Designing a mango fertiliser program

If you're not monitoring, you're guessing

Mango crop management

- Match application to demand
- Encourage post-harvest growth flush(es)
  - protect and feed this flush, this is your crop
- Ensure dormancy period
  - 2-3 month during autumn/winter
  - set up flushes for flowering
- Reduce stress during key times
  - flowering, fruit set and development
  - nutrition, irrigation, pest and disease

Implications to managing nutrition

- Ensure regular pattern for good bearing trees
- Promote a strong summer flush
  - provides the base for flowering and fruiting
- Provide growth stimulus at flowering
- Supply critical elements at growth stages
- Replace removed nutrients
  - small vs. big crops

Strong Flush Post Harvest

THE 4 R'S

- **The right nutrient choice**
  - a type needed by the tree
- **The right rate**
  - as the tree requires
- **The right time**
  - to match nutrient demand
- **The right place**
  - where the tree can access it

Relationships

- The 4 R's are interconnected and must be synchronized with plant, soil, climate, and management.

- The 4 R's are essential to increase efficiency of nutrient use and sustainability.

- The 4 R's must be kept in balance

How to determine -Right Nutrient & Rate

- Results of leaf and soil tests
- Soil type
- Mango phenology – what stage is tree at/entering?
- Crop yields- How much nutrition was removed by the crop?
- Fertilizer uptake efficiency and/or losses- How much was leached, volatilised, tied up?
- Past records

Interpreting plant tissue analysis

(Mango – last fully mature leaf)

Nutrient	Units	Desired range
Nitrogen	(% N)	1 - 1.5 varies with cv
Sulphur	(% S)	0.1 - 0.2
Phosphorus	(% P)	0.08 - 0.18 (0.1-0.2)
Potassium	(% K)	0.3 - 1.2 (0.75-1.2)
Calcium	(% Ca)	2.0 - 3.5
Magnesium	(% Mg)	0.15 - 0.4
Sodium	(% Na)	<0.20
Chloride	(% Cl)	<0.25
Boron	(ppm B)	50 – 70 (50-80)
Zinc	(ppm Zn)	20 - 100
Copper	(ppm Cu)	10 - 20
Iron	(ppm Fe)	30 – 120 (70-200)
Manganese	(ppm Mn)	60 – 500
Molybdenum	(ppm Mo	(0.05-1.0)

Optimum Soil levels for Mango

Element	Optimum Soil Level
pH	5.5 – 7
Organic Carbon	1-3 %
Conductivity	< 0.2 dmS
Nitrogen	<10
Phosphorus (Colwell)	60 - 80
Potassium	0.25 – 0.4 meg/100 g
Sulphur	> 12 mg/kg
Sodium	<1.0 meg/100 g
Chlorine	<250 mg/kg
Calcium	3 - 5 meg/100 g
Magnesium	0.75 – 1.25 meg/100 g
Copper	0.3 – 10 mg/kg
Zinc	2 – 15 mg/kg
Manganese	4 – 50 mg/kg
Iron	4 - 100 mg/kg
Boron	1 - 2 mg/kg
Cation Exchange	~5
% Sodium	< 1%
% Potassium	5 %
% Calcium	65 – 80%
% Magnesium	15 - 20 %

Cations in soil (CEC) and ideal balance for mangos

- Calcium 65-80%
- Magnesium 15-20%
- Potassium <10% (about 5% is good)
- Sodium <1%
- Aluminium <1%

Different soils = different management

High CEC = high nutrient and water retention capacity

Low CEC = low water and nutrient retention capacity

Effect of soil type on CEC

• Sands	2-3
• Sandy Loams	2-12
• Loams	5-20
• Clay Loams	5-20
• Clays	10-80+

NUTRIENT REMOVAL

Nutrient removal

Nutrient loss. Can lose nutrient from :

- Fruit removal
- Leaching
- Volatilization
- Removal of prunings from block

Nutrient removal (1000kg of fruit)

Nutrient	Amount removed (g)	Fertiliser equivalent
Nitrogen	845	1835g urea
Phosphorus	180	2000g superphosphate
Potassium	1285	9555g potassium sulfate
Calcium	1150	6210g gypsum
Magnesium	240	500g granomag
Boron	2.0	10g solubor
Zinc	2.0	5g zinc sulphate
Iron	6.0	30g iron sulphate

Trees can lose 0.3% N with good flowering

NUTRIENT LOSS

- N: 30 to 50+% by leaching, volatilisation.
- P: 50 to 100% by fixation.
- K & Mg: 20 to 30% by leaching.
- Ca & S: 5 to 20% by soil erosion or run off
- B: up to 60% lost by leaching

