e-ISSN: 2319-9857
p-ISSN: 2347-226X

Research and Reviews: Journal of Agriculture and Allied Sciences

Successful Ratoon Management in Sugarcane.

SM Prasanna[1]* and PS Pattar[2].

[1]College of Horticulture, Bagalkot, Karnataka, India.
[2] KVK, Bagalkot, Karnataka, India.

Review Article

Received: 19/08/2014
Revised : 12/09/2014
Accepted: 19/09/2014

***For Correspondence**

College of Horticulture, Bagalkot, Karnataka, India.

Keywords: Ratoon, sugarcane, trashes, management

ABSTRACT

Ratooning is a unique natural trait associated with most of the crops like banana, red gram, cotton, Jowar, sugarcane; however, it is commercially explored in sugarcane and banana in the Indian context. The characteristic features of ratoon crop is such that when the shoot portion is harvested the remaining root system being intact will result in fresh tillers from secondary shoots and another crop can be harvested during the following year. In this manner, nearly 2-3 crops can be harvested without much risk and uncertainties. The ratio of the maiden crop and the ratoon crop is 1:3, that is to say only about 25 per cent is maiden crop and bulk of the area is under ratoon crop. Apparently, the ratoon crop deserves much higher attention and care in the present scenario to boost the productivity of sugarcane.

INTRODUCTION

Sugarcane is rightly called as *'wonder cane'* owing to its versatile utility and the vast capability to meet the demands of the burgeoning population. It is utilized in manufacturing of sugar, bio-fuels, spirit besides generation of electricity. This particular sector has attained the most privileged status as one of the pivotal agriculture based industries. In addition, these agro based industries provide raw materials for papers, fertilizers, amendments, chemicals, distilleries and other associated sectors. Thus, sugarcane provides livelihood not only for the recently inducted foreman in the industry but also for the vulnerable peasant legacy engaged in the cane cultivation from the time immemorial.

Sugarcane is a tropical, perennial grass that forms lateral shoots at the base to produce multiple stems. The stems grow into cane stalk, which when mature constitutes approximately 75 per cent biomass of the entire plant. Further, a mature stalk is typically composed of fiber (11–16%), soluble sugars (12–16%), non-sugars (2–3%), and water (63–73%). The crop is highly responsive to the climate, soil type, irrigation, fertilizers and the harvest period. The average yield of cane stalk is 60–70 MT per hectare per year. However, this figure can vary between 30 and 180 MT per hectare depending on the knowledge base and crop management strategies adopted in cultivation. As such sugarcane is a cash crop, but nevertheless the green top is used as livestock fodder.

Sugarcane is cultivated in almost 105 countries; however, the production potential is substantially higher in tropical and sub-tropical regions compared to rest of the globe. Sugarcane cultivation requires a tropical or temperate climate, with a minimum of 60 cm (24") of annual rainfall/irrigation. It is one of the most efficient photosynthesizers in the plant kingdom. It is a C_4 plant, able to convert up to one percent of incident solar energy into biomass. In prime growing regions, such as Mauritius, Dominican Republic, Puerto Rico, India, Indonesia, Pakistan, Peru, Brazil, Bolivia, Colombia, Australia, Ecuador, Cuba, the Philippines, El Salvador and Hawaii, sugarcane crop can produce over 15 kg of cane per square meter of sunshine.

e-ISSN: 2319-9857
p-ISSN: 2347-226X

Most of the sugarcane is cultivated in the tropics and subtropics in areas with plentiful supply of water, for a continuous period of more than six to seven months each year, either from natural rainfall or through irrigation. The crop does not tolerate severe frosts. Therefore, most of the world's sugarcane is confined between 22°N and 22°S latitudes; however, its cultivation is extended up to 33°N and 33°S. On the soil front, sugarcane can be grown on many soils ranging from highly fertile well drained mollisols, through heavy cracking vertisols, infertile acid oxisols, peaty histosols to rocky andisols.

Ratooning is a unique natural trait associated with most of the crops like banana, red gram, cotton, Jowar, sugarcane; however, it is commercially explored in sugarcane and banana in the Indian context. The characteristic features of ratoon crop is such that when the shoot portion is harvested the remaining root system being intact will result in fresh tillers from secondary shoots and another crop can be harvested during the following year. In this manner, nearly 2-3 crops can be harvested without much risk and uncertainties. The ratio of the maiden crop and the ratoon crop is 1:3, that is to say only about 25 per cent is maiden crop and bulk of the area is under ratoon crop. Apparently, the ratoon crop deserves much higher attention and care in the present scenario to boost the productivity of sugarcane.

