

Banana (*Musa spp*)

French: Banane; Spanish: Plátano, Banano; Italian: Banana; German: Banane

Crop data

Permanent crop with a succession of herbaceous generations by vegetative sprouting. Mostly triploid.

Harvested part: fruit (consumed either raw or cooked according to the cultivar; plantains form a specific group within the cooking cultivars). Leaf blades are frequently used as wrapping material, especially in Asia.

Plantations are renewed every 3-5, 10 or 30 years according to region and cropping system.

Planting material: corms, corm pieces or suckers (tissue-cultured plantlets are becoming increasingly used for intensive cropping).

Plant density:

- for the Cavendish group of sweet bananas (which account for nearly all international trade), 1 400 - 3 500/ha, according to sunshine, cultivar, cropping technique and marketing constraints such as the premium paid for larger-sized individual fruits. With intensive mechanization and/or very high plant densities, in widely spaced single or double rows closely planted within the row; otherwise evenly spaced square or rectangular planting.

- for all other types, 900 - 1 600/ha (exceptionally up to 2 500/ha).

(All figures for single-follower de-suckering technique).

Flowering (plant crop):

- Cavendish group, 5-10 months after planting, depending on planting material, climate, irrigation, cultivar and fertilizer use;

- other types, a shorter interval for a few small-sized diploids and longer for plantains etc;

- (ratoon crop): interval after harvest of previous crop is less than for plant crop but varies with de-suckering technique.

Time from flowering to harvest: 80-180 days for both plant and ratoon crops, depending mainly on climate ("heat sum").

Thus, for the Cavendish group the interval between successive harvests is 7-15 months, depending on climate, cultivar and cropping techniques.

Bananas are grown on many soil types; physical qualities are more important than chemical composition, because the roots are fragile, with a low penetrating power and a great need of oxygen. Preferred pH about 6.0, but successful crops may be obtained down to pH 4.0 without liming, where exchangeable Al is low (peat soils), - or up to pH 8.5 where potential metal deficiencies are well controlled or non-existent. Water requirements are high (150 mm/month) and water absorption capacity is low, so irrigation, of whatever kind (overhead, microjet, drip, etc), should maintain soil moisture within 60-100 % of the range between permanent wilting point and field capacity.

Nutrient demand/uptake/removal

Nutrient removal (harvested fruit, Cavendish group) - Macronutrients
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kg/t whole bunches					
N	P2O5	K2O	MgO	CaO	S
1.7 ± 0.4	0.45 ± 0.15	6.0 ± 1.0	0.40 ± 0.15	0.30 ± 0.12	0.20 ± 0.05

Figures for other varieties are less well established but differ little from the above.

Nutrient uptake - Macronutrients									
Cultivar	Source	Bunch yield t/ha/cycle	Sampling	kg/ha					
				N	P2O5	K2O	MgO	CaO	S
Pisang Assam	Joseph, 1971	16	incomplete m.p.(-pulp)	40	18	343	80	45	-
Gros Michel	Martin-Prevel et al., 1968	26	whole matts	250	91	1 350	93	308	-
Dwarf Cavendish	Martin-Prevel et al., 1962	42	mother plants only	225	55	1 004	27-	122	-
Plantains (3cvs) min.	Marchal et al, 1979	32	whole matts	180	49	1 145	58	133	14
		48		226	69	1 625	66	196	20
Popoulu	Marchal et al, 1970	44	whole matts	370	108	2 440	114	252	31
Poyo, grand Nain	Martin-Prevel et al., 1965-66 Twyford et al., 1973-76	35-57	m.p., aver. Values	250	57	964	100	210	15
Robusta	Twyford et al, 1973-76	50	whole matts, extrapolated values	450	309+	2 109+	390+	420+	144
Poyo	Martin-Prevel et al., 1968	66	whole matts	450	70	1 500	80-	200	-
Grand Nain	Marchal et al, 1979	69	whole matts	293	69	1 325	108	224	29
Americani	Marchal et al, 1979	75	whole matts	294	92	1 565	124	266	36
Nanicao	Gallo et al, 1972	77	incompl. m.p (- corm, roots)	264	73	1 265	104	224	11

Poyo = Robusta, Valery (giant Cavendish) Grand Nain, Americani, Nanicao (semi-giant Cavendish)

Full références in : Martin-Plevel, 1980, 1987

m .p. := mother plants ; whole plants = mother plants + all existing followers

+ probably overestimated ; - Mg-deficient sites ; Also CI = 300 kg/ha (Gallo et al., 1972)

Nutrient uptake - Micronutrients									
Cultivar	Source	Bunch yield t/ha/cycle	Sampling	kg/ha					
				Fe	Mn	Zn	Cu	B	Mo
Robusta	Twyford et	-	mother	2.7	4.3	0.47	0.18	0.84	-

