Building a walnut fertilizer program

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February 2019

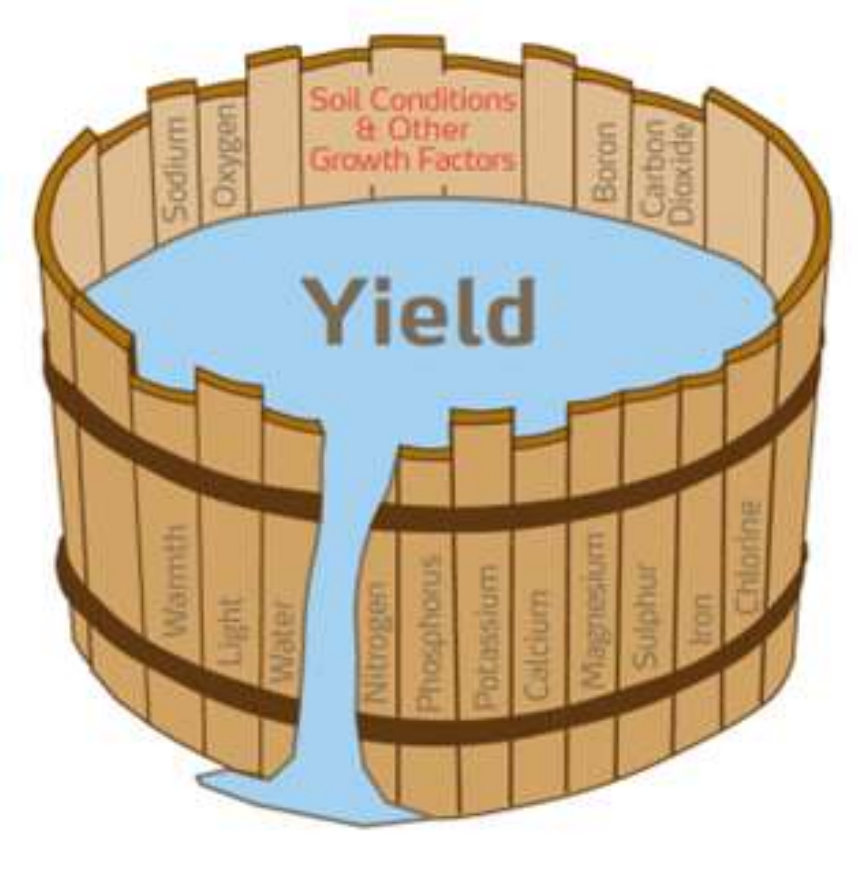
Why do we need fertilizer?

- Replenish the nutrition from the soil we remove with a crop
- Fill nutrient “gaps” that naturally occur in the soils
- Increase yields / quality
- Influence phenological stages in crops

What should we know before we start?

- How do plants access nutrients
- Crop removal
- Soil test results/ tissue test results
- What are the growers goals?

What's your limiting factor?



What do we need to know about nutrients?

- Most nutrients are taken up by the roots.
- Three forms of root uptake. Mass flow (with water), diffusion (concentration gradient) and interception (active root contact)
- Uptake rates dependent on temperature, water, soil conditions (pH ect)

Mobile in the soil

- Nitrogen (N)
- Calcium (Ca)
- Magnesium (Mg)
- Sulphur (S)
- Molybdenum (Mo)

Poorly Mobile in the soil

- Phosphorus (P)
- Potassium (K)
- Copper (Cu)
- Manganese (Mn)
- Zinc (Zn)
- Iron (Fe)

Nutrient mobility in the plant

Mobile in the Plant

- Nitrogen (N)
- Phosphorus (P)
- Potassium (K)
- Magnesium (Mg)
- Sulphur (S)
- Molybdenum (Mo)

Poorly Mobile

- Calcium (Ca)
- Boron (B)
- Copper (Cu)
- Manganese (Mn)
- Iron (Fe)
- Zinc (Zn)