General misconception or popular belief among the sugarcane cultivators is that the ratoon yield is always lower than the maiden crop. Owing to this, least attention is heeded for all the cultural practices in general and the nutrient management in particular for the ratoon cane. On the contrary, if not higher, at least comparable yields can be obtained in the ratoon crop by intervention with certain crucial management strategies. Before suggesting the novel technology for ratoon yield improvement, it is high time to take the stock of the situation and probe the faulty practices responsible for lower yields. A sensual retrospection into the cultural practices being adopted for ratoon management has revealed several anomalies which need to be rectified in order to enhance the yield are as under;

- Burning of trashes
- Improper planting material
- Inappropriate plant density
- Nutrient mismanagement
- Unscrupulous irrigation
- Pestering insects and diseases
- Inefficient weed management

Burning of Trashes

In the ratoon crops, burning of trashes is the most common practice being followed among the cultivators to get rid off the wastes generated in the field which are likely to pose hindrance for normal cultivation besides chances of enhanced pest and disease incidences. Moreover, the apprehensions among the farmers about the accidental fire hazards likely to occur during the later stages which would burn the young ratoon crop would compel them to burn the trashes early in the season.

However, in the genuine sense the residue generated in the cane field is not at all a waste; on the contrary it is good nutrient reserve. Generation of fresh trash to the tune of 40 MT/ha in this cropping system is no doubt a significant contribution towards soil organic pool in a typical arid and semi-arid situations. This trash is a source of nitrogen (100kg/ha), phosphorus (50 kg/ha) and potassium (140 kg/ha) but with broader C:N ratio (Table 1). Owing to this broader C:N ratio, the nitrogen present in the residues is not available immediately to the ratoon crop. Moreover, the applied nitrogen through fertilizers is going to be fixed in the residues to narrow down the C:N ratio. However, this is a temporary phase and the nitrogen will be released for plant uptake once the mineralization of the residues is initiated.

Table 1: Quantities of nutrients in kg/ha removed from the soil by sugarcane crop[1] (100 MT of millable cane and 60 MT of trash)

Plant parts	Nitrogen	Phosphorus	Potassium
Stalks	50	50	160
Tops and trash	100	50	140
Total above ground	**150**	**100**	**300**
Underground portion	50	20	20
Total below ground	50	20	20
Total (including above and below the ground)	**200**	**120**	**320**

e-ISSN: 2319-9857
p-ISSN: 2347-226X

The trash serves as a substrate for the soil microorganisms and certainly reinvigorates the soil health through efficient moisture conservation. It is a vital source of secondary (calcium, magnesium and sulphur) and micronutrients like iron, copper, boron, manganese, molybdenum and zinc (Table 2). In addition, the decomposed trash is capable of replenishing the exhaustive silicon requirements of the next crop.

Table 2: Nutrient distribution in the maiden crop [2, 3, 4, 5]

Nutrient	Roots	Millable stalks	Leaves	Total
	Kg/ha			
Nitrogen	8.0	83.0	77.0	168.0
Phosphorus	1.0	15.0	8.0	24.0
Potassium	4.0	109.0	105.0	218.0
Calcium	2.0	30.0	45.0	77.0
Magnesium	1.0	29.0	18.0	48.0
Sulphur	2.0	25.0	22.0	49.0
Chlorides	--	--	1.0	1.0
Silicon	--	98.0	150.0	248.0
	g/ha			
Boron	34.0	214.0	144.0	392.0
Copper	13.0	201.0	105.0	711.0
Iron	4900.0	3800.0	7900.0	16600.0
Manganese	84.0	1170.0	1981.0	3235.0
Molybdenum	--	4.0	10.0	14.0
Zinc	72.0	437.0	336.0	845.0

If the trash is burnt, the organic carbon, nitrogen and phosphorus will be lost to the atmosphere, while only the potassium is rendered available to plants. The micronutrient status will be dilapidated owing the loss of the intrinsic framework constituted by the organic matter in the form of chelates. On the contrary, the status of calcium, magnesium and silicon is likely to be improved by conversion of trashes into ashes. Nonetheless, the colossal loss of organic carbon, microbial biota, nitrogen, phosphorus and micronutrients remains indispensible and it is precisely reflected in the soil health and productivity. The organic carbon buildup in soil is gradual and sacrificing huge amount of trash (60 MT/ha-fresh) cannot be substantiated on any of the grounds, especially in the arid and semi-arid parts of the globe.

