differences were adjudged by Duncan's Multiple Range Test (DMRT) Gomez and Gomez (1984).

## RESULTS AND DISCUSSION

**Plant height**

Plant height was significantly influenced by the interaction between sugarbeet variety and integrated nutrient management at 40 and 100 DAS (Table 1). The plant height progressively increased over time attaining the highest at final sampling date (100 DAS).At 40 DAS, the tallest plant (23.00 cm) was recorded in $V_1$× $F_5$ (PAC-60008 fertilized with 75% NPK and other inorganic fertilizers + poultry manure @ 5 t ha$^{-1}$) that was at par with $V_1$ x $F_6$ (PAC-60008 fertilized with 50% NPK and other inorganic fertilizers + cowdung @ 10 t ha$^{-1}$), $V_1$ x $F_7$ (PAC-60008 fertilized with 50% NPK and other inorganic fertilizers + poultry manure @ 5 t ha-1), $V_1$ x $F_2$(PAC-60008 fertilized with Poultry manure @ 5 t ha-1),$V_2$ x $F_5$ (SV-887 fertilized with 75% NPK and other inorganic fertilizers + poultry manure @ 5 t ha-1) and the lowest plant (19.00 cm) was recorded in $V_2$ x $F_7$ (SV-887 fertilized with 50% NPK and other inorganic fertilizers + poultry manure @ 5 t ha-1) while at 100 DAS the tallest plant (57.25 cm) was obtained in $V_1$× $F_3$ (PAC-60008 fertilized with NPKSZnB @ 135-25-133-18-3.5-1.2 kg ha$^{-1}$) which was at par with $V_2$× $F_5$(SV-887 fertilized with 75% NPK and other inorganic fertilizers + poultry manure @ 5 t ha$^{-1}$),$V_2$× $F_8$(SV-887 fertilized with 75% NPK and other inorganic fertilizers + cowdung @ 5 t ha$^{-1}$), $V_1$× $F_9$ (PAC-60008 fertilized with 75% NPK and other inorganic fertilizers + poultry manure @ 2.5 t ha$^{-1}$),$V_2$ x $F_6$ (SV-887 fertilized with 50% NPK and other inorganic fertilizers + cowdung @ 10 t ha$^{-1}$),$V_2$ x $F_3$ (SV-887 fertilized with NPKSZnB @ 135-25-133-18-3.5-1.2 kg ha$^{-1}$), $V_2$x $F_4$(SV-887 fertilized with 75% NPK and other inorganic fertilizers + cowdung @ 10 t ha$^{-1}$), $V_1$ x $F_4$ (PAC-60008 fertilized with 75% NPK and other inorganic fertilizers + cowdung @ 10 t ha$^{-1}$ and the shortest plant (40.67 cm) was found in $V_1$× $F_1$ (PAC-60008 fertilized with cowdung @ 10 t ha$^{-1}$) (Table 1). Genotypic characteristics with higher dose of nutrient might be responsible higher plant height in sugarbeet.

**Leaf number**

Number of leaves plant$^{-1}$ with the interaction of variety and integrated nutrient management showed substantial differences over time. Table 2 shows that the leaf production plant$^{-1}$gradually increased in course of time and reached maximum at 100 DAS. The highest number of leaves plant$^{-1}$(36.83) was recorded in $V_2$× $F_5$ (SV-887 fertilized with 75% NPK and other inorganic fertilizers + poultry manure @ 5 t ha$^{-1}$) which was at par with $V_2$× $F_8$ (SV-887 fertilized with 75% NPK and other inorganic fertilizers + cowdung @ 5 t ha$^{-1}$) and the lowest number of leaves plant$^{-1}$(24.17) was found in $V_1$ × $F_2$(PAC-60008

fertilized with poultry manure @ 5 t $ha^{-1}$.