Estimated Fertilizer Efficiency Factor

Nutrient	Source 1	Source 2	Comment
N	50%	50-70%	•40% if water logged soil •30% if high leaching soil
P	40%	0-50%	•20% in high P fixing soils
K	60%	70-80%	
Ca	60%	80-95%	
Mg	60%	70-80%	

NUTRIENT UPTAKE EFFICIENCY

- Nitrogen 30-50% *(less on hot humid conditions)*
- Phosphorus 40% *(much lower in some soil types)*
- Potassium 60%
- Calcium 80%
- Magnesium 70%
- Sulphur 80%

Nitrogen

- Rate based on leaf test results
- Greatest demand during growth
  - post harvest and flowering
- Increases fruit size and number
- Apply frequently on lighter soils
- **Green trees are not always due to high N**
  - **High Mn, Zn, Mg, and PBZ can also green trees**
- Adjust rate with crop load
  - more on heavier crops

Suggested pre-flower leaf N levels

Cultivar	Optimum % Leaf N
KP	1.1 – 1.3
R2E2	1.3 – 1.4
Honey Gold	1.3 – 1.4
Calypso	1.0 – 1.5
Keitt	1.0 – 1.2
Other – Asian cultivars	1.2 – 1.4

N Based on pre-flower leaf levels

Leaf N (%)	N by m^2	Urea by m^2	Urea by $10m^2$
<1.0%	8g	17g	170g
1 – 1.25%	4g	9g	90g
1.3 – 1.5%	Not required	Not required	Not required
>1.5%	Too much	Too much	Too much

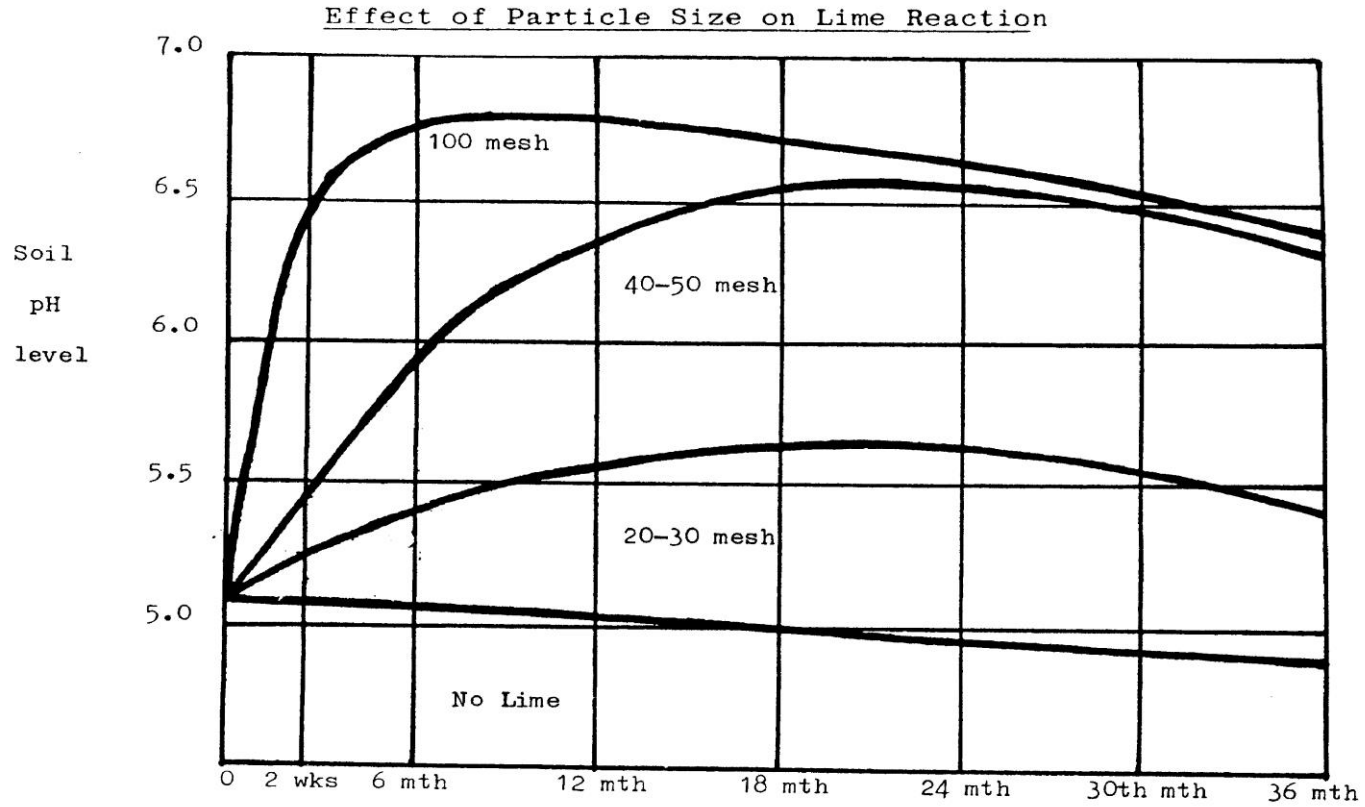
Based on Honey Gold trials 2007-10, does not apply to Keitt