Trash Management

Trash incorporation and *in situ* decomposition improves soil physical, chemical and biological properties. Efficient trash management indirectly suppresses the weed flora and conserves the moisture in the soil. Suitable technologies for trash management in sugarcane field have been evolved and farmers can adopt these eco-friendly measures in order to augment the ratoon yields without disturbing the fragile ecosystem.

The trash has to be powdered using trash shredder equipment (Fig 2) and spread like a mat in the empty space between the crop rows. Irrigation has to be provided to moisten the trash material and the press-mud (@ 1.5 to 2.0 MT/ac) has to be spread on the trash mat. Upon that, cow dung slurry (@ 100 kg cow dung stirred in500 liters water) has to be sprinkled to provide the necessary microbial consortia required for decomposition.

Figure 2: Sugarcane harvester (Photo source KVK Bagalkot)

e-ISSN: 2319-9857
p-ISSN: 2347-226X

Figure 2: Sugarcane trash shredder (Photo source Internet)

To accelerate the rate of decomposition, microbial species like Pleorotus, Trichderma, Pseudomonas, Azatobacter and Aspergillus (@ 8-10 kg/ac) need to be mixed with well decomposed organic manure and broadcasted. So as to narrow down the C:N ratio, about 30 kg nitrogen has to be supplemented through urea. Above this, a thin soil layer should be applied and the moisture is maintained through light irrigation. With the time, the trash will be decomposed completely and render as a good source of plant nutrients besides a hub for profuse microbial activity.

Hitherto, the main emphasis was heralded towards recycling and incorporation of trashes; however burning of trashes into ashes is inevitable in some of the exceptional cases like;

- Severe pest incidences in the maiden crop- Scales, termites, mealy bugs
- Chronic disease infestations
- As far as destroying the residual inoculums of pest and diseases are concerned, burning of residues is a rational practice but it should be confined only to the severely infested areas.
- Rampant rodent menace (rats and bandicoots)
- Poor drainage/water-logged conditions impeding normal cultural operations,

Improper planting material

In general to realize optimum yields it is quite obvious that the selection of planting material is of pivotal importance. If the planting material is of premium quality, the yields of the maiden crop as well as ratoon crops will be better. The prerequisites while selection of suitable variety is nonetheless based on the potential yield, sugar recovery, and efficient root system and particularly with traits of endurance to moisture stress in the early phases of the crop. Further, the planting material should be free from pest and diseases and possess healthy and vigorous growth traits. Moreover, it is not worth to utilize the ratoon crop as the planting material under any circumstances. Prominent varieties like CO-8011, CO-8014 (late maturity), CO-86032, CO-85002 (mid-late maturity), COC-94012, and CO-740 (early maturity) are suitable for higher ratoon yield in the current scenario. Most of the factories insist the growers to opt for CO-671 variety owing to the fact that it matures early and has higher sugar recovery. On the other hand, this is a shy tillering variety; eventually the ratoon yields will be lower.

Inappropriate plant density

Ideal or optimum plant density is one of the fundamental factors responsible for efficient exploration of nutrient reserves, water and insolation. The efficient utilization of natural resources cedes bounteous harvests. The plant density in the ratoon crop will be severely crippled owing death of propagation material, biotic and abiotic stresses and senility of the mother plant. In general, the gaps to the tune of 30 per cent persist after the harvest of the maiden crop. If these gaps are unattended, eventually the weed population will splurge and ultimately the yields are reduced.

The gap areas in the ratoon crop should be filled within 30 days of stubble shaving. The sprouted cane stubbles taken from the same field is the best material for ensuring full establishment. The next best method is gap filling with seedlings raised in poly-bags or trays. The gestation period of the ratoon crop starts as soon as the maiden crop is harvested. From the day one, the required care has to be initiated to see that healthy, vigorous and optimum population of the cane being ensured in the ratoon crop.

e-ISSN: 2319-9857
p-ISSN: 2347-226X

Nutrient mismanagement

At the outset, the concept of efficient nutrient management needs to be clarified; so mere application of fertilizers to meet the requirements of all the essential nutrients will not achieve the vital objectives of plant nutrition. The interactions between the nutrients, soil-plant relations, nutrient ratios in the plant system and the crucial period of nutrient requirement need to be adequately explored to achieve higher production. The maximum rate of nutrient uptake (kg ha^{-1} day^{-1}) in sugarcane maiden crop versus ratoon crop worked out by Malavolta [1],has precisely established the latter requires higher nutrients (Table 3). Obviously, against the myth prevailing among the growers, higher nutrients are required for the ratoon crop so the fertilizer application must be scheduled in order to meet the enhanced demand by the succeeding ratoon crop.

