Studies on soil special variability and its impact on cane yield under precision nutrient management system

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Abstract. *In present investigation an attempt was made to quantify the soil variability of 30 grids of 10 m x 10 m dimension at research farm of Nandi Sahakari Sakkare Karkhane (NSSK), Krishna Nagar, District. Bijapur. Each grid (10 m x 10 m) showed variation with available nitrogen as low as 140 kg ha^{-1} to as high as 245 kg/ha with a range of 105 kg/ha, phosphorus as low as 53 kg P_2O_5 ha^{-1} and as high as 89.3 kg P_2O_5 ha^{-1} with a range of 36.3 kg P_2O_5 ha^{-1}, potassium as low as 427 kg K_2O ha^{-1}and as high as 698 kg K_2O ha^{-1}with a range of 184 kg K_2O ha^{-1}, whereas organic carbon was as low as 0.68 per cent to as high as 1.46 per cent with a range of 0.78 per cent. The deviation that existed among the grids with available nitrogen, phosphorus and potassium was to the tune of 30, 9.5 and 57 kg ha^{-1}, respectively indicating that there existed sufficient soil variability in nutrients status. Concurrently, a common crop of sugarcane was harvested to quantify inherent capacity of soil to produce yield the variation in yielding ability of soil sugarcane harvested from 30 grids (10 m x 10 m) showed wider yield variation (82.7 t ha^{-1} – 128.2 t ha^{-1}), 45.5 t ha^{-1} with a standard deviation of (s = 10.48) and the range of nutrients uptake varied from 148.9 – 547.4 kg N ha^{-1} (398.5), 2.48 –15.61 kg P ha^{-1} (13.13) and 124.8 – 434.2 kg K ha^{-1} (309.4). Indicating that according inherent capacity of the soil nutrients were (NPK) omitted from the experimental unit and it clearly reflects the scope to enhance the yield by adopting site specific nutrient management approach through variable rate approach.*

Keywords. *Soil Spacial Variability, Sugarcane, Precision Nutrient Management, Yield*

Introduction

No part of earth is homogeneous with respect to its mineral nutrient status. The traditional approach to soil fertility management has been to treat fields as homogenous area and to calculate fertilizers, chemicals and other crop production inputs on the whole field basis. This management protocol often results in over-application or of crop production inputs in some field areas and in other words variations in field characteristics including soil organic carbon, soil texture, soil structure, soil nutrients, field topography and other properties those support the crop production activity. This has been reported at least 80 years back that fields are not homogenous and sampling techniques to describe field variability have been recommended (Linsley and Bauer, 1929). Site-specific nutrient management assists the growers in making precise management decisions for different cropping systems throughout the world. Site-specific management recognizes the inherent spatial variability associated with most fields under crop production (Thrikawala *et al.*, 1999).

Depending on the management objective of the present investigation, the delineation of management zones should consider crop yield patterns and different soil properties. Spatial information in establishing management zones should be quantitative, densely or continuously sampled, and stable over time and directly related to crop yield. It may be prudent to combine zones that constantly perform similarly over time and to split zones that show more variability than first thought (Deorge, 2000). With this objective an attempt was made to quantify the special variability of 30 grids of 10 m x 10 m size and their inherent capacity to support sugarcane production.

Material method

The experiment was laid out at research Farm of NSSK, Krishna Nagar Bijapur District. One acre area was divided into 30 equal plots of size 10 m x 10 m size. Ridges and furrows were opened at 120 cm apart, soil samples were drawn from the experimental side and were analyzed for available nitrogen, phosphorus and potassium as per the standard procedure and planting of sugarcane with two eye budded sets with sets treatment with Bavistin @ 2 g per litre was done before sowing. Eight rows of sugarcane in each plot were accommodated.

Observation on various growth and yield, quality parameters of sugarcane was made as per the standard methodology and Spectral reflectance of the crop canopy was measured with the help of hand held multi band Spectro-radiometer (Optomech Engineers Pvt. Ltd. Model 041) and NDVI was calculated by following formula.

$$NDVI=\frac{NIR-R}{NIR+R}$$

Where,

NIR and R are the reflectance in the Near Infrared and Red regions, respectively.

Result and discussion

Soil special variability of experimental site

Soils differed spatially in grids size of 10 m x 10 m within an acre for major nutrients (nitrogen, phosphorus and potassium) and for per cent organic carbon content. The extent of variability of available nutrients in a grid size of 10 m x 10 m was 105 kg N (140-245), 36.3 kg P_2O_5 (53 – 89.3), 184 kg K_2O (427- 611) per hectare and organic carbon content was 0.78 (0.68 – 1.46) per cent in the first year of experimentation and after conducting the uniformity trial on sugarcane the soil variability reduced for available nitrogen to 44.8 kg ha^{-1} (173.6 – 218.4) and potassium to 86.8 kg ha^{-1} (296.8 – 383.6) between the grids. On the contrary the available phosphorus variability increased to 40.3 kg ha^{-1} (18.3 – 58.6) during second year of experimentation which indicated that higher amounts of available nutrients in the soil supports plant growth to get a good yield (Sun-Ok Chung *et al.*, 2005).