Crop removal data

Walnut Nutrient Removal Charts

Nutrient Removal (4 t/ha Yield)												
	N	P	K	S	Ca	Mg	Mn	Zn	Cu	Mo	B	Fe
Nutrient Removal (kg nutrient / t crop)	26	3.5	4.4	1.3	1.1	1.6	0.1	0.1	0.1	0.005	0.1	0.1
Nutrient Removal (kg nutrient / ha)	104.00	14.00	17.60	5.20	4.40	6.40	0.40	0.40	0.40	0.02	0.40	0.40
Efficiency Factor	**70%** - to account for environmental losses and consumption (leaf matter, roots, biomass) not exported in crop											
Estimated Crop Nutrient Requirement (kg nutrient / ha - removal & losses)	148.57	20.00	25.14	7.43	6.29	9.14	0.57	0.57	0.57	0.03	0.57	0.57

Source: http://www.potash-info.com/research/nutrientconc/nutrientcont.htm

Soil testing

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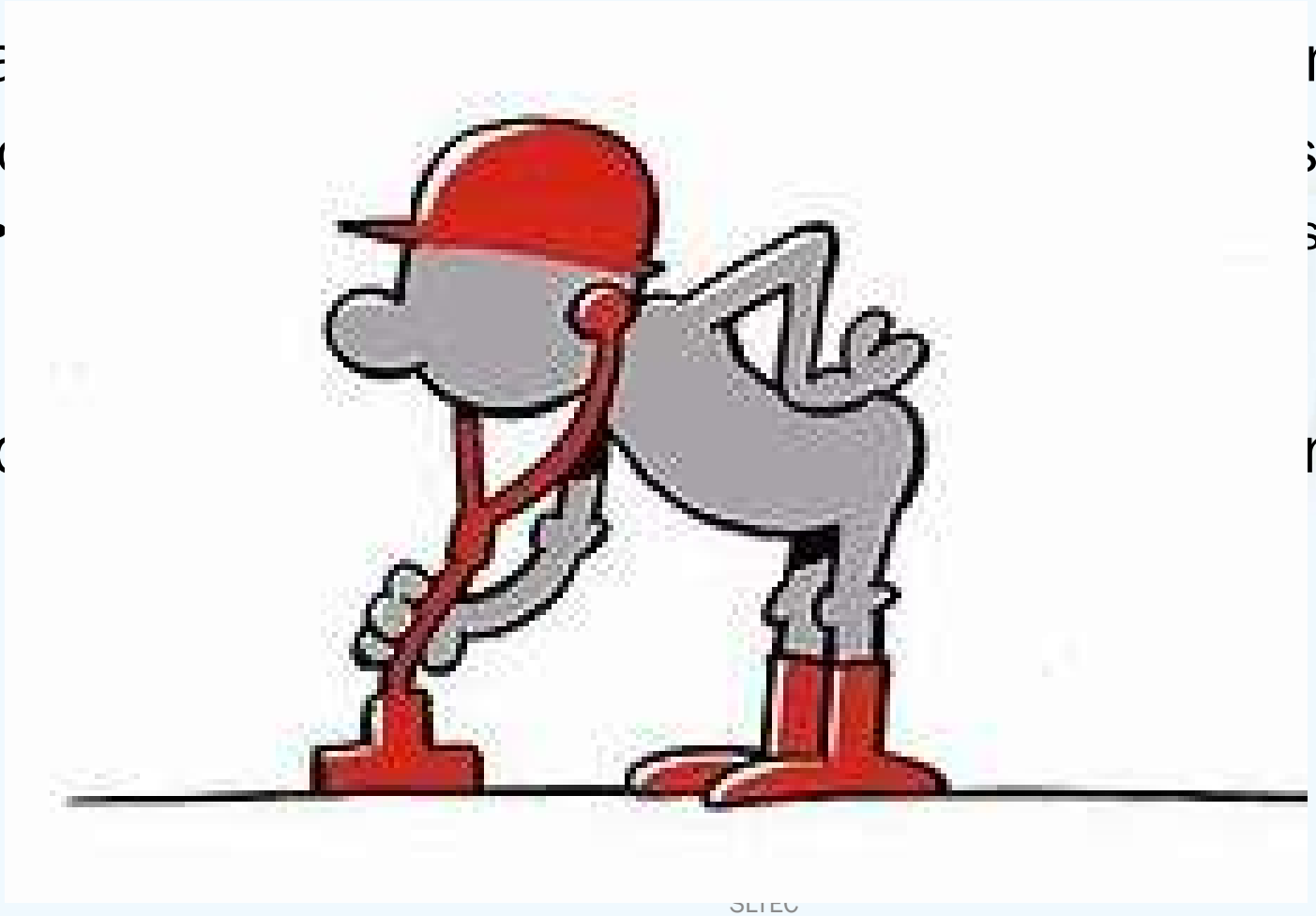