**SPAD value**

The SPAD value or chlorophyll meter values of sugarbeet are illustrated in Table 3. SPAD value of sugarbeet was significantly influenced by the interaction between variety and integrated nutrient management at all dates of sampling. The SPAD value showed an increasing trend and reached maximum at 80 DAS and thereafter declined irrespective of treatment differences. Similar trend of SPAD value of various crops was reported elsewhere (Tajul*et al*., 2013; Islam *et al*., 2014; Paul *et al.*, 2018). The highest SPAD values of 40 and 60 DAS (40.30 and 66.33, respectively) were recorded in $V_2 \times F_5$ (SV-887 fertilized with 75% NPK and other inorganic fertilizers + poultry manure @ 5 t $ha^{-1}$) while at 80 and 100 DAS (87.20 and 51.87 respectively), the highest SPAD values were found in $V_2 \times F_4$ (SV-887 fertilized with 75% NPK and other inorganic fertilizers + cowdung @ 10 t $ha^{-1}$) and $V_2 \times F_3$ (SV-887 fertilized with NPKSZnB @ 135-25-133-18-3.5-1.2 kg $ha^{-1}$), and the lowest SPAD values of 40 and 60 DAS (28.47 and 37.63 respectively) were recorded in $V_1$ x $F_5$(PAC-60008 fertilized 75% NPK and other inorganic fertilizers + poultry manure @ 5 t $ha^{-1}$) and $V_1$ x $F_1$(PAC-60008 fertilized with cowdung @ 10 t $ha^{-1}$) while at 80 and 100 DAS (43.93 and 37.90 respectively), the lowest SPAD values were found in and $V_1$ x $F_1$(PAC-60008 fertilized with Cowdung @ 10 t $ha^{-1}$) and $V_1$ x $F_7$(PAC-60008 fertilized with 50% NPK and other inorganic fertilizers + poultry manure @ 5 t $ha^{-1}$), respectively (Table 3).

**Top length and top yield**

The highest top length (50.33 cm) at harvest were recorded in $V_2 \times F_3$ (SV-887 fertilized with NPKSZnB @ 135-25-133-18-3.5-1.2 kg $ha^{-1}$) while the lowest one (30.00 cm) was recorded in $V_1 \times F_2$ (PAC-60008 fertilized with poultry manure 5 @ t $ha^{-1}$). The highest beet top yield (38.67t $ha^{-1}$) was found in $V_1 \times F_9$ (PAC-60008 fertilized with 75% NPK and other inorganic fertilizers + poultry manure @ 2.5 t $ha^{-1}$),which was statistically identical with $V_2 \times F_3$ (SV-887 fertilized with NPKSZnB @ 135-25-133-18-3.5-1.2 kg $ha^{-1}$) while the lowest one (20.00 t $ha^{-1}$) was recorded in $V_1 \times F_1$ (PAC-60008 fertilized with cowdung @ 10 t $ha^{-1}$). Combined application of inorganic fertilizer with manure increased beet top yield compared to sole application of manure as well as inorganic fertilizer was reported by Balakrishnan and Selvakumar (2008).

**Yield components and beet yield**

Root length was not significantly affected due to interaction effect of variety and integrated nutrient management. Table 4 shows that root length ranged 21.67 cm to 27.00 cm. Numerically the longest root (27.00 cm ) was produced in $V_1 \times F_5$ (PAC-60008 fertilized with 75% NPK and other inorganic fertilizers + poultry manure @ 5 t $ha^{-1}$) and $V_1 \times F_9$ (PAC-60008 fertilized with 75% NPK and other inorganic fertilizers + poultry manure @ 2.5 t $ha^{-1}$) while the shortest (21.67 cm) one was produced in $V_2 \times F_2$ (SV-887 fertilized with poultry manure @ 5 t $ha^{-1}$). The highest beet girth (38.58 cm), average beet weight (0.98 kg) and beet yield (98.18 t $ha^{-1}$) were recorded in $V_1 \times F_5$ (PAC-60008 fertilized with 75% NPK and other inorganic fertilizers + poultry manure @ 5 t $ha^{-1}$),which were at par with $V_1 \times F_3$ (PAC-60008 fertilized with NPKSZnB @ 135-25-133-18-3.5-1.2 kg $ha^{-1}$) and $V_1 \times F_9$ (PAC-60008 fertilized with 75% NPK and other inorganic fertilizers + poultry manure @ 2.5 t $ha^{-1}$). The lowest beet girth (29.30 cm) was recorded in $V_1 \times F_1$ (PAC-60008 fertilized with cowdung @ 10 t $ha^{-1}$) while the lowest average beet weight (0.220 kg) and beet yield (22.10 t $ha^{-1}$) were obtained in $V_2 \times F_1$ (SV-887 fertilized with cowdung @ 10 t $ha^{-1}$). The longest root, highest beet girth and average beet weight $plant^{-1}$ contributed to the highest sugarbeet yield. Integrated nutrient management significantly influenced the yield components and root yield of sugarbeet. Balakrishnan and Selvakumar (2008) reported that 100% inorganic fertilizer through urea along with manure significantly increased beet yield which was comparable to 50% inorganic fertilizer along with manure.