The variation was to the extent of 176 kg (149-325) nitrogen, 37 kg (56-93) phosphorus and 333 kg (559-892) potassium per hectare. The per cent organic carbon also ranged from 0.43 to 1.13 with a variation of 0.70 per cent among the 32 fields during the first year of study (2006-07). During second year (2007-08), after harvest of the plant crop which was grown with application recommended doses of fertilizers maintained the same nutrient variability status of soils with the nutrients availability ranges of 199 kg (131-330) nitrogen, 31 kg (60-91) phosphorus and 300 kg (559-859) potassium per hectare. The range of variation in per cent organic carbon content also remained almost same 0.59 (0.45 – 1.04) indicating that there exists a huge soil variability and allows for site-specific or field specific nutrients management either through yield based management concepts or through grid based concepts which help to save lot of fertilizers apart from maintaining the sustained yield levels, soil health and environment (Tawainga *et al.*, 2003) and (Michael Flowers *et al.*, 2005).

Sugarcane yields of uniformity trial with respect to the initial soil nitrogen availability indicated that the lower available soil nitrogen grids recorded lower yields of sugarcane. While, the higher available soil nitrogen grids recorded higher yields indicating that the available soil nitrogen is being used by the crop and the quantity of available nitrogen decides the yield levels (Peter *et al.*, 2003). On the contrary few grids with higher as well as lower available soil nitrogen recorded medium yield levels of sugarcane which tried to exhibit the potentiality of the soils to mineralize the nutrient nitrogen from the total nitrogen in due course of time during the crop growth period and helped the crop to grow luxuriantly without facing any deficiency which, otherwise to say the soils have an inherent nutrient buffering capacity to suffice the nutrient needs of the crop whenever the external sources of nutrients are not applied. Phosphorus and potassium nutrients being ample and were available in soil in their higher range could not influence much although potassium had a large range of availability among the nutrients but there was a strong buffering capacity as it was grown on medium deep black soils.

Growth and yield parameters

The growth and yield attributes like number of clumps, number of tillers and number of millable canes (NMC) were directly correlated to yield which indicated that higher the number of clumps and tillers, contribute to higher number of millable canes and ultimately adds to the yield. However, cane girth and weight of five canes though contribute positively to the yield but they had inverse relation with the number of millable canes (Table 5). Since the space, nutrients and water availability per unit area is same for the varied number of millable canes, they express their growth and development through increase in their cane girth, moisture and total solids. Lesser the number of millable canes per unit area could provide a condition to express the canes to its potential while the higher number of millable canes restricts their expression of the characters due to insufficient resources available. Juice content plays major role in increasing weight to the cane apart from best agronomic practices followed in getting the quality parameters.

Important vegetation indicator like SPAD (Table 2) and NDVI (3) values recorded infer that the sugarcane crop during its basic vegetative (growth) phase puts up lot of greenness and canopy spread based on the availability of resources and tend to reduce itself towards maturity, irrespective of the fertility levels of soils. Similarly, SPAD values were maximum at 6 months in sugarcane and tend to reduce towards maturity.

Nutrient uptake by sugarcane

Nitrogen uptake by the crop in uniformity trial was 441.4 kg/ha in the grid 56 which recorded the highest sugarcane yield of 128.2 t/ha. While, the grid 41 which recorded the lowest sugarcane yield 82.7 t/ha had taken up 388.9 kg nitrogen. The amount of nitrogen taken up by the crop to produce one tone of sugarcane is 3.44 kg N in the grid which produced highest yield while it was 4.70

kg N in the grid which recorded lowest yield. The grid with highest nitrogen uptake of 547 kg/ha recorded only 114.3 t/ha of sugarcane with 4.79 kg N/tone and the grid with lowest nitrogen uptake of 148.9 kg/ha recorded 98.5 t/ha of sugarcane with 1.51 kg N/tone although both the grids with highest as well as the lowest nitrogen uptake had the same initial nitrogen status (175 kg N/ha). With the same initial soil nitrogen status yield as well as uptake varied and the high yield plots recorded lower amounts of uptake per tonnes and vice-versa and many grids which lie in between the highest and the lowest ranges recorded the sugarcane yield in the similar way. This purely indicates that apart from nutrient status the agronomic management practices and the environment factors (biotic and abiotic) do play a major role in good growth and development of the crop. Similar observations were made by Mu-Lien Lin and Tsang-Sen Liu (2005).

Conclusion or Summary

From the soil test values of various grid revealed that there was a significant variations in available macro nutrient status in the soil. Concurrently it was evident by large yield variations in grids of uniformity trial (82.7 t/ha - 128.2 t/ha) 45.5 t/ha and nutrients uptake by the crop ranged between 148.9 – 547.4 kg N/ha (398.5), 2.48 – 15.61 kg P/ha (13.13) and 124.8 – 434.2 kg K/ha (309.4) clearly indicated that high initial soil fertility and its buffering capacity plays a major role in supplying nutrients to the crop.

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