Soil test results

LAND USE : WALNUTS **ANALYSIS REQUIRED :** Full (ST-1)

ITEMS			RESULTS	DESIRABLE LEVEL
pH(1:5 Water)*			6.4	6.0-7.0
pH(1:5 0.01M $CaCl_2$)*			5.88	
Electrical Conductivity*	EC	µS/cm	242	< 315
TOTAL SOLUBLE SALT	TSS	ppm	798.6	< 1040
AVAILABLE CALCIUM*	Ca	ppm	1470	2062
AVAILABLE MAGNESIUM*	Mg	ppm	439.2	273
AVAILABLE SODIUM*	Na	ppm	71.07	< 174
AVAILABLE NITROGEN	N	ppm	64.8	54
AVAILABLE PHOSPHORUS*	P	ppm	53.1	45
AVAILABLE POTASSIUM*	K	ppm	581.1	303
AVAILABLE SULPHUR*	S	ppm	21.7	11 - 15
AVAILABLE COPPER*	Cu	ppm	2.48	3
AVAILABLE ZINC*	Zn	ppm	6.39	4 - 6
AVAILABLE IRON*	Fe	ppm	51	> 30
AVAILABLE MANGANESE*	Mn	ppm	42	> 20
AVAILABLE COBALT	Co	ppm	2.04	0.7-0.8
AVAILABLE MOLYBDENUM	Mo	ppm	0.44	0.3-0.4
AVAILABLE BORON*	B	ppm	0.33	0.6-1.0
TOTAL ORGANIC MATTER*	OM	%	5.9	4 - 6
TOTAL ORGANIC CARBON*	OC	%	2.95	2 - 3
TOTAL PHOSPHORUS*	TP	ppm	not required	
EXTRACTABLE ALUMINIUM*	Al	ppm	not required	
TOTAL NITROGEN*	N	%	not required	
TOTAL CALCIUM	Ca	ppm	not required	
TOTAL MAGNESIUM	Mg	ppm	not required	
CHLORIDE	Cl	ppm	not required	
AVAILABLE SILICA	Si	ppm	not required	

*This laboratory has been awarded a Certificate of Proficiency for specific soil and plant tissue analyses by the Australiasian Soil and Plant Analysis Council (ASPAC). Test for which proficiency has been demonstrated are highlighted in this report.

FILE NO : 1604118548 **LAND USE:** WALNUTS

ITEMS			RESULTS	DESIRABLE LEVEL
EXCHANGEABLE CALCIUM	Ca	meq/100g of soil	6.27	8.63
EXCHANGEABLE MAGNESIUM	Mg	meq/100g of soil	3.12	1.99
EXCHANGEABLE SODIUM	Na	meq/100g of soil	0.26	< 0.66
EXCHANGEABLE POTASSIUM	K	meq/100g of soil	1.27	0.66
EXCHANGEABLE HYDROGEN	H	meq/100g of soil	5.3	
ADJ. EXCHANG. HYDROGEN	H	meq/100g of soil	2.35	< 1.99
CATION EXCHANGE CAPACITY	CEC		16.22	
ADJUSTED CEC	Adj.CEC		13.27	
EXCH. SODIUM PERCENTAGE	ESP		1.6	< 5
CALCIUM / MAGNESIUM RATIO	Ca/Mg		2.01	2 - 4
BASE SATURATION PERCENTAGE	BSP		71	

