Sugarcane *(Saccharum officinarum L.)*

French: Canne à sucre; Spanish: Caña de azucar; Italian: Canna da zucchero; German: Zuckerrohr; Portuguese: Cane de acucar

Crop data

Perennial grass. Harvested part: stalks (sugar/sucrose extracted from juice after crushing).

True seed (fuzz) is used only for plant breeding; flowering is undesirable in the commercial crop. Commercial propagation is by cuttings or setts of 2-3 buds or eyes, usually 30 cm in length, planted in long furrows 15-30 cm deep, or in trenches, at 10 000-15 000 3-eye/bud setts/cuttings per hectare (one-third overlapping), with an intended stalk density at harvest of 90 000-150 000/ha.

Row spacing: high density, 75 cm; general, 90-100 cm, or for mechanized harvesting 125-150 cm.

Clump spacing within the row: 30-45 cm.

Planting time: practically throughout the year in equatorial belt; mostly in spring or late spring, or sometimes in autumn, in subtropical and subtemperate regions.

Maturity is reckoned by age and variety; hand refractometer Brix of at least 18° is usually a reliable index.

Harvesting: minimum 10 months, maximum 24 months after planting, mostly during the cooler and relatively dry part of the year. Usually the harvesting and planting operations overlap in order to avoid storing the planting material.

Crop cycle: One to four or five ratoons; followed by a green manure or arable crop before re-planting to sugarcane.

Soil: medium to heavy, pH 5.0-8.5. Liming required if pH < 5, or gypsum if pH > 9.5.

Climate: optimum temperature range 25-30 °C. High temperature, with high humidity and moist soil, is favourable for vegetative growth but it should be followed by cool dry wheather to promote ripening.

Irrigation: crop is adapted to semi-arid conditions with good availability of irrigation water. Requirement, 75-150 cm. Reasonably tolerant to waterlogging for up to 7-10 days except during tillering and sprouting.

Nutrient demand/uptake/removal

Nutrient uptake/removal - Macronutrients							
Country	**Source***	**kg/ton**					
		N	**P2O5**	**K2O**	**MgO**	**CaO**	**S**
India	Zende, 1983	1.2	0.46	1.44	-	-	-
Brasil	Malavolta, 1982	0.8	0.30	1.32	0.50	0.42	0.25
South Africa	Thompson, 1988	1.75	0.41	6.00	0.66	0.70	-
* Pooled data							

Nutrient uptake/removal - Micronutrients							
Country	**Source***	**g/ton**					
		Fe	**Mn**	**Zn**	**Cu**	**B**	**Mo**
Brazil	Malavolta, 1982	31	11	4.5	2.0	2.0	0.01
South Africa	Thompson, 1988	-	11	2.5	0.5	1.2	-
* Pooled data							

Plant analysis data

Crop logging and foliar diagnosis are widely used. Procedures have been outlined both for crops with an average of 12 months duration and for crops (in Hawaii) of about 2 years duration. Two systems have been evolved for the latter:

1. HSPA (Hawaiian Sugar Planters Association) 8-10 internode or stalk log procedure, supplemented by soil analysis;
2. Clement's crop log, using 3-, 4-, 5- and 6-leaf laminae for N, and sheath from the same leaves for P, K, Mg, Ca and micronutrients, and for the sugar index.

Optimum values for several varieties (HSPA - System)				
Crop age	**%**			
(months)	**Moisture**	**N**	**P**	**K**
6	86-88	>35	0.038-0.04	1.0
8	84-86	0.28-0.35	0.032-0.04	0.7-0.8
10	83-85	0.24-0.28	0.032-0.04	0.7-0.8

The first method is inappropriate for a one-year crop, and the second method is not directly applicable to a one-year crop without modification.

A third method, more widely practised, uses 3-leaf laminae at the boom stage of growth (samples being taken at 3, 4 1/2 and 5-6 months for plant cane and at 3-4 and 5-6 months for ratoons).