Around flower initiation	Deficient (symptoms)	<2.3	0.12	1.9	0.15-0.24	0.4(°)	0.21	-
	Low	2.3-3.3	0.13	<4.5	0.25-0.29	-	0.21-0.25	-
	Optimum	3.3-3.7	>0.14	4.5-5.0	0.30-0.40	0.8-1.3	>0.25	(1.0)
	High (luxury)	>3.7	-	>5.0	>0.40	>1.3	-	(2.0)
	Excess (toxicity)	-	0.3	5.5-6.5	-	-	-	(3.5)
Just fully expanded bunch	Deficient (symptoms)	1.6-2.1	-	1.3-2.6	0.07-0.25	0.15	-	-
	Low	2.0-2.5	0.12-0.16	2.7-3.2	-	-	-	-
	Optimum	2.7-3.6	0.16-0.27	3.2-5.4	0.27-0.60	0.66-1.20	0.16-0.30	0.9-1.8
	High (luxury)	-	-	-	-	-	-	>2.0
	Excess (toxicity)	-	-	-	-	-	-	3.5
<p>* K:Mg:Ca and K:N equilibria also to be considered. Optimum for K:Mg:Ca in gramm-equivalents = 52-60:16-25:2-29. (°) Up to 0.7 for first cycle issued from big corms</p> <p>Italics: recalculated from non-IRS results (Martin-Prevel, 1987, and internal reports by IRFA/CIRAD) Normal: figures used by J. Marchal for current practice by IRFA/CIRAD Between brackets: order of magnitude (acc. Lahav and Turner, 1983, and Soto, 1985)</p>								

Leaf analysis standards (International Reference Sample - IRS) - Micronutrients							
Plant growth stage	Nutritional status	ppm dry matter					
		Fe	Mn	Zn	Cu	B	Na
Around flower initiation	Deficient (symptoms)	77	25-100	14-(°)37	-	-	-
	Low	-	110-150	-	-	-	<100
	Optimum	≥100	160-2500	>20	(9)	(11)	-
	High (luxury)	-	>2 500	-	-	-	>100
	Excess (toxicity)	300	>4 800	-	-	-	>300
Just fully expanded bunch	Deficient (symptoms)	-	40-150	6-17	<5?	<10?	-
	Low	-	-	-	-	-	< 60
	Optimum	80-360	200-1800	20-50	6-30	10-25	-
	High (luxury)	-	2 000-3 000	-	-	-	>150
	Excess (toxicity)	-	>3 000	-	-	30-100	up to 3 500
<p>P/Zn ratio (high in case of Zn deficiency) to be preferably considered Italics: recalculated from non-IRS results (Martin-Prevel, 1987, and internal reports by IRFA/CIRAD) Normal: figures used by J. Marchal for current practice by IRFA/CIRAD Between brackets: order of magnitude (acc. Lahav and Turner, 1983, and Soto, 1985)</p>							

Fertilizer recommendations

Whilst N and K should be supplied according to the very high biomass requirements of the crop, attention must be given to maintaining an appropriate soil cationic balance. On most soil types this means (with pH around 6.0) about 80 % CEC saturation by K, Mg and Ca in the approximate proportions 1:3:6. Dressings of dolomite and/or limestone, for incorporation into the soil, should be calculated so as to achieve and maintain these proportions in the top 20 cm of soil. On highly unsaturated soils with a high cation exchange capacity, this may seldom be possible, in which case attention should be given principally to the K:Mg ratio, which should never exceed 1:2 in ferrallitic or sandy soils or 1:1 in volcanic or organic soils. The level of exchangeable K should preferably be raised to about 10 % of the total exchangeable cations by a basal application in the first year and subsequently maintained by dressings calculated to compensate for removals and leaching losses.

The amounts of N and K₂O to be given to a plant crop should be calculated from the expected yield on a particular field and the total uptake per metric ton of whole bunches as quoted earlier. N application should be split into a number of dressings so as to provide a continuous supply from planting right through to harvest, with smaller and more frequent dressings where the risk of loss by leaching is higher (Godefroy et al, 1989), ranging from intervals of 1-3 months in relatively dry climates down to every 2-4 weeks in the humid tropics with suitable modification in seasons of high growth potential or in seasons affected by cold or drought. Subject to the demands of maintaining a correct cationic balance, the K application is generally divided in a rather similar manner to that of N except that dressings should be smaller at the beginning of the growth period and increased during the months immediately before and after flowering.

Similar calculations may be made for ratoon crops, making due allowance for the large losses resulting from chopping down the mother plants, and the more rapid growth during a shorter time period. In practice, the same average monthly rates as for the plant crop are generally adopted.