ITEMS		PERCENTAGE OF ADJUSTED CEC	DESIRABLE LEVEL
EXCHANGEABLE CALCIUM	Ca	47.2	65-70%
EXCHANGEABLE MAGNESIUM	Mg	23.5	12-15%
EXCHANGEABLE SODIUM	Na	2	0.5-5%
EXCHANGEABLE POTASSIUM	K	9.6	3-5%
EXCHANGEABLE HYDROGEN	H	17.7	<20%

Soil test results

- Low Ca ppm, % EC,
- Low Copper ppm
- Low Boron ppm

- High N, P, K, Mg Mn + Fe ppm
- High Mg + K EC

- Cation Exchange Capacity – High Mg, K,
- Cation Exchange Capacity – Low Ca

Soil test recommendations

RECOMMENDATION

707 kg of Calcium is needed to raise the Available Calcium to 68% and/or Exchangeable Calcium to 65%

GYPSUM REQUIREMENT	2.71 t/ha			
LIME REQUIREMENT	0.21 t/ha			
DOLOMITE REQUIREMENT	0 t/ha			
MAGNESIUM SULPHATE	0 kg/ha	or	MAGNESIUM OXIDE	0 kg/ha

TOTAL FERTILISER REQUIREMENT (kg/ha)	N	P	K	S
	38	0	0	0

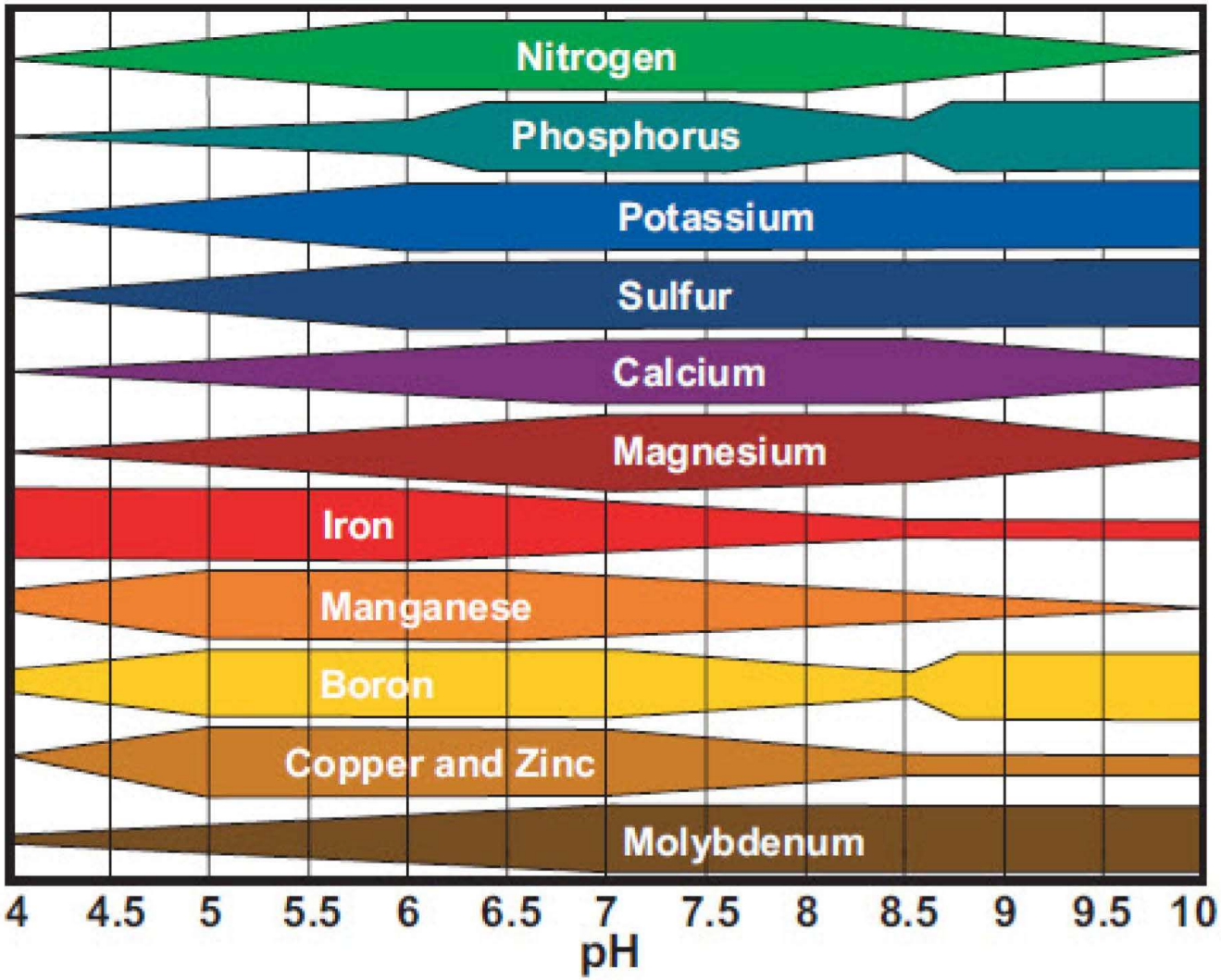
with Trace Elements:

