# RESPONSE OF SUGARBEET *BETA VULGARIS* (VARIETY KAWETERMA) TO DIFFERENT FERTILITY LEVELS

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## ABSTRACT

The response of sugarbeet variety Kaweterma to different fertility levels was ascertained in the field. The treatments included six N-P levels viz: 0-0 (control), 50-50, 75-75, 100-100, 125-125 and 150-150 N-P kg $ha^{-1}$. Application of N-P fertilizers in higher quantities (150-150 kg $ha^{-1}$) resulted 93230 $ha^{-1}$ plant population, 62.50 cm leaves length, 37.38 leaves $plant^{-1}$, 2.22 kg sugarbeet weight $plant^{-1}$, 83.142 m.t $ha^{-1}$ beetroot yield, 22.37% brix content and 11.34% sugar recovery. N-P application at the rate of 125-125 and 100-100 kg $ha^{-1}$ produced 92367 and 90053 $ha^{-1}$ plant population, 61.25 and 58.75 cm leaves length, 35.91 and 31.95 leaves $plant^{-1}$, 2.21 and 2.13 kg sugarbeet weight $plant^{-1}$, 80.588 and 79.484 m.t $ha^{-1}$ beetroot yield, 22.34 and 22.11% brix content and 11.31 and 11.19% sugar recovery. It was observed that there was a gradual improvement in all the growth and yield components with increasing fertility levels. However, this increase was uneconomical when applied beyond 100-100 kg $ha^{-1}$, because differences amongst 100-100, 125-125 and 150-150 kg N-P $ha^{-1}$ for all the parameters were statistically non-significant. Hence, 100-100 kg N-P level was considered to be an optimum level for economical production of sugarbeet under Tandojam conditions.

Keywords: Sugarbeet, fertility levels, beetroot yield, brix, sugar recovery.

## INTRODUCTION

Sugar Beet, *Beta vulgaris* L. belongs to the family *chenopodiaceae*, is grown throughout the world mainly wild *Beta maritime* for food and medical purpose and its roots used as vegetable. There are three types of beetroot, the globe beet (which is the most popular); the intermediate or cylindrical beet and the long beet. Although the long beet is still grown commercially and for exhibition, it has been superseded to a great extent by the other two kinds. For early sowing always use the globe beet. The intermediate beet is bigger but it grows more slowly. So it is more suitable for main crop use (Martyn, 1978). Sugarbeets are believed to the native to the Mediterranean area of Europe, Egypt and North Africa, and secondary area of development was located in the near East. Many members of the beet family are found in areas with elevated salt leaves. Beets have been grown as a potherb throughout the recorded history. The roots of wild beets, however, were used by ancient civilizations only for medicine. These wild forms did not resemble the modern enlarged beet (Hamilton, 2005).

Sindh is the only other province where sugarbeet is cultivated but on a very small scale. The reported area under cultivation in Sindh is about 100 hectares. Sugarcane is the main source of sugar production in the country. Our sugar industry is entirely dependent on the availability of sugarcane. However, it is a high delta crop notorious for its lavish water use and occupies land for 10-14 months. In this respect, sugarbeet has a comparative advantage, as it is a low delta crop and occupies land for 4-5-months (Syed, 2002).

Proper management of fertilizer applications to sugarbeets still remains a challenge for growers. The researchers have quantified rates of fertilizer uptake, and estimated the amount of N, P and K in sugarbeet crops that was derived from the soil itself, compared to that derived from fertilizers. Use of chemical fertilizers has become essential for good beet crop harvest. The macronutrient (N.P.K) has their individual role in development of root zone and good crop stand. Moreover, these elements are vitally needed to establish different properties in the beet root juice and similarly needed for satisfactory crop growth (Pakissan.com, 2004). Plant analysis is associated with nutrient's concentration in a specific plant part to the growth of the plant (George and Schmitt, 2002; Mortvedt *et al*., 2005; Cattanach *et al*., 1993). Sugarbeets responded to N deficiency by an increase in sucrose percentage of storage roots and the change results from an inhibition of vegetative growth, which permits a higher proportion of the sucrose produced in the leaves to accumulate in the roots rather than be used in growth (Mortvedt *et al*., 2005). The crop responses to P fertilization are quite common. The P deficiency is by far the most difficult to recognize. An overall stunting of the plant and a slight deepening of the green foliage color are the only visual signs (Mortvedt *et al*., 2004). In case of Potassium, a 30-ton sugarbeet root crop contains about 180 pounds of $K_2O$ (150 pounds K) in its tops and roots. The experiment was conducted to examine the response of sugarbeet to different fertility levels in terms of its growth, yield and sugar recovery under Tandojam conditions.