Plant analysis/crop log data - Macronutrients						
Country - Region	**Source**	**Age in months**		**% of dry matter**		
		Plant	**Ratoon**	**N**	**P**	**K**
British Guiana	Evans, 1965	3	2	2.4-2.5	0.21	1.25
Mauritius	Halais, 1962	6	4 ½	1.9	-	-
Puerto Rico	Samuels, 1965	-	-	1.5-2.0	0.18-0.25	1.62-2.0
South Africa	Meyer et.al, 1989	-	-	-	-	1.6-1.8
Pakistan	Wahab, 1961	-	-	1.6	0.2-0.22	2.0-2.2
Trinidad	Vlitos and Lawrie, 1963	-	-	1.7-2.0	0.2-0.29	1.1-1.9
USA Louisiana	Golden et al, 1965	-	-	1.5-1.7	0.18-0.22	1.2-1.8
Hawaii	(Clement's system)	3-6 elongating leaf sheath once in 35 days		1.85	0.08*	2.25*
	(HSPA system)	8-10 internodes once in 2 - 3 months		0.24-0.35	0.03-0.04	0.7-1.0
Brazil	Malavolta, 1982	-	-	1.9-2.0	0.2-0.24	1.1-1.3
India	Lakshmikantham, 1971	3-6 leaves within 4 months for N, sheath for P and K-		1.96	0.086*	1.99*
* Sugar free dry weight basis						

Plant analysis data - Micronutrients								
Country	**Source**	**Status**	**ppm dry matter**					
			Mn	**Fe**	**Cu**	**Zn**	**B**	**Mo**
British Guiana	Evans, 1956	Normal	40-250	40-100	5-15	20-100	10-40	0.08-0.8
		Deficient	25	5	4	10	4	0.04-0.05
		Toxic	400	200	-	-	-	-
Brazil	Malavolta, 1982	Adequate	100-500	200-500	8-10	25-50	15-50	0.15-0.30
		Deficient	40	100	1-5	15	5-10	0.05-0.10
South Africa	Meyer et al, 1971	-	-	11-270	49-915	-	10-55	1-10

Soil analysis

Critical limits of available nutrient status as a guide to fertilizer need:

Available nutrient status			
Country and region	**Source**	**P**	**K**
India	Jafri, 1983	20 kg P (Olsen)	100 kg exchangeable K
Queensland	Leverington,1962	66 ppm	0.2 meq./100 g
Barbados	Saint, 1962	-	125 ppm K
Fiji	Holford, 1966	5-20 ppm (modified Truog)	50-150 ppm (0.5 N acetic acid)
Philippines	Demetrio, 1960	32 ppm	150 ppm
South Africa	Wood, 1987	70 kg	112 ppm

Recommended rates of fertilizer P2O5 based on the results of soil analysis:

Method	**Level of available P**	**Likelihood of response**	**Recommended P2O5**

			rate (kg/ha)
Modified Truog	< 25 25-45 kg/ha >45	certain uncertain none	200-500 50-100 none
Modified Olsen	0- 6 7-14 ppm >15	certain uncertain none	100-170 60-100 none