COPPER	2.25 kg/ha
ZINC	0 kg/ha
COBALT	0 kg/ha
MOLYBDENUM	0 kg/ha
IRON	0 kg/ha
MANGANESE	0 kg/ha
BORON	1.13 kg/ha

- Apply Gypsum 1t/Ha over the rooting zone every year for three years
- Apply lime to increase the pH (CaCl) to 6.5
- Use Calcium Nitrate for nitrogen source (N + Ca, not acidifying to the soil)
- Leaf tissue test for trace elements

Getting the basics correct.

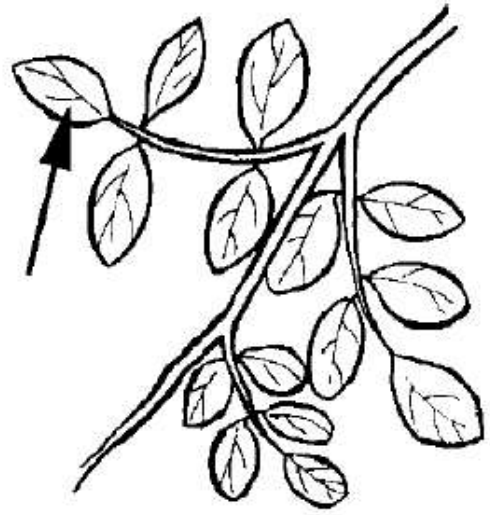
- Get



Nutrient

Element	pH 6.5
Nitrogen (N)	100%
Phosphorus (P)	100%
Potassium (K)	100%

Tissue Testing



English Walnuts

Sample teminal leaflet from a mature leaf.

English Walnut Mid-season (6-8 weeks after bloom)

Terminal leaflets from mature leaves on terminal shoots.

Tissue Testing

FILE NO : 1712131295 **SAMPLE OF:** WALNUT **PAGE NO :** 2

2. Analysis Results

ITEMS			RESULTS	DESIRABLE LEVEL RANGE	
TOTAL NITROGEN*	N	%	4.07	2.50	3.30
TOTAL PHOSPHORUS*	P	%	0.468	0.10	0.30
TOTAL POTASSIUM*	K	%	1.83	1.20	1.30
TOTAL SULPHUR	S	%	0.284		
TOTAL CALCIUM*	Ca	%	0.386		1.20
TOTAL MAGNESIUM*	Mg	%	0.251	0.30	1.00
TOTAL SODIUM*	Na	%	0.0086		
TOTAL IRON*	Fe	ppm	125	50	305
TOTAL MANGANESE*	Mn	ppm	135	30	350
TOTAL ZINC*	Zn	ppm	65.2	20	200
TOTAL COPPER*	Cu	ppm	7.09	4	20
TOTAL COBALT*	Co	ppm	0.0232		
TOTAL BORON*	B	ppm	56.0	35	300
TOTAL MOLYBDENUM	Mo	ppm	0.0136		
TOTAL CHLORIDE*	Cl	%	0.0209		
TOTAL SELENIUM	Se	ppm	Not Requested		

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Tissue Testing Results

- High/ adequate N,P,K
- Low Ca, Mg
- Monitor Zn, Cu, B & Mo

Review of tests.