## MATERIALS AND METHODS

The experiment was laid out in a four replicated randomized complete block design (RCBD), the sub-plot size kept was 4.2m x 6m (25.2m$^2$). A fallow left (in the off-season) piece of land was selected and prepared by giving cross wise deep ploughings. After soaking dose, when the land came in condition, the seedbed was prepared by using cultivator (cross-wise) and rotavator. Thereafter, clods were broken completely by clod crusher followed by thorough levelling. After seedbed preparation 60 cm apart ridges were prepared with tractor drawn ridger. Pure seed of sugarbeet variety “Kaweterma” was obtained with the courtesy of from Sugarcane Specialist, Agriculture Research Institute, Tandojam and the sowing was completed in the third week of October 2005. Before sowing, a certain amount of chemical fertilizers (nitrogen and phosphorus) was applied by mixing in the soil to improve the soil for any sort of deficiency in these essential nutrient elements. After completion of the germination, the plants were thinned to maintain plant to plant spacing of 20 cm. Nitrogen was applied in the form of urea and Phosphorus in the form of Diammonium Phosphate (D.A.P). All P and 1/3$^{rd}$ of nitrogen were applied at the time of sowing, while the remaining nitrogen was divided into two equal doses and applied at third and fourth irrigation. All the agronomic practices were carried out uniformly in all the plots. Eight irrigations were applied from sowing upto the crop maturity. After completion of field observations, the samples were brought to the laboratory of Sugarcane Section, Agriculture Research Institute, Tandojam, where the beetroots were sliced and juice was extracted to record Brix and sugar recovery. Finally, the data so collected were subjected to statistical analysis to analyze the treatment variation, while L.S.D. (Least Significant Difference) test was applied to observe the significance of difference within treatments as suggested by Gomez and Gomez (1984).

## RESULTS AND DISCUSSION

### Plant population $ha^{-1}$

The plant population $ha^{-1}$ was significantly higher (93230) in plots fertilized with highest fertility level of 150-150 kg N-P $ha^{-1}$, closely followed by plant population of 92367 and 90053 plants $ha^{-1}$, recorded in plots fertilized with 125-125 kg and 100-100 kg N-P $ha^{-1}$, respectively. The sugarbeet crop fertilized with 75-75 kg and 50-50 kg N-P $ha^{-1}$ had mean plant population of 78743 and 71389 plants $ha^{-1}$, respectively. However, the lowest plant population of 69173 plants $ha^{-1}$ was recorded in plots left untreated (control). This higher plant population in plots treated with higher fertility levels was mainly associated with the better germination of seeds, because due to application of nitrogen and phosphorus in higher quantities, the soil fertility improved to an adequate level and hence increased plant population resulted. A comprehensive research on various aspects of sugarbeet has been carried out world over and is published in various research journals. Jaszczolt (1998) studied different fertilizer sources and concluded that application of N-P fertilizers improved the plant growth substantially and when applied at sowing it resulted better crop stand and higher plant population.

### Length of leaves (cm)

The length of leaves was highest (62.50 cm) in plots fertilized with highest fertility level of 150-150 kg N-P $ha^{-1}$, closely followed by 61.25 and 58.75 cm length of leaves, recorded in plots fertilized with 125-125 kg and 100-100 kg N-P $ha^{-1}$, respectively. The crop fertilized with 75-75 kg and 50-50 kg N-P $ha^{-1}$ produced leaves of 52.25 cm and 44.25 cm in length, respectively. However, the lowest length of leaves of 33.75 cm on average was recorded in plots given zero fertilizer (control). This higher length of leaves in plots treated with higher fertility levels was mainly associated with adequacy of soil in essential nutrient elements i.e. N and P due to their application in higher quantities. Moreover, the results suggested that there was a successive increase in length of leaves with each increase in N-P level, but the increase in N-P level beyond 100-100 kg $ha^{-1}$ was not economical, because the differences amongst 150-150, 125-125 and 100-100 kg N-P $ha^{-1}$ were statistically non-significant. Similarly, Khan *et al.*, (1998) from Pakistan reported that plant height with 200 kg N was higher than with 150 kg N from sugarbeet variety KaweTerma.