Table 3: Maximum Rate of Uptake of Nutrients by maiden and ratoon crop [1]

Nutrient	Maiden crop	First ratoon
	Kg ha^{-1} day^{-1}	
Nitrogen	0.59	0.73
Phosphorus	0.08	0.11
Potassium	0.71	0.95
Calcium	0.45	0.33
Magnesium	0.24	0.26
Sulphur	0.16	0.31

The nutrient requirement will not be uniform throughout the lifecycle of the crop plants. For instance, the relative nitrogen and phosphorus requirement is least during germination and establishment stage. However, it attains the maximum status during tillering stage and but eventually reduces with advancement towards maturity. On the contrary, the potassium requirement is lower during both germination and tillering stages but with time the requirement reaches its peak during grand growth stage (Fig 1). It is quite obvious; the nutrient requirement becomes minimal when the crop approaches senescence or maturity, where potassium is no exception. As far as assimilation and mobility of micronutrients in the plant system is concerned; the performance is dismal and needs to be intervened with foliar applications. In this backdrop, efficient nutrient replenishing strategies have to be worked out to ensure higher nutrient use efficiency and intern higher yields and enhanced returns.

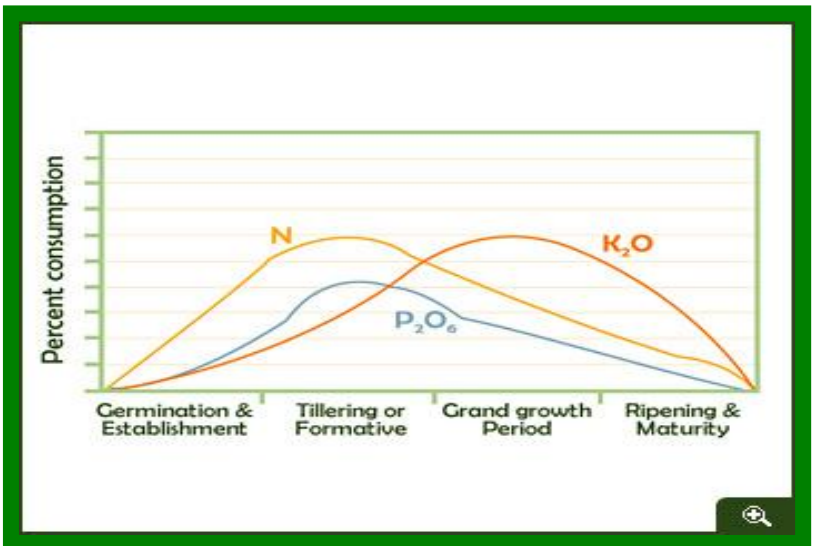

Figure 1: Nutrient utilization in different growth stages in sugarcane

Better nutrient management

Sugarcane is an exhaustive crop and most of the nutrient reserves in the soil will be fatigued after the harvest of the maiden crop. Further, the soil physico-chemical properties are altered to a severe extent and the normal root development as well as nutrient absorption is strictly interrupted in the ratoon cane. Most of the nitrogen in the soil is immobilized in the trash incorporated and rendered unavailable to the

plants. Besides recommended dose of fertilizer (RDF), additional nitrogen (25% higher) needs to be applied in the initial stage. With this, the growth of the ratoon cane will be accelerated and higher yields can be expected. Intercropping with leguminous crops (soybean, chickpea, cowpea daincha and green gram) in between the cane rows will absolutely enhance the fertilizer use efficiency and creates a scope for reducing the RDF of the cane (Plate). The need of the hour is to adopt integrated nutrition management where the organic and inorganic sources are blended to meet the nutrient needs of the crop. In the organic mode, farmyard manure (@ 10MT/ac) or vermicompost (@ 4 MT/ac) has to be applied. In addition, major nutrients like nitrogen, phosphorus and potash (125, 30 and 75 kg/ac, respectively) is required for the ratoon crop. The inorganic fertilizers need to be applied in convenient split doses to enhance the fertilizer use efficiency. The first split dose of fertilizers (45 kg N, entire P and 25 kg K) is recommended during ridge breaking stage. Subsequently, two more splits (each with 40 kg N and 25 kg K) need to be applied 30 and 60 days after ridge breaking as top dressing.