**Brix (%)**

Sugarbeet brix (%) was significant due to interaction between variety and nutrient management at all sampling dates. Table 5 shows that in course of time percent brix increased up to 135 DAS irrespective of treatment combination while in some cases it was decreased. Similar decreasing trend of brix (%) was reported by Paul *et al.* (2018). At 120 DAS, the highest brix (15.33%) was recorded in $V_1 \times F_9$ (PAC-60008 fertilized with 75% NPK and other inorganic fertilizers + poultry manure @ 2.5 t $ha^{-1}$) which was at par with $V_1$ x $F_4$ (PAC-60008 fertilized with 75% NPK and other inorganic fertilizers + cowdung @ 10 t $ha^{-1}$and the lowest one (12%)was obtained in $V_2 \times F_3$ (SV-887 fertilized with NPKSZnB @ 135-25-133-18-3.5-1.2 kg $ha^{-1}$),which was similar to $V_2 \times F_6$(SV-887 fertilized with 50% NPK and other inorganic fertilizers + cowdung @ 10 t $ha^{-1}$). Table 5 indicates that at 135 DAS, the highest brix (17.67%) was recorded in $V_1 \times F_6$ (PAC-60008 fertilized with 50% NPK and other inorganic fertilizers + cowdung @ 10 t $ha^{-1}$) and $V_2 \times F_2$ (SV-887 fertilized with poultry manure @ 5 t $ha^{-1}$), which was at par with $V_1 \times F_9$ (PAC-60008 fertilized with 75% NPK and other inorganic fertilizers + poultry manure @ 2.5 t $ha^{-1}$), $V_1$ x $F_4$ (PAC-60008 fertilized with 75% NPK and other inorganic fertilizers + cowdung @ 10 t ha-1), $V_1 \times F_8$ (PAC-60008 fertilized with 75% NPK and other inorganic fertilizers + cowdung @ 5 t $ha^{-1}$), $V_2 \times F_5$(SV-887 fertilized with 75% NPK and other inorganic fertilizers + poultry manure @ 5 t $ha^{-1}$), $V_1 \times F_2$ (PAC-60008 fertilized with poultry manure @ 5 t $ha^{-1}$), $V_1 \times F_3$ (PAC-60008 fertilized with NPKSZnB @ 135-25-133-18-3.5-1.2 kg $ha^{-1}$), $V_1 \times F_7$ (PAC-60008 fertilized with 50% NPK and other inorganic fertilizers + poultry manure @ 5 t $ha^{-1}$), while the lowest one (15%) was found in $V_2 \times F_3$ (SV-887 fertilized with NPKSZnB @ 135-25-133-18-3.5-1.2 kg $ha^{-1}$). At 150 DAS, the highest brix (18%) was recorded in $V_1 \times F_7$(PAC-60008 fertilized with 50% NPK and other inorganic fertilizers + poultry manure @ 5 t $ha^{-1}$ ) which was as good as the combination of $V_1 \times F_5$ (PAC-60008 fertilized with 75% NPK and other inorganic fertilizers + poultry manure @ 5 t $ha^{-1}$), $V_1 \times F_2$ (PAC-60008 fertilized with poultry manure @ 5 t $ha^{-1}$), $V_1 \times F_4$ (PAC-60008 fertilized with 75% NPK and other inorganic fertilizers + cowdung @ 10 t $ha^{-1}$) while the lowest brix (14.67%) was found in $V_2 \times F_2$ (SV-887 fertilized with poultry manure @ 5 t $ha^{-1}$) and $V_2 \times F_8$ (SV-887 with 75% NPK and other inorganic fertilizers + cowdung @ 5 t $ha^{-1}$).

## CONCLUSION

From the findings of the present experiment, it can be concluded that sugarbeet variety PAC-60008 fertilized with 75% recommended dose of NPK and other inorganic fertilizers + poultry manure @ 2.5 t $ha^{-1}$ appears as the promising combination in terms of beet yield.

