

Soil fertility

and nutrient management for sustainable sugarcane production

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Maximizing sugarcane production requires nutrient-rich soil to support robust crop growth. The total production of sugarcane in the country during crop year season 2021-22 reached a record high of 431.81 million tonnes. This reflects not only the potential of the crop varieties but also the importance of relationship between soil health and nutrient management practices followed. The demand for nutrients by the high-yielding crop can result in nutrient imbalances. Based on the estimates of sugarcane production and supply, the net income for a sugarcane farmer amounts to approximately ₹158 per quintal of cane yield considering the production cost of ₹157 per quintal and the FRP (Fair and Remunerative Price) of ₹315 per quintal. The net income of a farmer correlates with soil fertility as fertile soil not only increases the quantity of sugarcane yield available for sale to sugar mills but also enhances the quality of the harvested sugarcane. Hence, maintaining a balance between nutrient inputs and nutrient removal by the sugarcane crop is crucial for effective soil fertility management and sustainability of the soil health.

Keywords: Fertility, Nutrient, Soil health, Sugarcane

SUGARCANE holds significant importance in India as a primary cash crop and a major global sugar source, contributing to about 70% of the world's sugar supply. It contains roughly 84% pure juice and 16% dietary fibre, offers both sweetness and digestive benefits, promoting regular bowel movements. In sugarcane cultivation, the fertility of the soil directly influences various aspects of the crop, from its overall vigour to stalk development, sugar content, and overall productivity. Sugarcane is a nutrient-intensive crop and continuous cultivation can deplete soil nutrients, making it essential to replenish these nutrients through proper soil management practices. Soil testing and analysis can help in determining the specific nutrient needs of the soil, allowing for more targeted and efficient fertilization. Overall, managing soil fertility is essential for sustaining sugarcane production while minimizing negative environmental impacts.

Soil fertility management in sugarcane crop production

Effective soil fertility management is pivotal in achieving optimal yield, quality, and sustainability in sugarcane crop production. It ensures that sugarcane plants access essential nutrients throughout their growth cycle for maximum yield. Soil testing provides valuable insights into the nutrient status of the soil, guiding the formulation of appropriate nutrient management plans. It involves analysis of soil samples to determine nutrient levels, pH, and other soil properties. Nutrients such as nitrogen, phosphorus, potassium and various micronutrients are necessary for plant metabolism, photosynthesis, root development and sugar accumulation. Adequate nutrient availability also contributes to better tillering, higher number of millable canes (NMC), and increased biomass production; all of which positively impact cane productivity. Healthy soil enhances plant vigour and

overall health, making sugarcane more resistant to diseases and pests. Therefore, regular soil testing is a valuable tool for identifying nutrient status, deficiencies and developing appropriate nutrient management strategies.

Nutrient requirement in sugarcane

Sugarcane crop requires a balanced supply of both macronutrients and micronutrients for optimal growth and development. Nitrogen requirement of sugarcane is higher during the tillering phase followed by early grand growth phase i.e., 40 to 160 days after planting (Fig. 1).

The optimum time of phosphorus application is at initial stages of tillering so that sufficient phosphorus should be available in the soil during formative phase of crop for better growth and development. Early and late, both, application of potash is usually recommended. Because, early application with nitrogen causes better utilization of nitrogen

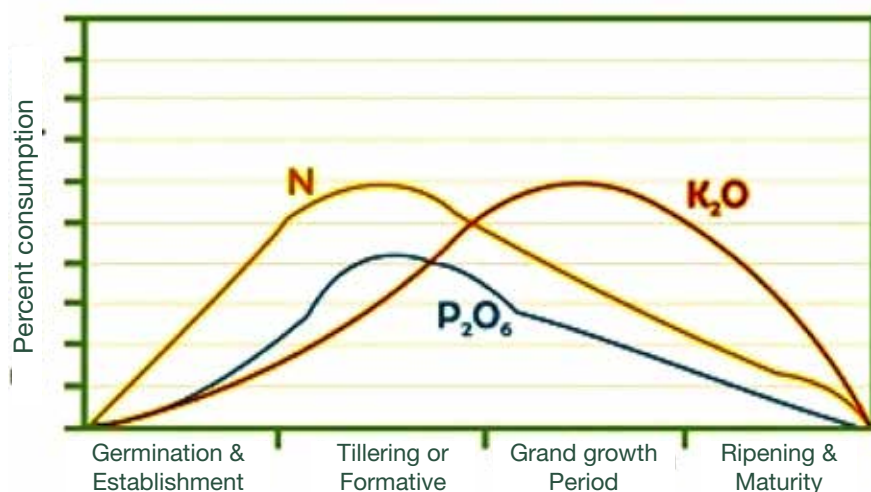


Fig. 1. Relative requirement of N, P & K (%) at different growth stages of sugarcane.
Source: Bachchhav, S.M. (2005). Fertigation technology for increasing sugarcane production. *Indian Journal of Fertilizers*, 1: 85-89.