Use about 2/3^{rds} on KP

Calcium

- Rate based on leaf and soil tests
- Want leaf level of 2 – 3.5 %. Soil of 3-5 meq/100 g
- Form depends on soil pH
- Moisture needed for uptake
  - spread near end of wet
- Use liquid form during flowering and early fruit development
- Particle size determines speed of uptake
  - the finer particles are absorbed quicker
- Apply to suit root flush timing

Effect of particle size on lime reaction



Lime worked into pasture soil.
NSW Irrigation R & E Committee Farmers Newsletter. June 1980. No 147, p 15

Boron

- Rate based on soil and leaf test results
- Want leaf level of 50-70 mg/kg or ppm
- Rate & timing very dependent on soil type
  - lower amount on lighter soil types
  - apply more frequently on lighter soils
  - apply small amounts frequently
- Needed each time there is new growth
- Foliar applications to soft tissue only
  - during flowering
  - poor uptake on old leaves

Potassium

- Rate based on soil and leaf test results
- Want leaf reading 0.75- 1.2% and soil of 0.25 – 0.40 meq
- Need K post harvest and flowering
- >60% over fruit filling period
- Easily leached - lighter soils apply frequently
- Adjust rate with crop load – more on heavier crops

Fertilizer by the handful

Amount of Fertiliser/closed handful

Fertilizer	Average of 6 people	Range
Urea	16.6 g	11.13 - 22.15 g
15-15-15	34.1 g	20.8 - 53.34 g
Conclusion: Use of term handful can be dangerous!!!		