**Table-1 Interaction effects of variety and integrated nutrient management on plant height at different days after sowing of tropical sugarbeet**

| Interaction (Variety x integrated nutrient management) | Plant height (cm) | | | |
|---|---|---|---|---|
| | Days after sowing (DAS) | | | |
| | **40** | **60** | **80** | **100** |
| $V_1 \times F_1$ | 19.75ef | 32.50 | 41.08 | 40.67h |
| $V_1 \times F_2$ | 21.67abc | 36.17 | 43.08 | 44.08 g |
| $V_1 \times F_3$ | 19.75ef | 38.42 | 50.83 | 57.25a |
| $V_1 \times F_4$ | 20.50cde | 38.50 | 48.08 | 53.92abcd |
| $V_1 \times F_5$ | 23.00a | 39.75 | 49.08 | 51.08 de |
| $V_1 \times F_6$ | 22.17ab | 38.33 | 48.42 | 53.50bcd |
| $V_1 \times F_7$ | 22.17ab | 37.75 | 48.67 | 52.25cd |
| $V_1 \times F_8$ | 20.08def | 37.42 | 48.00 | 52.00cd |
| $V_1 \times F_9$ | 20.50cde | 38.33 | 48.17 | 55.17abc |
| $V_2 \times F_1$ | 20.17def | 33.17 | 41.33 | 45.92fg |
| $V_2 \times F_2$ | 21.17bcde | 35.75 | 44.58 | 48.33ef |
| $V_2 \times F_3$ | 21.33bcd | 39.17 | 51.00 | 54.50abcd |
| $V_2 \times F_4$ | 20.42cdef | 36.83 | 47.33 | 54.25abcd |
| $V_2 \times F_5$ | 22.33ab | 40.75 | 51.42 | 56.33ab |
| $V_2 \times F_6$ | 20.25cdef | 36.17 | 47.50 | 53.83abcd |
| $V_2 \times F_7$ | 19.00f | 34.83 | 46.42 | 51.08de |
| $V_2 \times F_8$ | 21.50bcd | 38.58 | 50.92 | 55.42abc |
| $V_2 \times F_9$ | 20.33cdef | 37.50 | 49.08 | 52.67bcd |
| $\bar{S}x$ | 0.435 | 0.764 | 0.893 | 1.12 |
| Level of sig. | ** | NS | NS | ** |
| CV (%) | 3.61 | 3.55 | 3.26 | 3.75 |

In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT)
** =Significant at 1% level of probability. NS= Not significant
$V_1$ = PAC- 60008, $V_2$ = SV-887

$F_1$ = Cowdung @ 10 t $ha^{-1}$, $F_2$ = Poultry manure @ 5 t $ha^{-1}$, $F_3$ = Recommended dose of chemical fertilizer (NPKSZnB @ 135-25-133-18-3.5-1.2 kg $ha^{-1}$), $F_4$ = 75% NPK and other inorganic fertilizers + cowdung @ 10 t $ha^{-1}$, $F_5$ = 75% NPK and other inorganic fertilizers + poultry manure @ 5 t $ha^{-1}$, $F_6$ = 50% NPK and other inorganic fertilizers + cowdung @ 10 t $ha^{-1}$, $F_7$ = 50% NPK and other inorganic fertilizers + poultry manure @ 5 t $ha^{-1}$, $F_8$ = 75% NPK and other inorganic fertilizers + cowdung @ 5 t $ha^{-1}$ and $F_9$ = 75% NPK and other inorganic fertilizers + poultry manure @ 2.5 t $ha^{-1}$

**Table-2 Interaction effects of variety and integrated nutrient management on number of leaves plant$^{-1}$ at different days after sowing of tropical sugarbeet**