The micronutrient deficiency is ubiquitous owing to the usage of high analysis fertilizers (meant for only major nutrients) in the post green revolution era and sugarcane is no exception. Amongst the micronutrients, iron and zinc deficiency is more common at 6-8 month old maiden crop and early stages of ratoon cane which poses serious threats to sustainable yields. Iron deficiency results in chloritic, pale whitish or yellowish leaves which is typical symptom expressed in salt affected soils rich in calcium carbonate. Zinc deficiency is expressed as white bud syndrome where the lower portion of the young leaves have white strip (devoid of chlorophyll) which extends to the entire shoot portion and results in smaller leaves and short internodes. Adequate compost or vermicompost supplementation will ensure the required replenishment of the micronutrients. Even otherwise to rectify the deficiency, sulphates of iron and zinc (each @ 10 kg/ac) need to be applied to the soil in bands very near to the crop row. Since these micronutrients are relatively less mobile in the plant system foliar application (@ 0.5%) is appears to be viable option for correcting the deficiency.

Unscrupulous irrigation

Irrigation is a mixed blessing; scientific and scrupulous need based irrigation results in copious harvests, on the contrary excess and injudicious application results in lower yields besides formation of salt affected soils. Irrigation is not only with good quality water originating from rivers and reservoirs but also it includes marginal saline and alkali waters excavated from deep underground. It is quite natural that the continuous use of poor quality saline and alkali waters results in salt affected soils. On the contrary, even the good quality water renders soils unproductive when it is excessively used for agriculture. Hence need based irrigation, supplementing good quality water during sensitive crop stages, conjunctive use of marginal waters with good quality waters, blending the saline/alkali waters with good waters to reduce the acuteness of the problem are the arenas in the irrigation management that need to be explored for better results. During the growth of the sugarcane, the water requirement varies distinctly with the growth stages. The water requirements (through both precipitation and irrigation) during germination and initial growth, tillering stage, grand growth phase and ripening and maturity is available for reference (Table 4) and can be used as sensible guide for the practical purpose.

Table 4: Annual water requirement of sugarcane during different growth stages [5]

Growth Stage	Age of the crop	Duration	Water requirement (WR-mm)	Per day WR mm
Germination	0-45 days	45 days	300	6.67
Tillering stage	45-120 days	75 days	550	7.33
Grand growth phase	120-270 days	150 days	1200	8.00
Ripening stage	270-360 days	90 days	450	5.00
Total	**360**	—	**2500**	**6.94**

Further, drip irrigation a promising micro-irrigation technology is suitable for irrigation. It is very efficient method which is capable of reducing the water usage to the tune of 30 per cent with an additional advantage of getting 20 per cent higher yields. Adoption of this technology minimizes the labor requirement and fertilizer utilization besides suppression of weed population. Furthermore, there is ample of scope for introducing water soluble fertilizers through drip system - fertigation, which would enhance the fertilizer use efficiency to a greater extent. Through fertigation N and P requirements can be met, while the entire P (100 kg/ac) has to be applied to the soil. In order to supply N and K nutrients through fertigation the following schedule indicated in the Table 5 has to be followed. Adequate care must be taken to ensure

choke free irrigation system because salts through water and fertilizers are likely to clog the orifices in the drippers.

Table 5: Fertilizer requirement and schedule for fertigation [3]

Stage	Frequency	Urea	Potash
14-60 Days	Alternate day	2.0	1.0
61-150 Days	Alternate day	2.5	1.0
151-180 Days	Alternate day	1.0	1.0
181-210 Days	Alternate day	----	1.0

Pestering Insects and Diseases

Among the insect pests, early shoot borer, root grub, scales, termites and mealy bugs are important pests of sugarcane. Most of these are crop specific except root grub and termites, which are polyphagous pests. The root grub has assumed the proposition of important pestering insect. This can be controlled with water inundation, mere suffocation or anoxic condition is sufficient to manage the pests at economic threshold level (ETL). Similarly, for termites also appropriate irrigation is the best solution. However, other pests can be controlled by proper schedule of plant protection measures.

On the disease facade, red rot, rust and smut are very prominent diseases in sugarcane. In order to control these diseases, the following strategies need to be applied;

- Deep ploughing in the summer season.
- Systemic fungicides spray
- Disease free planting material must be selected and set treatment should be made mandatory.
- Heat treated sets must be used for planting.
- If the disease infested stalks are found it is advised to pluck and burn.
- Crop rotations should be followed.