- Calcium is low for both. Ca exchange is low. Gypsum + Calcium fertilizer is needed.
- N,P,K are adequate for both.
- Soil test had high Mg, tissue test had low Mg, Why?
- Copper (Cu) indicated low for soil and “lowish” for tissue. Noted.
- Boron (B) low on soil and “lowish” on tissue test. Action needed if bearing.
- Zinc (Zn) need to be watched. Zinc is essential for bearing walnuts. Keep on the high side of available.
- Molybdenum (Mo) Tissue test only. Soil testing can not detect such low levels. (annual application to keep N efficient)

Current outcome for the farm...

- Nitrogen 12.4%
- Calcium 12.2%
- Magnesium 3.4%
- Zinc 0.2%
- Boron 0.2%
- S.G 1.49

What does a complete program look like?

- For non bearing trees
  - Correct ratio of Ca + N (1:1)
    - Strong lateral growth, short internodes (options for pruning later)
    - Set a strong structure and canopy for the tree (needs to be able to carry, and mature the nuts later on).
  - Work on getting the soil right (pH, CEC) the crop wants it easy when it begins to set fruit.
  - Manage and set up the tree ready for blossom and fruit set/ fruit fill.

What dose a complete program look like?

- For a bearing or year before bearing we need to refine the program.
- Look at removal data.
- Check traces (tissue testing)
- Know what the soil can deliver and what it may lack
  - You will know what to look for and have a plan in place.

Growing period 1

- Dormancy (winter)
  - Apply soil ameliorants
    - Lime
    - Gypsum
    - Animal litter/ compost
    - Dry fert base

Growing period 2

- Bloom, Spring (October- November)
  - Apply Phosphorus (P) to push the root and shoot development

- Consider foliar sprays for trace elements to ensure there is nothing holding back growth

Growing period 3

- Fruit Development (Summer)
  - Apply Cal Mag + Boron. Gives the tree correct ratio of Ca : N
    - Delivered uniform growth and set the canopy up to hold a high yield.
  - Tissue test 6-8 weeks after bloom.
    - This allows time to alter the program to fix deficiencies that may be present.