| Interaction (Variety x integrated nutrient management) | Number of leaves plant$^{-1}$ | | | |
|---|---|---|---|---|
| | Days after sowing (DAS) | | | |
| | 40 | 60 | 80 | 100 |
| $V_1$ x $F_1$ | 7.75cde | 11.67ef | 17.50defg | 29.42de |
| $V_1$ x $F_2$ | 7.91abcd | 11.42f | 18.17cdefg | 24.17i |
| $V_1$ x $F_3$ | 7.08f | 11.83def | 17.42efg | 27.25fg |
| $V_1$ x $F_4$ | 7.00f | 11.92cdef | 16.92g | 30.00d |
| $V_1$ x $F_5$ | 7.58def | 11.83def | 18.83bcde | 25.83gh |
| $V_1$ x $F_6$ | 7.58def | 12.58bcd | 18.50cdef | 28.42def |
| $V_1$ x $F_7$ | 7.92bcd | 12.58bcd | 18.25cdefg | 27.67f |
| $V_1$ x $F_8$ | 7.25ef | 11.67ef | 17.25fg | 29.83de |
| $V_1$ x $F_9$ | 7.75cde | 12.42bcde | 18.33cdef | 29.58de |
| $V_2$ x $F_1$ | 8.00abcd | 12.42bcde | 18.58cdef | 25.33hi |
| $V_2$ x $F_2$ | 8.58a | 12.75bc | 18.92bcd | 29.67de |
| $V_2$ x $F_3$ | 8.50ab | 13.00b | 18.75bcde | 33.17c |
| $V_2$ x $F_4$ | 8.00abcd | 12.50bcde | 19.25bc | 28.17ef |
| $V_2$ x $F_5$ | 8.33abc | 13.92a | 21.42a | 36.83a |
| $V_2$ x $F_6$ | 8.00abcd | 12.92b | 18.58cdef | 34.92b |
| $V_2$ x $F_7$ | 7.25ef | 12.17bcdef | 18.08cdefg | 32.08c |
| $V_2$ x $F_8$ | 8.16abcd | 12.92b | 20.00b | 35.67ab |
| $V_2$ x $F_9$ | 7.91bcd | 12.50bcde | 18.42cdef | 28.33def |
| $\bar{S}x$ | 0.198 | 0.265 | 0.424 | 0.540 |
| Level of sig. | ** | ** | ** | ** |
| CV (%) | 4.40 | 3.70 | 3.96 | 3.14 |

In a column, figures with same letter (s) or without letter do not different significantly whereas figures with dissimilar letter differ significantly (as per DMRT).
** =Significant at 1% level of probability. NS= Not significant
$V_1$ = PAC-60008, $V_2$ = SV-887

$F_1$ = Cowdung @ 10 t ha$^{-1}$, $F_2$ = Poultry manure @ 5 t ha$^{-1}$, $F_3$ = Recommended dose of chemical fertilizer (NPKSZnB @ 135-25-133-18-3.5-1.2 kg ha$^{-1}$), $F_4$ = 75% NPK and other inorganic fertilizers + cowdung @ 10 t ha$^{-1}$, $F_5$ = 75% NPK and other inorganic fertilizers + poultry manure @ 5 t ha$^{-1}$, $F_6$ = 50% NPK and other inorganic fertilizers + cowdung @ 10 t ha$^{-1}$, $F_7$ = 50% NPK and other inorganic fertilizers + poultry manure @ 5 t ha$^{-1}$, $F_8$ = 75% NPK and other inorganic fertilizers + cowdung @ 5 t ha$^{-1}$ and $F_9$ = 75% NPK and other inorganic fertilizers + poultry manure @ 2.5 t ha$^{-1}$

**Table-3 Interaction effects of variety and integrated nutrient management on chlorophyll content at different days after sowing of tropical sugarbeet**

| Interaction (Variety x integrated nutrient management) | Chlorophyll content (SPAD value) Days after sowing (DAS) | | | |
|---|---|---|---|---|
| | **40** | **60** | **80** | **100** |
| $V_1$ x $F_1$ | 29.73hi | 37.63j | 43.93g | 40.27def |
| $V_1$ x $F_2$ | 33.10efg | 46.87ghi | 52.20f | 41.83bcdef |
| $V_1$ x $F_3$ | 35.27cde | 55.67cde | 58.80e | 44.40bcd |
| $V_1$ x $F_4$ | 31.27ghi | 35.70j | 46.97g | 41.33cdef |
| $V_1$ x $F_5$ | 28.47i | 46.50 ghi | 46.43g | 44.00bcde |
| $V_1$ x $F_6$ | 30.23ghi | 48.40fgh | 46.23g | 40.87def |
| $V_1$ x $F_7$ | 29.27hi | 44.77hi | 53.50f | 37.90f |
| $V_1$ x $F_8$ | 30.90ghi | 47.10ghi | 54.13f | 39.07ef |
| $V_1$ x $F_9$ | 32.90efg | 42.53i | 58.37e | 42.97bcde |
| $V_2$ x $F_1$ | 32.00fgh | 50.70efg | 68.40cd | 46.07bc |
| $V_2$ x $F_2$ | 36.93bcd | 52.77def | 67.07cd | 42.27bcdef |
| $V_2$ x $F_3$ | 37.90abc | 58.70bc | 85.63a | 51.87a |
| $V_2$ x $F_4$ | 34.20def | 52.53def | 87.20a | 42.17bcdef |
| $V_2$ x $F_5$ | 40.30a | 66.33a | 60.73e | 42.83bcdef |
| $V_2$ x $F_6$ | 39.70ab | 51.47efg | 71.30c | 46.47b |
| $V_2$ x $F_7$ | 37.30bc | 48.10fgh | 75.80b | 43.33bcde |
| $V_2$ x $F_8$ | 35.33cde | 62.47ab | 66.33d | 46.17bc |
| $V_2$ x $F_9$ | 36.73cd | 56.77cd | 85.27a | 42.77bcdef |
| $\bar{S}x$ | 0.917 | 1.60 | 1.46 | 1.48 |
| Level of sig. | ** | ** | ** | * |
| CV (%) | 4.67 | 5.52 | 4.04 | 5.96 |