### Number of leaves $plant^{-1}$

The number of leaves $plant^{-1}$ was significantly highest (37.38) in plots fertilized with highest N-P level of 150-150 kg $ha^{-1}$, closely followed by 35.91 leaves $plant^{-1}$, recorded in plots fertilized with 125-125 kg N-P $ha^{-1}$, and under N-P level of 100-100 kg $ha^{-1}$ the number of leaves $plant^{-1}$ was reduced to 31.95 on average. In case of 75-75 kg and 50-50 kg N-P $ha^{-1}$ fertility levels, the mean number of leaves recorded were 25.36 and 21.58, respectively. However, the minimum number of leaves $plant^{-1}$ of 13.48 was recorded in plots left untreated (control). This higher number of leaves $plant^{-1}$ in plots treated with higher fertility levels was mainly associated with improved soil fertility of the experimental plots due to N-P application at higher quantities as compared to lower N-P levels or control plots. The results further indicated that there was a gradual increase in the number of leaves with each increase in fertility level, but this increase was uneconomical when N-P level exceeded 125-125 kg $ha^{-1}$, because differences in between 125-125 and 150-150 kg N-P $ha^{-1}$ was non-significant. Similar results have also been reported by Safronovskaya (1998) who recommended 60 t farmyard manure + 120 kg N, 80 kg P, 180 kg K for higher sugarbeet yields, while Wyszynski *et al.*, (1999) recommended application of 130-160 kg N $ha^{-1}$ required to achieve optimum plant growth in sugarbeet.

**Sugarbeet weight per plant$^{-1}$**

The sugarbeet weight plant$^{-1}$ was significantly maximum (2.22 kg) in plots fertilized with highest N-P level of 150-150 kg ha$^{-1}$, closely followed by 2.21 kg and 2.13 kg plant$^{-1}$, recorded in plots fertilized with 125-125 kg and 100-100 N-P ha$^{-1}$, respectively. The results further showed that the fertility levels of 75-75 and 50-50 kg N-P ha$^{-1}$ resulted mean sugarbeet weight of 1.63 and 1.22 kg ha$^{-1}$, respectively. However, the minimum sugarbeet weight of 0.66 kg plant$^{-1}$ was recorded in plots left untreated (control). This higher sugarbeet weight plant$^{-1}$ in plots treated with higher fertility levels was resulted due to healthy growing plants which obviously further resulted in healthy beetroots. However, this all happened due to improved soil fertility of the experimental plots due to N-P application at higher quantities. These results have further been supported by Wyszynski *et al*., (1999) recommended application of 130-160 kg N ha$^{-1}$ required to achieve a sucrose yield of 10 t ha$^{-1}$ and found that root quality decreased at higher N rates.

**Sugarbeet weight per ha$^{-1}$**

The beetroot yield was significantly maximum (83.142 m.t ha$^{-1}$) in plots fertilized with highest N-P level of 150-150 kg ha$^{-1}$, closely followed by 80.588 and 79.484 m.t ha$^{-1}$, recorded in plots fertilized with 125-125 kg and 100-100 N-P ha$^{-1}$, respectively. The results further showed that the fertility levels of 75-75 and 50-50 kg N-P ha$^{-1}$ resulted mean beetroot yield of 65.499 and 54.638 m.t ha$^{-1}$, respectively. However, the minimum beetroot yield of 35.255 m.t ha$^{-1}$ was recorded in control plots where no fertilizer was applied. This higher beetroot yield ha$^{-1}$ in plots treated with higher fertility levels was mainly associated with greater sugarbeet weight plant$^{-1}$ which has direct effect on the accumulated beetroot yield ha$^{-1}$. Supporting the above experiences of present investigation, Asad *et al*., (2000) concluded that 120 kg N ha$^{-1}$ was economical than 150 kg ha$^{-1}$, while Barik (2001) used 120 kg N ha$^{-1}$ and 150 kg K ha$^{-1}$ treatment at 110 days of the crop. Similarly, Barlóg (2003) mentioned that the nitrogen is the basic mineral nutrient determining the yield and quality of the sugarbeet root. The efficiency of nitrogen-based nutrition can be increased by balanced application of nutrients directly controlling the yielding functions of nitrogen. It should be mainly focused on phosphorus and potassium, since these nutrients form the physiological basis of high yields. In a similar study, Uvarov *et al*., (2004) from Russia concluded that 90-90-90 kg NPK + 40 t ha$^{-1}$ manure was most effective combination in sugarbeet production.