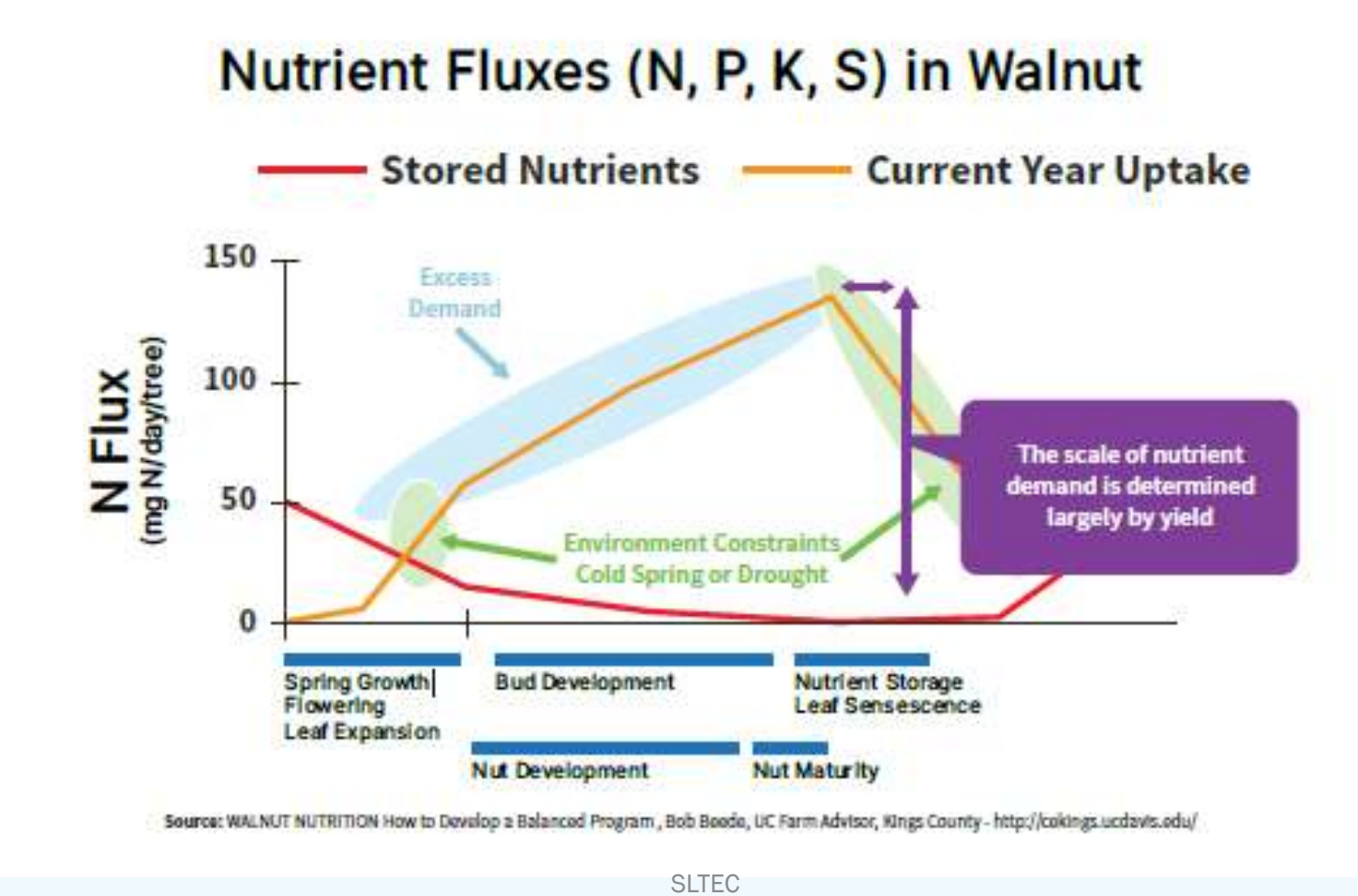
Growing period 4

- Post Harvest (Feb onwards)
  - Apply Cal Mag + Boron
    - This will set the tree up with adequate carbohydrates entering the dormancy. This will allow for strong uniform bud growth next season.
    - For non bearing trees this may not be needed (refer to soil and tissue results) for “post harvest” fertilizer.

Cold and Wet

- Cold and Wet
  - If the crop is affected by a cold and or wet period we recommend a foliar application of Baseline Phos Plus to stimulate growth.
  - Baseline Plus is a blend of 12 nutrients and 4 stimulants with the benefits of added phosphonic acid.