In a column, figures with same letter (s) or without letter do not different significantly whereas figures with dissimilar letter differ significantly (as per DMRT).

** =Significant at 1% level of probability.* =Significant at 5% level of probabilityNS= Not significant
$V_1$ = PAC-60008, $V_2$ = SV-887

$F_1$ = Cowdung @ 10 t $ha^{-1}$, $F_2$ = Poultry manure @ 5 t $ha^{-1}$, $F_3$ = Recommended dose of chemical fertilizer (NPKSZnB @ 135-25-133-18-3.5-1.2 kg $ha^{-1}$), $F_4$ = 75% NPK and other inorganic fertilizers + cowdung @ 10 t $ha^{-1}$, $F_5$ = 75% NPK and other inorganic fertilizers + poultry manure @ 5 t $ha^{-1}$, $F_6$ = 50% NPK and other inorganic fertilizers + cowdung @ 10 t $ha^{-1}$, $F_7$ = 50% NPK and other inorganic fertilizers + poultry manure @ 5 t $ha^{-1}$, $F_8$ = 75% NPK and other inorganic fertilizers + cowdung @ 5 t $ha^{-1}$ and $F_9$ = 75% NPK and other inorganic fertilizers + poultry manure @ 2.5 t $ha^{-1}$

**Table-4 Interaction effects of variety and integrated nutrient management on crop characters, yield components and yield of tropical sugarbeet**

| Interaction (Variety x integrated nutrient management) | Top length (cm) | Top yield (t ha$^{-1}$) | Root length (cm) | Beet girth (cm) | Average beet weight (kg) | Beet yield (t ha$^{-1}$) |
|---|---|---|---|---|---|---|
| $V_1$ x $F_1$ | 34.27i | 20.00i | 23.70 | 29.30 h | 0.27hi | 26.67hi |
| $V_1$ x $F_2$ | 30.00j | 21.67gh | 22.83 | 30.00gh | 0.30h | 30.65h |
| $V_1$ x $F_3$ | 42.67de | 36.00b | 26.42 | 37.58ab | 0.96a | 95.52a |
| $V_1$ x $F_4$ | 38.75fg | 26.67f | 24.00 | 31.58fgh | 0.86b | 85.67b |
| $V_1$ x $F_5$ | 39.00fg | 32.00c | 27.00 | 38.58a | 0.98a | 98.18a |
| $V_1$ x $F_6$ | 41.00ef | 29.67de | 24.50 | 33.42cdef | 0.69ef | 68.93ef |
| $V_1$ x $F_7$ | 43.50d | 30.33cd | 22.00 | 34.00cdef | 0.71e | 71.07e |
| $V_1$ x $F_8$ | 38.00g | 28.33e | 24.92 | 31.83efg | 0.79cd | 79.33cd |
| $V_1$ x $F_9$ | 45.17bcd | 38.67a | 27.00 | 37.33ab | 0.94a | 94.33a |
| $V_2$ x $F_1$ | 37.25gh | 20.33hi | 23.17 | 29.33h | 0.22i | 22.10i |
| $V_2$ x $F_2$ | 35.33hi | 23.00g | 21.67 | 29.44h | 0.27hi | 27.38hi |
| $V_2$ x $F_3$ | 50.33a | 38.33a | 25.33 | 35.67bc | 0.86b | 86.03b |
| $V_2$ x $F_4$ | 43.73d | 31.00cd | 25.97 | 34.60cd | 0.84bc | 84.27bc |
| $V_2$ x $F_5$ | 46.92bc | 36.00b | 25.83 | 34.75cd | 0.88b | 88.00b |
| $V_2$ x $F_6$ | 45.17cd | 30.67cd | 22.17 | 32.58def | 0.61g | 61.27g |
| $V_2$ x $F_7$ | 43.00de | 31.00cd | 24.25 | 34.25cde | 0.64fg | 64.10fg |
| $V_2$ x $F_8$ | 47.50b | 30.00d | 25.00 | 33.92cdef | 0.65fg | 65.13efg |
| $V_2$ x $F_9$ | 43.42d | 35.00b | 25.08 | 34.33cde | 0.77d | 77.33d |
| $\bar{S}x$ | 0.766 | 0.547 | 0.787 | 0.763 | 0.018 | 1.99 |
| Level of sig. | ** | ** | NS | ** | ** | ** |
| CV (%) | 3.21 | 3.17 | 5.58 | 3.95 | 4.37 | 5.08 |