**Brix percentage**

Brix percentage was significantly higher (22.37 %) in plots fertilized with highest N-P level of 150-150 kg ha$^{-1}$, closely followed by 22.34% and 22.11%, recorded in plots fertilized with 125-125 and 100-100 kg N-P ha$^{-1}$, respectively. The brix percentage in sugarbeet juice from the plants fertilized with 75-75 and 50-50 kg N-P ha$^{-1}$ was 20.20 and 19.09 %, respectively. However, the lowest brix content of 17.70% was recorded in control plots where no fertilizer was applied. This higher brix percentage in plots treated with higher fertility levels may have association with the nitrogen and phosphorus which are needed for formation of sugar in the juice. It was observed that there was successive increase in brix percentage with increasing fertility level, but this increase was uneconomical when N-P level exceeded 100-100 kg ha$^{-1}$, because differences amongst 100-100, 125-125 and 150-150 kg N-P ha$^{-1}$ were statistically non-significant for brix percentage. The results of the present investigation are fully confirmed by the findings of Shahani *et al*., (2005) brix content in sugarbeet was 22.50 percent under 100-75 kg N-P ha$^{-1}$. Similarly, Usmanikhail *et al*., (2005) concluded that 100-100 kg N-P ha$^{-1}$ fertility level proved to be an optimum level for producing significantly economical results.

**Sugar recovery**

The sugar recovery was significantly highest (11.34 %) in plots fertilized with higher N-P level of 150-150 kg $ha^{-1}$, closely followed by 11.31% and 11.19%, recorded in plots fertilized with 125-125 and 100-100 kg N-P $ha^{-1}$, respectively. The sugar recovery in sugarbeet juice from the plants fertilized with 75-75 and 50-50 kg N-P $ha^{-1}$ was 10.34 and 9.78 %, respectively. However, the lowest sugar recovery of 8.98% was recorded in control plots where no fertilizer was applied. This higher sugar recovery in plots treated with higher fertility levels probably have association with the N-P fertilizers, because application of these chemical fertilizers upto adequate levels helps the plant to form more glucose and hence recovery improved. It was observed that sugar recovery was improved consecutively with increasing fertility level, but this increase was not so pronounced when N-P level exceeded 100-100 kg $ha^{-1}$, because differences amongst 100-100, 125-125 and 150-150 kg N-P $ha^{-1}$ were statistically non-significant for sugar recovery. The results of the present investigation are fully confirmed by the findings of Shahani *et al*., (2005) recovery in sugarbeet was higher under 100-75 kg N-P $ha^{-1}$. Similarly, Usmanikhail *et al*., (2005) concluded that 100-100 kg N-P $ha^{-1}$ fertility level proved to be an optimum level for producing significantly economical results

## CONCLUSIONS

It was concluded from the results of the present investigation that there was a consecutive improvement in all the quantity and quality components of sugarbeet, but statistically the differences among 100-100, 125-125 and 150-150 kg N-P $ha^{-1}$ were non-significant for all the growth, beetroot yield and recovery parameters. Thus, fertilizer application beyond 100-100 kg N-P $ha^{-1}$ was not economical and the above fertility level was considered as an optimum level for economical sugarbeet production under Tandojam conditions.

**Table-1 Mean plant population $ha^{-1}$ of sugarbeet as affected by different fertility levels**

| Treatments (NP kg $ha^{-1}$) | Plant population $ha^{-1}$ | Length of leaves (cm) | No.of leaves $plant^{-1}$ | Beetroot weight (kg $plant^{-1}$) | Beetroot yield (kg $ha^{-1}$) | Brix (%) | Recovery (%) |
|---|---|---|---|---|---|---|---|
| T1= Control | 69173c | 33.75a | 13.48e | 0.66d | 35.255d | 17.70d | 8.98d |
| T2=50-50 | 71389c | 44.25c | 21.58d | 1.22c | 54.638c | 19.09c | 9.78c |
| T3=75-75 | 78743b | 52.25b | 25.36c | 1.63b | 65.499b | 20.20b | 10.34b |
| T4=100-100 | 90053a | 58.75a | 31.95b | 2.13a | 79.484a | 22.11a | 11.19a |
| T5=125-125 | 93367a | 61.25a | 35.91a | 2.21a | 80.588a | 22.34a | 11.31a |
| T6=150-150 | 93230a | 62.50a | 37.38a | 2.22a | 83.142a | 22.37a | 11.34a |
| S.E± | 558.2330 | 0.9923 | 0.6362 | 0.0511 | 0.9290 | 0.0.822 | 0.0620 |
| LSD 0.05 | 3190.00 | 3.547 | 2.275 | 0.1846 | 2.972 | 0.2955 | 0.2213 |
| LSD 0.01 | 3945.00 | 4.807 | 3.082 | 0.2502 | 4.027 | 0.4005 | 0.2999 |
| CV% | 4.66 | 5.21 | 5.66 | 7.36 | 3.38 | 1.09 | 1.45 |

Values followed by same letters do not differ significantly at 0.05 probability level.

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