Nitrogen Flux



SLTEC product offering

Product Technical Information

Product Code	Name	N% (w/v)	P% (w/v)	K% (w/v)	S% (w/v)	Ca% (w/v)	Specific Gravity (kg/L)	pH Range	Typical Application Rates	
									Fertigation	Foliar Use at least 100 L/ha water
SS9003	**SS 10:14:0 + Zn™** N as NH_4 10.2%, P as PO_4 13.6%	10.2	13.6	-	-	-	1.27 - 1.28	6.5 - 7.0	10 - 50 L/ha	2 - 10 L/ha
GG0024	**Cal Mag & Boron™** Mg 3.4%, B 0.2%	12.4	-	-	-	12.3	1.49 - 1.50	2.0 - 2.5	10 - 50 L/ha	1% total water rate
GG0064	**Nitro QUAD 3™** N as NO_3 10.3%, N as NH_4 10.3, N as urea 20.7%, C 0.2%, Fulvic Acid 0.008%, Humic Acid 0.2%, Fish Emulsion 0.2%, Kelp 0.2%, Molasses 0.2%	41.4	-	-	-	-	1.32 - 1.33	4.0 - 7.0	10 - 50 L/ha	2 - 20 L/ha
SNPK0046	**TE 8 PLUS™** N as NO_3 2.6, Mg 2.4%, Mn 3.2%, Zn 3.2%, Cu 0.5%, Mo 0.02%, B 0.2%, Fe 0.7%, Fulvic Acid 0.5%	2.6	-	0.1	4.2	-	1.29 - 1.30	1.0 - 2.0	2 - 20 L/ha	2 - 5 L/ha
SNPK0053	**MoBo Complex™** Mo 0.3%, B 14.7%	6.0	-	-	-	-	1.38 - 1.39	7.0 - 8.0	2 - 10 L/ha	1 - 5 L/ha
GG0009	**Baseline Phos Plus™** N as urea 11.7%, P as PO_4 1.4%, P as phosphonic acid 4.7%, Mg 0.2%, Mn 0.006%, Zn 0.01%, Cu 0.005%, Mo 0.005%, B 0.02%, Fe 0.01%, Fulvic Acid 0.01%, Humic Acid 0.3%, Fish Emulsion 0.4%, Kelp 0.4%, Molasses 0.4%	11.7	4.9	13.6	2.0	0.01	1.30 - 1.31	7.0 - 8.0	10 - 50 L/ha	2 - 10 L/ha

SLTEC generic program Non-Bearing and Fruiting

Walnut Program
(Non-Bearing Tree program indicated with "N/B")

Product Code	Product Name	Product Description	Application Method	Total No. of Applications	Total L/kg Applied for Season	Period 1 – Dormancy (Winter)		Period 2 – Bloom (Spring)		Period 3 – Fruit Development (Summer)		Period 4 – Harvest	
						Suggested application timings, methods and rates (L/ha)							
-	**Soil Amendments**	Soil amendments to be applied as per recommendation from a soil test.	Incorporated pre-plant / broadcast if established	1	Rates are dependent on soil test results	N/B							Soil Test
SS9003	**SS 10:14:0 + Zn**	An ideal ratio of ammonium nitrogen and phosphorus and Chelated Zinc with chelated zinc	Fertigation	2	80				N/B 30	N/B 50			
GO0024	**Cal Mag & Boron™**	Plant available nitrogen, calcium, magnesium and boron	Fertigation	10	500					N/B 250 L over 5 Applications			

SLTEC generic program Non-Bearing and Fruiting

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SS9003	SS 10:14:0 + Zn	An ideal ratio of ammonium nitrogen and phosphorus and Chelated Zinc with chelated zinc	Fertigation	2	80				N/B 30	N/B 50			
GG0024	Cal Mag & Boron™	Plant available nitrogen, calcium, magnesium and boron	Fertigation	10	500					N/B 250 L over 5 Applications		250 L over 5 Applications Post-Harvest	
GG0064	Nitro QUAD 3™	UAN with 3% QuadSHOT® to improve availability and crop safety	Fertigation	2	200						100 L over 2 applications		
SNPK0046	TE 8 PLUS™	A foliar multi-trace element blend activated with fulvic acid (0.5%)	Foliar	1	5			N/B 5					20
SNPK0053	MoBo Complex™	Boron Complex enhanced with 0.3% molybdenum to aid in nitrate and sugar metabolism	Foliar	2	4				2	2			
GG0175	Baseline Phos Plus™	A complete (12-5-15) liquid combination of 16 nutrients and biostimulants with the added benefits of phosphonic acid	Foliar	Apply as needed - Foliar stimulant with phosphonic acid to stimulate roots and growth in wet / cold periods									

Outcomes

- Gather all the data you can.
- Make decisions based on science and data.
- Make decisions based on sustainability and economics.

- Doing a bit of a “balanced program” is better than doing a lot of a single nutrient.

- Thank you
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