Fertilizer recommendations

Fertilizer recommendations						
Country/region	**Source**	**No. of splits**	**Max. Duration of application**	**kg/ha**		
				N	**P2O5**	**K2O**
Argentina - Tucuman	Fogliata, 1970	-	-	100	adapted to requirement	
Australia - Queensland						
plant		-	-	56	25-80	75-110
ratoon		-	-	78	-	-
				(in addition to Bureau mixture)		
Bangla Desh		-	-	120	85	110
Brazil	Malavolta, 1987					
Sao Paulo						
plant		3 (N)	4-6 months	45-90	60-120	60-120
ratoon		1		45-90	30- 60	30- 60
British Guiana	Evans, 1963	-	-	65-90	65- 90	65- 90
India	Mathur, 1980					
Subtropic		3 (N)	4 months	100-250	60 as per requirement	80
Tropics		4 (N)	4-6 adsali crop in MR	200-300	120	120
		3 (N)	4 months for others	150-200	60	80
Indonesia		-	-	120	as per requirement	
Jamaica	Shaw de Innes, 1965	-	-	80-160	as per requirement	
Mauritius	Wong, 1968	-	-	100-125 (2-1-1 mixture)		
Mexico		-	-	120-200	40-80	40-120
Pakistan		-	-	90-160	-	-
Philippines	Lopez et. al,1965					
VMC		-	-	125	120	180
District - Luzon		-	-	120-140	-	-
Puerto Rico	Samuels, 1965	-	-	135-200	62	112
South Africa	Wood, 1989					
Coastal lowland						
plant		2(N;K)	10 weeks	100-120	40	100
ratoon				140	20	150
Natal Midland						
plant		-	-	80	60	125
ratoon		-	-	120	40	175
Lowveld						
plant		-	-	120	30	125
ratoon		-	-	100	10	175
USA- Hawaii	Hubert, 1963					
irrigated		2	10-12 months for 2-years	400	280	400-450
rainfed		2	crop	300	280	400-450

N - The following formula for calculating the amount of N to be applied was evolved from extensive studies on cultivators fields in India (Lashmikantham, 1971):

Recommended rate (lb/acre N) = B/A x age correction x (100 - x)

Where:
A = Optimum N value minus N value when no N applied
B = Optimum N value minus test value from cultivator's field)
B/A = N index
X = N already given to the crop up to the time at which the fertilizer is to be applied.

N rates used in India range from 0-50 kg/ha N in U.P. and Bihar, compared with 250-300 kg/ha N in A. P., Karnataka and Maharashtra, to over 350 kg/ha N in the S.E. coastal area of Tamil Nadu. In general, the rate matches the intensity of irrigation which is higher in the tropics than in the subtropics (except Punjab).

As a simple rule of thumb, 1 kg N per ton of cane expected is given for plant cane and 1.25-1.50 kg N per ton of cane expected for ratoon crops. In other words the optimum for ratoons is at least 25 % greater than for plant cane.

The rate is adjusted to the extent of 10 % of the recommended rate to allow for leguminous green manure of compost and f.y.m. which has been used, but no correction is permissible for any residual N from one sugarcane crop to the next.

Enough N must be applied at an early stage of growth; in general, for a 12-months crop all should be applied within 3 months after planting. For a 2-year crop, or for areas with two rainy seasons and where tillering takes place in two flushes, a late supplementary N application is beneficial.

The effect of increasing N application is to increase the yields per hectare of both cane and sugar until the cane yield gradually levels off, while the sugar response falls off more sharply. Because reduction in quality may be associated both with too high a rate and with delayed application of N, it is essential to complete N application at least 5 months before the intended date of harvest.

In order to avoid loss by volatilization, all fertilizer N (including prilled urea) should be incorporated into the soil by deep placement.

P - For the plant crop and subsequent ratoon crop, all applied at planting in the furrow below the setts, normally as a basal dressing of a suitable compound fertilizer containing all the P and K and one-third to one-half of the total N required.

K - Large amount needed. In many countries the the amount applied, 100-200 kg/ha K2O, is similar to that of N. It is normally all included in the basal dressing, but there are areas (e.g. on sandy loams) where it is preferable to apply only one-half in the basal dressing and the remainder 6 months later.

K deficiency not only reduces the cane yield but also has an adverse effect on quality. K application often increases the percentage of sugar in the cane, and juice recovery, even where there is no increase in cane yield, particularly when harvest is delayed. The response to applied K has been observed to increase in successive ratoons.

Preferred nutrient forms

N - All sources equally effective.

P - Water-soluble forms preferred on soils rich in calcareous silt. More insoluble forms beneficial on acidic or lateritic soils (e.g. in Australia, large dressings of finely ground rock phosphate are used to build up soil reserves, followed by smaller annual applications of a soluble form of P).

K - Potassium chloride and potassium sulphate are equally effective.

Further reading

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