In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT)
** =Significant at 1% level of probability. NS= Not significant
$V_1$ = PAC- 60008, $V_2$ = SV-887

$F_1$ = Cowdung @ 10 t ha$^{-1}$, $F_2$ = Poultry manure @ 5 t ha$^{-1}$, $F_3$ = Recommended dose of chemical fertilizer (NPKSZnB @ 135-25-133-18-3.5-1.2 kg ha$^{-1}$), $F_4$ = 75% NPK and other inorganic fertilizers + cowdung @ 10 t ha$^{-1}$, $F_5$ = 75% NPK and other inorganic fertilizers + poultry manure @ 5 t ha$^{-1}$, $F_6$ = 50% NPK and other inorganic fertilizers + cowdung @ 10 t ha$^{-1}$, $F_7$ = 50% NPK and other inorganic fertilizers + poultry manure @ 5 t ha$^{-1}$, $F_8$ = 75% NPK and other inorganic fertilizers + cowdung @ 5 t ha$^{-1}$ and $F_9$ = 75% NPK and other inorganic fertilizers + poultry manure @ 2.5 t ha$^{-1}$

**Table-5 Interaction effects of variety and integrated nutrient management on brix content (%) at different days after sowing of tropical sugarbeet**

| Interaction (Variety x integrated nutrient management) | Brix content (%) | | |
|---|---|---|---|
| | Days after sowing (DAS) | | |
| | **120** | **135** | **150** |
| $V_1$ x $F_1$ | 14.00bc | 15.67def | 16.33bcd |
| $V_1$ x $F_2$ | 14.00bc | 16.67abcd | 17.00abc |
| $V_1$ x $F_3$ | 13.33cde | 16.67abcd | 15.67cde |
| $V_1$ x $F_4$ | 15.00ab | 17.33ab | 16.67abcd |
| $V_1$ x $F_5$ | 14.00bc | 16.00cdef | 17.50ab |
| $V_1$ x $F_6$ | 14.00bc | 17.67a | 16.00cde |
| $V_1$ x $F_7$ | 14.00c | 16.67abcd | 18.00a |
| $V_1$ x $F_8$ | 14.00bc | 17.00abc | 16.33bcd |
| $V_1$ x $F_9$ | 15.33a | 17.33ab | 16.00cde |
| $V_2$ x $F_1$ | 13.33cde | 16.00cdef | 15.67cde |
| $V_2$ x $F_2$ | 13.67cd | 17.67a | 14.67e |
| $V_2$ x $F_3$ | 12.00f | 15.00f | 15.67cde |
| $V_2$ x $F_4$ | 12.33ef | 15.33ef | 16.00 cde |
| $V_2$ x $F_5$ | 14.00bc | 17.00abc | 15.33de |
| $V_2$ x $F_6$ | 12.00f | 15.67def | 15.67cde |
| $V_2$ x $F_7$ | 13.33cde | 16.33 bcde | 15.67cde |
| $V_2$ x $F_8$ | 12.33ef | 15.67def | 14.67e |
| $V_2$ x $F_9$ | 12.67def | 16.00cdef | 16.33bcd |
| $\bar{S}x$ | 0.333 | 0.311 | 0.437 |
| Level of sig. | ** | ** | ** |
| CV (%) | 4.26 | 3.28 | 4.71 |

In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT)
** =Significant at 1% level of probability. NS= Not significant
$V_1$ = PAC- 60008, $V_2$ = SV-887