by the crop; while late application of potassium at grand growth phase improves the sugar recovery. Application of recommended dose of nitrogen in three to four splits resulted in increased number of millable canes, seed cane yield and quality (Table 1). It facilitates higher tillering, cane formation and cane growth along with lower tiller mortality. Its later application not only promotes water shoot formation, but also adversely affects sugar recovery due to increased soluble N in cane juice; which ultimately attracts insect-pests and diseases. The N requirement for sugarcane is about 150–180 kg/ha in northern India and 250–350 kg/ha in southern India. Apply 60–80 kg P_2O_5 and 60 kg K_2O /ha in north India and 100 kg P_2O_5 /ha and 80–

120 kg K_2O /ha in southern parts of the country. A dose of 150 kg N/ha applied half at planting and half at 60 days after planting (end June) gives better cane yield in late planted conditions. In soils low in nitrogen, increase the dose of nitrogen by 25% over general recommended dose whereas in soils high in nitrogen, lower this dose by 25%. Micronutrients such as iron, zinc, manganese, copper, molybdenum, boron and secondary elements such as calcium, magnesium, sulphur is required comparatively in small quantities but are critical for various physiological processes. Iron and manganese support chlorophyll synthesis, while zinc and magnesium contribute to enzyme function and photosynthesis. Calcium ensures sturdy stalks, and sulphur mediates

protein synthesis.

Symptoms of nutrient deficiencies and their effects

The nutrient deficiencies in sugarcane can hinder growth and development, impacting various physiological processes (Fig. 2). Balancing nutrient availability and maintaining soil fertility is crucial for sustainable sugarcane production.

- **Nitrogen deficiency:** This leads to yellowing leaves and stunted growth, early leaf senescence, shorter stalks while excess nitrogen delays maturity and makes the crop vulnerable to lodging and pests.
- **Phosphorus deficiency:** It results in poor tillering, reduced internodal length, reduced root development, and lower juice purity.
- **Potassium deficiency:** Lack of potassium leads to stress susceptibility, reduced internodal length and low sugar recovery. Yellow-orange chlorosis of leaf borders and tips with slender stalks. Excess potassium causes sugar crystallization and higher sugar losses in molasses.
- **Micronutrient deficiency:** In sugarcane, micronutrients deficiency causes nutrient imbalances, reduced growth and lower sugar accumulation. Zinc deficiency causes yellowing of leaf blade, red lesions on leaves, reduced tillering and shorter internodes

Table 1. Recommended fertilizer doses of plant and ratoon crops in sugarcane for different agroclimatic zones

Agroclimatic zone	Sugarcane producing states	N	P	K
		(kg/ha)		
Peninsular Zone	Karnataka, Gujarat, Maharashtra, Madhya Pradesh, Chhattisgarh, Plateau region of Tamil Nadu, Kerala, Telangana	250 ^P , 200 ^R (165-250)	100 ^P , 60 ^R (60-125)	125 ^P , 60 ^R (82.5-190)
East Coast Zone	Odisha, Coastal Andhra Pradesh, Coastal Tamil Nadu	250 ^P , 200 ^R (112-275)	100 ^P , 60 ^R (63-100)	60 ^P , 60 ^R (60-120)
North West Zone	Western and Central Uttar Pradesh, Punjab, Haryana, Uttarakhand, Rajasthan	150 ^P , 200 ^R (120-200)	60 ^P , 60 ^R (60-150)	60 ^P , 60 ^R (0-60)
North Central Zone	West Bengal, Bihar, Eastern Uttar Pradesh	150 ^P , 200 ^R (150-180)	85 ^P , 60 ^R (60-85)	60 ^P , 60 ^R (40-60)
North Eastern Zone	Assam, Nagaland	136 ^P , 200 ^R	70 ^P , 60 ^R	60 ^P , 60 ^R
Peninsular Zone	Karnataka, Gujarat, Maharashtra, Madhya Pradesh, Chhattisgarh, Plateau region of Tamil Nadu, Kerala, Telangana	250 ^P , 200 ^R (165-250)	100 ^P , 60 ^R (60-125)	125 ^P , 60 ^R (82.5-190)

^PPlant Crop, ^RRatoon Crop, Range values in parenthesis represent the soil test-based application of different states with soil types.
Source: AICRP(S)



Fig. 2. Deficiency symptoms of different nutrients in sugarcane crop.

Table 2. Nutrient management strategies for enhancing sugarcane crop productivity