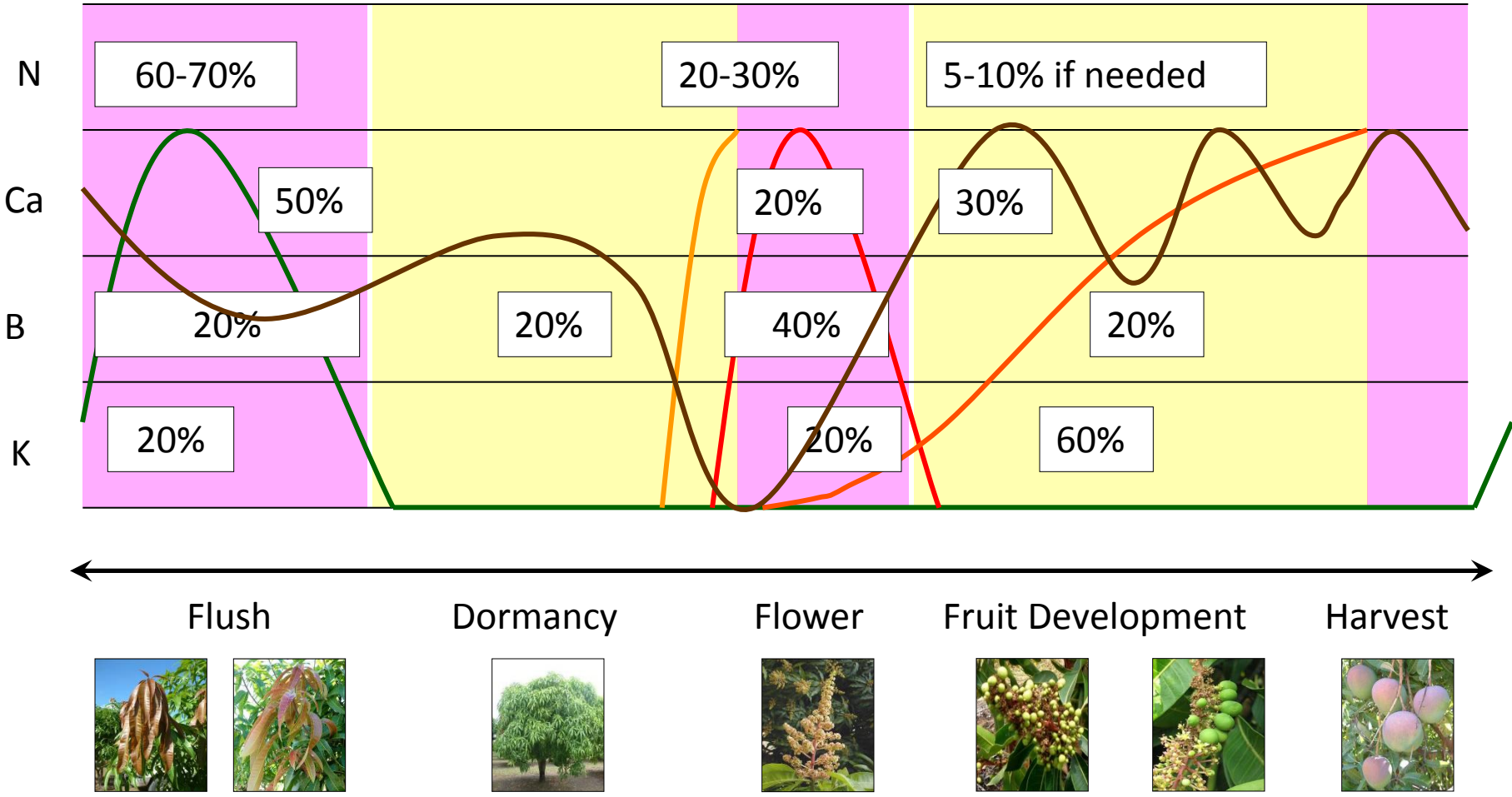
Right fertiliser placement

- Nutrients are taken up by fine small roots/root hairs.
- Where are most tree fine roots?
- Not next to tree trunk!!
- Where is irrigation zone?
- Spread evenly
- Some fertiliser best incorporated or some best banded

Where are mango feeder roots??

ting

Phenology based nutrition



Critical Windows for Application

	Flush	Dormancy	Flower	Fruit Development	Harvest
N	60-70%		20-30%	5-10% if needed	
Ca	50%		20%	30%	
B	20%	20%	40%	20%	
K	20%		20%	60%	





Fertilizer pricing

Fertiliser value- Cost per unit of nutrient

- Fertilizer costs are high and often money can be saved.
- In comparing the costs of one fertiliser with another, the price per tonne does not mean much. The cost per unit of nutrient is what is important.
- If for example you need N and you can buy it as either urea or sulphate of ammonia, you need to see which is cheaper.

To calculate unit cost of per kg of nutrient

$$\frac{\text{Price per tonne}}{\text{elemental percentage} \times 10} = \text{cost per kg of nutrient}$$

Urea is 46% N and Sulphate of ammonia is 21% N

Suppose Urea costs $960/tonne and S of A $640/tonne

Urea: $960/46*10 = $2.08 per unit N

S of A: $640/21*10 = $3.04 per unit N

Fertilizer Analysis

- NPK
- In some imported fertilisers, analysis is given as N-P_2O_5-K_2O rather than NPK. Therefore it is essential that labels of imported fertilisers be checked before use. To convert P_2O_5 to P, multiply by 0.44 and K_2O to K multiply by 0.83.

- Australia 15-15-15 is 15% N; 15% P; 15% K
- Some Asian 15-15-15 are 15% N; 6.6% P; 12.4 % K

UNIT COMPARISION

< Less than

> Greater than

1% = 10,000 ppm or 10 g/L

1 ppm = 1 mg/kg =1 mg/L

To convert meq/100 g to ppm or mg/kg
(meq/100 g x equivalent wt. x 10 = ppm)

To convert mg/kg to meq/100
(mg/kg / equivalent wt x 10 = meq/100 g)

Equivalent wt. Ca = 20 Mg = 12 K = 39 Na = 23

Speed of nutrient uptake from soil

Fast	Slow
Nitrates	Calcium
Potassium	Phosphorus
Sulphates	Iron
Magnesium	Copper
Zinc	Molybdenum???
Boron	
Manganese	
Sodium	
Chloride	

Mobility of nutrients in the plant

Mobile	Variably mobile	Immobile/Limited
Nitrates	Sulphur	Calcium
Phosphates	Copper	Manganese
Potassium	Zinc	Iron
Magnesium	Molybdenum	Boron
Sodium		
Chloride		

Incompatible Fertilisers

Lime and superphosphate

Dolomite and superphosphate

Zinc and superphosphate

Ammonium sulfate and lime

Solubor and any sulphate

Calcium Nitrate and any sulphate

Monopotassium phosphate and magnesium sulphate

Any others ???