$F_1$ = Cowdung @ 10 t $ha^{-1}$, $F_2$ = Poultry manure @ 5 t $ha^{-1}$, $F_3$ = Recommended dose of chemical fertilizer (NPKSZnB @ 135-25-133-18-3.5-1.2 kg $ha^{-1}$), $F_4$ = 75% NPK and other inorganic fertilizers + cowdung @ 10 t $ha^{-1}$, $F_5$ = 75% NPK and other inorganic fertilizers + poultry manure @ 5 t $ha^{-1}$, $F_6$ = 50% NPK and other inorganic fertilizers + cowdung @ 10 t $ha^{-1}$, $F_7$ = 50% NPK and other inorganic fertilizers + poultry manure @ 5 t $ha^{-1}$, $F_8$ = 75% NPK and other inorganic fertilizers + cowdung @ 5 t $ha^{-1}$ and $F_9$ = 75% NPK and other inorganic fertilizers + poultry manure @ 2.5 t $ha^{-1}$

**ACKNOWLEDGEMENTS**

The financial assistance of Bangladesh Agricultural University Research System (BAURES) (2015/08/BAU) to conduct the research project is thankfully acknowledged.

**REFERENCES**

Ahmad, I., B. Ahmad, S. Ali, H.Q. Fang, T. Liu, M. Kamran, Y. Wu, M.U. Rahman and S. Faisal, 2016. Organic and Inorganic Fertilization Influenced on Yield and Quality of Sugar Beet Genotypes, *Russian Agricultural Sciences.* 42 (3-4): 218–223.

Balakrishnan, A. and T. Selvakumar, 2008. Integrated nutrient management for tropical sugarbeet hydrids.*Sugar Tech.* 10 (2): 177-180.

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

Gomez, K.A. and A.A. Gomez, 1984. Statistical procedure for agricultural research. John Wiley and Sons, New York, second edition. p.680.

Hergert, G.W. and R A. Nielsen, 2011. Effect of manure compost on sugar beet yield and quality.Conference Paper, March 2011. DOI: 10.5274/ASSBT.2011.88.

Islam, M.R., K.M.S. Haque, N. Akter and M.A. Karim, 2014. Leaf chlorophyll dynamics in wheat based on SPAD meter reading and its relationship with grain yield. *Scientia Agric.* 8 (1): 13-18.

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

Javaheri, M.A., N. Rashidand A. Baghizadeh, 2005. Influence of organic farm yard manure, potassium and boron on quantity and quality of sugar beet in Bardsirregion, J. Sugar Beet., 21 : 31–41.

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

Oyedeji, S., D.A. Animasaun, A.A. Bello and O.O. Agboola, 2014. Effect of NPK and Poultry Manure on Growth, Yield, and Proximate Composition of Three Amaranths. *Journal of Botany*. http://dx.doi.org/10.1155/2014/828750.

Pal, S., S.K. Paul, M.A.R.Sarkar and D.R.Gupta, 2016. Response on yield and protein content of fine aromatic rice varieties to integrated use of cowdung and inorganic fertilizers. *Journal of Crop and Weed.* 12 (1): 1-6.

Paul, S.K., U. Paul, MA.R. Sarkar and M.S. Hossain, 2018.Yield and quality of tropical sugarbeet as influenced by variety, spacing and fertilizer application. *Sugar Tech*. 20(2):175–181. doi.org/10.1007/s12355-017-0545-3.

Rahman, M.S., S. Khatun and M.K. Rahman, 2016. Sugarcane and sugar industry in Bangladesh: An overview. *Sugar Tech.* 18(6):627–635.

Salami, M., and S. Saadat, 2013. Study of potassium and nitrogen fertilizer levels on the yield of sugar beet in jolge cultivar. *The Journal of Novel Applied Sciences.* 2:94–100.

Soomro, A.F., S. Tunio, M.I. Keerio, I. Rajper, Q. Chachar and M.Y. Arain, 2014. Effect of inorganic NPK fertilizers under different proportions on growth, yield and juice quality of sugarcane (*Saccharum officinarum* L). *Pure and Applied Biology.* 3(1): 10–18.

Tajul, M.I., M.M. Alam, S.M.M. Hossain and K. Naher, 2013. Influence of plant population and nitrogen-fertilizer at variouslevels on growth and growth efficiency of maize.*The Scientific World Journal.* 19(2): 150–159.

Topcuoğlu, B. and K**.** Önal, 2005. The effects of organic waste application on sugar beet: Part I. The effect of poultry manure on sugar beet. https://www.researchgate.net/ publication/ 287073086.

UNDP and FAO, 1988. Land resources appraisal of Bangladesh for agricultural development report-2. BARC, Farmgate, Dhaka, pp. 212-221.

Zhu J., N. Tremblayand Y. Liang, 2012. Comparing SPAD and atLEAF values for chlorophyll assessment in crop species. Can*. J. Soil Sci*., 92: 645-648.