Preferred nutrient forms

Given adequate S, the cheapest forms of N and K fertilizers available may be used. Potassium nitrate, although acceptable in theory, is scarcely ever used except in irrigation water, due to its high cost and liability to loss by leaching. Where there is a need for added S, this can be given either in the form of a sulphate-based N fertilizer or, preferably on acid soils, potassium sulphate, so that S would account for 3-5 % of the total input unless abundant organic manure is used. Double K-Mg sulphates (Patentkali, etc) are useful where Mg deficiency is incipient. The preferred form of P depends on soil pH and P-fixation capacity. Where appropriate, rock phosphates can contribute, with lime and/or dolomite, towards CEC saturation; and low-P compound fertilizers are convenient except on soils where P-fixation capacity is high.

Present fertilizer practices

Departures from recommended usage often result in low yields, through under-use, or in poor quality and uneconomic production due to imbalanced or over-use or incorrect timing.

Organic manures are excellent for improving soil conditions and provide variable amounts of macronutrients, which must be taken into account if imbalances are to be avoided; they may also supply all the micronutrients needed. Cattle or chicken manures, at rates of 35-120 t/ha, are widely used in some countries, and in others, residues such as coffee pulp, cacao shells and composted town refuse, while copious mulching with grasses or branches has been common practice for decades in many regions. Where high yields are obtained by using only mineral fertilizers, the soil organic matter content can be improved by returning around 200

t/ha/year of plant residues, but care must be taken to ensure that adequate amounts of all macro- and micronutrients are provided.

N fertilizer is used almost everywhere unless abundant organic manure is applied; but even with abundant manure application K fertilizer must also be given except on volcanic soils containing very high reserves. Mg is considered the third most important nutrient, whether incorporated in a soil amendment or broadcast as a straight fertilizer (Epsom salts or kieserite) or in mixed or compound fertilizers.

Most fertilizers are hand-spread except when basal dressings are incorporated during land preparation. However, there is considerable controversy over the best method of placement. With good control of nematodes and soil aeration, an even broadcast would appear more logical, but applications in practice are often concentrated within a circle of 1.0-1.5 m diameter around the pseudo-stem, or (after flowering) in a crescent shape around the daughter plants. In mechanized fields the fertilizers are often spread along the rows.

Foliar feeding is efficient with the right nutrients and wetting agents. It is preferably used successfully for micronutrients, especially when they can be mixed with the aerial oil-fungicide sprays regularly applied against Sigatoka disease in tropical climates. Rates of 5-10 kg/ha Zn, B or Mn (in descending order of importance) applied in this way once to three times a year are sufficient, instead of soil applications of 20 kg/ha or more which are often ineffective because of blocking antagonisms.

Some individual growers apply amounts up to 1 200 kg/ha N, 800 kg/ha P₂O₅, 1 800 kg/ha K₂O yearly, but the most common practices for Cavendish cultivars in various countries are summarised in the following table. The higher figures correspond broadly with the highest yields. The less productive stands, whether of Cavendish or other cultivars, receive less fertilizer but are less profitable.

Present fertilizer practices for "Cavendish" cultivars with good average yields unless differently stated				
Region/Country	kg/ha/year			Other elements - Remarks (kg respect. t/ha)
	N	P₂O₅	K₂O	
Africa				
Cameroon	140-400	0	0-(800)	no K necessary on young volcanic soils, fertilizers must contain S
Cote d'Ivoire - peat soils	100-330	30-100	700-1600	5-10 Cu, 500-2 000 dolomite
- other soils	300-500	30-100	600-1200	500- 2000 dolomite
South Africa	140-500	0-100	750-1600	organic manure 0-120 tons
Canary Is. - drip irrigat.	500-600	200-300	700-1000	organic or plastic mulch
- surf. irrigat.	600-800	300-450	900-1500	organic mulch
Morocco, greenhouses	440-750	0-285	800-1600	10-25 Mn, 0-200 MgO, 0-150 S manure
Egypt	380-2 500	55-300	0-950	org. manure - low yields without K
Middle East, Asia, Oceania				

Israel				
- coastal plain	400	200	1440	organic manure (*)
- Jordan valley	400	90	0	org. manure - no K necessary (*)
India	300-600	320-345	340-720	organic manure (*)
Taiwan	400	115	900	(*)
Australia				
- N Territories	110	230	760	(*)
- Queensland	280-370	160-460	480-1560	(*)
- N.S. Wales	180	90-230	360- 720	(*)
Latin America and Caribbean				
Brazil				
- Sao Paulo	250-500	125-240	500-950	not "Cavendish", yield 5-20 t/ha
- other states	0- 80	0- 50	0-120	
Costa Rica	300-450	0-160	600-750	50-200 MgO, 500-600 CaO
Honduras	290	0	0	no K necessary on most soils (*)
Martinique, Guadeloupe				
- andosols and recent pumices	300-700	0-180	800-1350	80-270 MgO, 150-400 CaO CaO according to soil analysis
- other soils	250-600	0-150	600-1600	
Jamaica	225	150	560	(*)
Sources: (*) Lahav and Turner, 1983 - Others: personal records and IRFA/CIRAD reports				

Further reading

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