Inefficient weed management

Weeds flora is the stiff competitor with cultivated crops and can decrease the yields to a greater extent if that is not attended. Good trash management would definitely suppress the weed population besides efficient moisture conservation. One of the worst weeds- striga is a root parasite known to infect all the grass species including cultivated crops like jowar, bajra, paddy and sugarcane. It is a notorious weed capable of thriving in the adverse conditions for about 20 years and each plant can produce 4 lakh seeds for further multiplication. In the recent past it has become a serious menace for sugarcane and the infestation is severe in the years with low rainfall and it is going to appear within 50-60 days after transplanting or ratoon inception. Crop rotations, deep ploughing before transplantation, frequent irrigation and chemical weed control (2.4.D 2.5 kg/1000 liters + urea 20% spray) measures are the effective tools for the control. The control measures should be taken well before flowering of the weed so as arrest further spread in the adjoining areas. Other weed population has to be controlled with pre-emergent (Atrazine 50 WP 1kg/200-300 liters water/ac immediately after planting) and post emergent (2, 4 D sodium 80 WP 1kg/200-300 liters water/ac after 50-60 days) by spraying between the crop rows.

Snippets for efficient ratoon management

I. Management of the field after harvest of the plant crop

The following operations need to be completed within 10 days of harvest of plant crop to obtain better establishment and uniform sprouting of shoots.

- Incorporate the trash using trash shredder.
- Follow stubble shaving with mechanical stubble shaver.
- Work with cooper plough along with sides of the ridges to break the compaction and for large scale cultivation use tractor drawn off barrer.
- The gaps in the ratoon sugarcane crop should be filled within 30 days of stubble shaving. The sprouted cane stubbles taken from the same field is the best material for full establishment. The

e-ISSN: 2319-9857
p-ISSN: 2347-226X

next best method is gap filling with seedlings raised in poly-bags; however, it adds cost to the total expenditure.

- Apply basal dose of organic manure and super phosphate as recommended for plant crop.

II. Management of the crop

- Apply 25% additional N application on 5-7 days after ratooning.
- Spray Ferrous sulphate at 2.5 kg/ha on the 15th day. If chlorotic condition persists, repeat twice further at 15 days interval. Add urea 2.5 kg/ha in the last spray.
- Hoeing and weeding on 20th day and 40th to 50th day.
- First top dressing on 25th day and second on 45th to 50th day.
- Final manuring on 70th to 75th day.
- Partial earthing up on 50th day. If junior-hoe is worked two or three times up to 90th day, partial earthing up is not necessary.
- Final earthing up on 90th day.
- De-trashing on 120th and 180th day.
- Trash twist propping on 180th day.
- Harvest after 11 months.

Figure 3: Chickpea in between rows of sugarcane (Photo source KVK Bagalkot)

Figure 4: Trash spread in sugarcane field (Photo source KVK Bagalkot)

e-ISSN: 2319-9857
p-ISSN: 2347-226X

Figure 5: Trash burnt in sugarcane (Photo source KVK Bagalkot)

Preparation of microbial consortia to accelerate decomposition

REFERENCES

1. Malavolta E. 1994. Nutrient and Fertiliser Management in Sugarcane. IPI Bulletin No. 14. International Potash Institute, Switzerland.
2. Catani RA, HC Arruda, D Pellegrino, and H Bergamin Filho. 1959. A absorção de nitrogênio, fósforo, potásio, cálcio, magnésio, enxofre e silicio pela cana-de açúcar o419 e o seu crescimento em função da idade. An.E.S.A. “Luiz de Queiroz”, UDP (Piracicaba) 16:167-190.
3. Haag HP, AR Dechen, QAC Carmello. 1987. Nutrição mineral da cana-de- çúcar. *In*: Cana-de-açúcar: Cultivo e Utilização. First vol. p. 88-162. Paranhos, S.B. Fundação Cargill, Campinas.
4. Sampaio EVSB, IH Salcedo, and FJA Cavalcanti. Dinãmica de nutrientes em cana de açúcar. III. Conteúdo de nutrientes e distribuição radicular no solo. Pesq. Agropecuária Bras (Brasília). 1987; 22(4):425-431.
5. Kordorfer GH. 1989, Crescimento e distribuiq.o do sistema radicular de cana de aqdcar em solo LVA., Bol. Tec. Copersucar (Piracicaba) p. 47-89.