Nutrient application	Recommended dose/Technique	Effect on sugarcane crop
Nitrogen	Recommended dose in 3-4 splits (25% additional nitrogen in certain soils)	Increased millable canes, seed cane yield, and quality
Phosphorus	As per recommended dose	Improved root development and growth
Potassium	As per recommended dose	Enhanced cane growth and development
Sulphur	40-60 kg/hectare, gypsum is an effective source	Improved growth in calcareous soils
Micronutrients (Iron, Zinc, Manganese, Copper, Molybdenum, Boron)	Apply if deficiencies exist: 25 kg Ferrous Sulphate per hectare/ Foliar spray of 1-2% solution of FeSO_4 along with 0.5% MnSO_4 and 2% urea, two to three times. 20 kg Zinc Sulphate per hectare 10 kg Manganese Sulphate per hectare 10 kg Copper Sulphate per hectare 2.5 kg Sodium Molybdate per hectare 5 kg Borax per hectare	Enhanced growth and development, especially in calcareous soils
FYM (Farm yard manure)	20 tonne/hectare FYM or compost in combination with NPK based on soil test basis	Significant positive effect on growth of plant crop and ratoon crop
<i>Azotobacter</i> or <i>Azospirillum</i> (in two equal splits at 30 and 60 days after planting)	10 kg/hectare <i>Azotobacter</i> or <i>Azospirillum</i>	25% saving in nitrogenous fertilizers and also significantly higher seed cane yield
Use of Phosphorous Solubilising Bacteria (PSB)/ <i>Gluconacetobacter</i>	10 kg of PSB/hectare to save 25% phosphorus	Positive responses reported
Sulphitated press mud + 75% of recommended nitrogen dose	Incorporation of 4 tonnes/hectare of press mud + 75% of recommended nitrogen dose	Cane yield equivalent to recommended nitrogen

Source: AICRP(S)

Table 3. Intercropping options for sugarcane with planting schedules and seed rates

Intercrop	No. of rows between Sugarcane	Seed rate (kg/ha)	Time of sowing/planting
<i>Intercropping in autumn-planted sugarcane</i>			
Wheat	3	75	Last week of October
Chickpea	2	50	2nd fortnight of October
Mustard	2	30	Last week of September to October 20
Lentil	2	20	2 nd fortnight of October
Garlic	4	250	Last week of September to end of October
Onion	4	8	2 nd fortnight of October for Sugarcane, Mid December to Mid-January for onion
Potato	2	3000	1st fortnight of October
Pea	2	150	Month of October
Cauliflower	2	3	Mid-September to October
Cabbage	2	1-1.5	Mid-September to October
Knol khol	2	2	2nd fortnight of October
Fenugreek	3	40	Full Month of October
Coriander	3	30	Full Month of October
Radish	2	20	Full Month of October
Turnip	2	15	Full Month of October
Baby Corn	2	40-50	Last week of October
<i>Intercropping in Spring-Planted Sugarcane</i>			
Green Gram	2	15-20	February 20 to end of March
Black Gram	2	15-20	February 20 to end of March
Lady Finger	2	50-60	February 20 to first week of March
Cowpea	2	30-35	February 20 to first week of March
Cluster bean	2	15-20	February 20 to first week of March
Green Gram	2	15-20	February 20 to end of March

Source: AICRP(S)

with thin stalks. Inter-venial chlorosis occurs from tip to base of leaves due to iron deficiency. Boron deficiency occurs on young leaves of sugarcane with distorted leaves and causes death of apical meristem.

Nutrient management

Nutrient management for sugarcane crop is very important

and the agronomic requirements for tropical and subtropical belts are different. In tropical zone, seed cane is fertilized with 75 to 100% of recommended dose of nitrogen in 2-4 equal splits depending upon soil texture, irrigation practice followed and the variety grown. In subtropical zone, with wide variability in edaphic, environmental and management conditions, the seed

cane needs 25% additional N over recommended doses of N, P and K. Application of total nitrogen may be phased out in 4 equal splits for realizing beneficial effects in terms of yield and quality (Table 2).

Successful intercropping relies on the selection of crop, variety, sowing time, planting geometry, fertilizer management and other crop management practices. In southern India, sugarcane is usually rotated with rice. In north India, sugarcane is generally grown after harvest of cotton, maize, sorghum, paddy, toria, potato, pea, wheat etc. Monocropping increases build-up of diseases and degrades soil by diminishing the nutrients in soil over time which impacts soil health. Sugarcane crop production system should be followed with ratoons, other rotational crops and pulse intercrops (Table 3). Implementing crop rotations involving cereals, legumes, and green manure crops contributes to the equilibrium of soil microbe ecosystems.

SUMMARY

Optimal soil fertility is crucial for maximizing sugarcane yields and quality. Regular soil testing enables precise nutrient management, fostering sustainable production. Intercropping aids nutrient recycling and disease control, while crop rotations sustain soil health. Overall, efficient soil fertility management ensures profitable and sustainable sugarcane cultivation, benefiting both farmers and sugar mills.

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Water

- Even though households are relatively low consumers of water, population growth and expanded water use have outweighed the effect of water saving technology and behavior.
- Less than 3% of the world's water is fresh (drinkable), of which 2.5% is frozen in the Antarctica, Arctic and glaciers. Humanity must therefore rely on 0.5% for all of man's ecosystem's and fresh water needs.
- Man is polluting water faster than nature can recycle and purify water in rivers and lakes. More than one billion people still do not have access to fresh water.
- Excessive use of water contributes to the global water stress. Water is free from nature but the infrastructure needed to deliver it is expensive.

- See more at: <http://www.unep.org/wed/theme/water.asp#sthash.ki5vg3IB.dpuf>
 Courtesy: United Nations Environment Programme website - <http://www.unep.org/wed>