Plant Nutrition & Crop Quality

By John Guerard
Grimmway Farms

GRIMMWAY FARMS

Grimmway Farms was started by Rod & Bob Grimm in Orange County in 1968

They moved their operation to Bakersfield in the early 1970's growing and packing carrots.

Today Grimmway Farms grows not only carrots but many other vegetables as well.

Grimmway packs & ships both conventional & organic produce exclusively out of Calif. and sells directly to all the major grocery stores and markets in the US and Canada.

VERTICALLY INTERGRATED

- GRIMMWAY FARMS

  CONVENTIONAL FARMING
- CAL-ORGANIC

  ORGANIC FARMING

  GREENHOUSE OPERATION
- KING PAK

  POTATO FARMING
- PREMIER

  CITRUS PACKING

Currently, Grimmway farms around 30,000 acres of carrots and 28,000 acres of organic vegetables.

Two-thirds of the conv. carrots are grown with outside growers.

Owned conv. land is rotated with potatoes, tomatoes, garlic, green beans, and wheat.

We grow over 50 different organic vegetables year round, all on our own fields

Growing areas:

There are two seasons in Bakersfield (S/S, F/W).

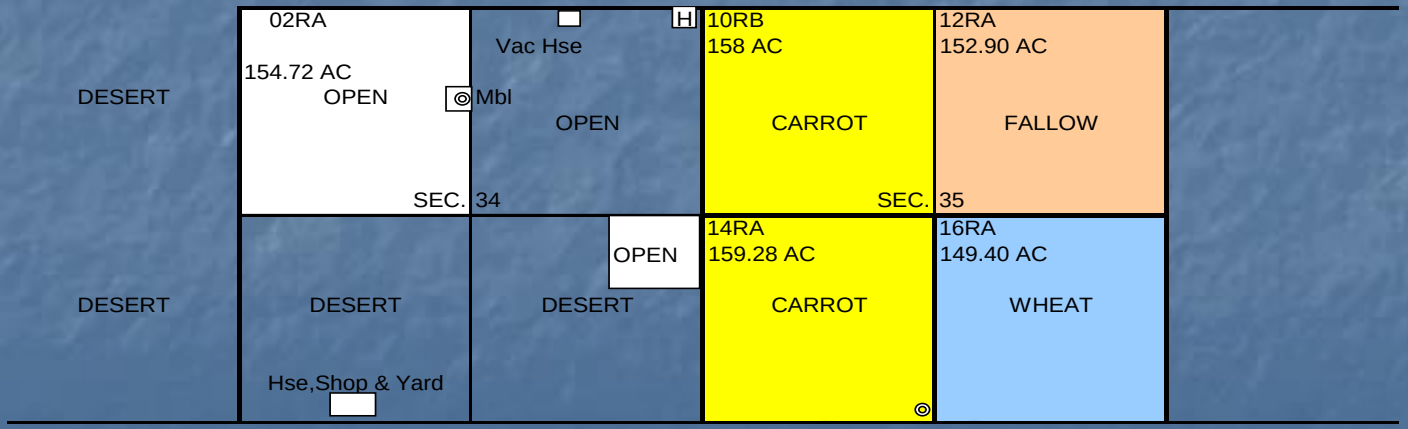
Coachella & Imperial valley's (winter).

Cuyama, Lancaster, Cumming's Valley, Central Coast, Upper San Joaquin Valley, and Colorado (summer)

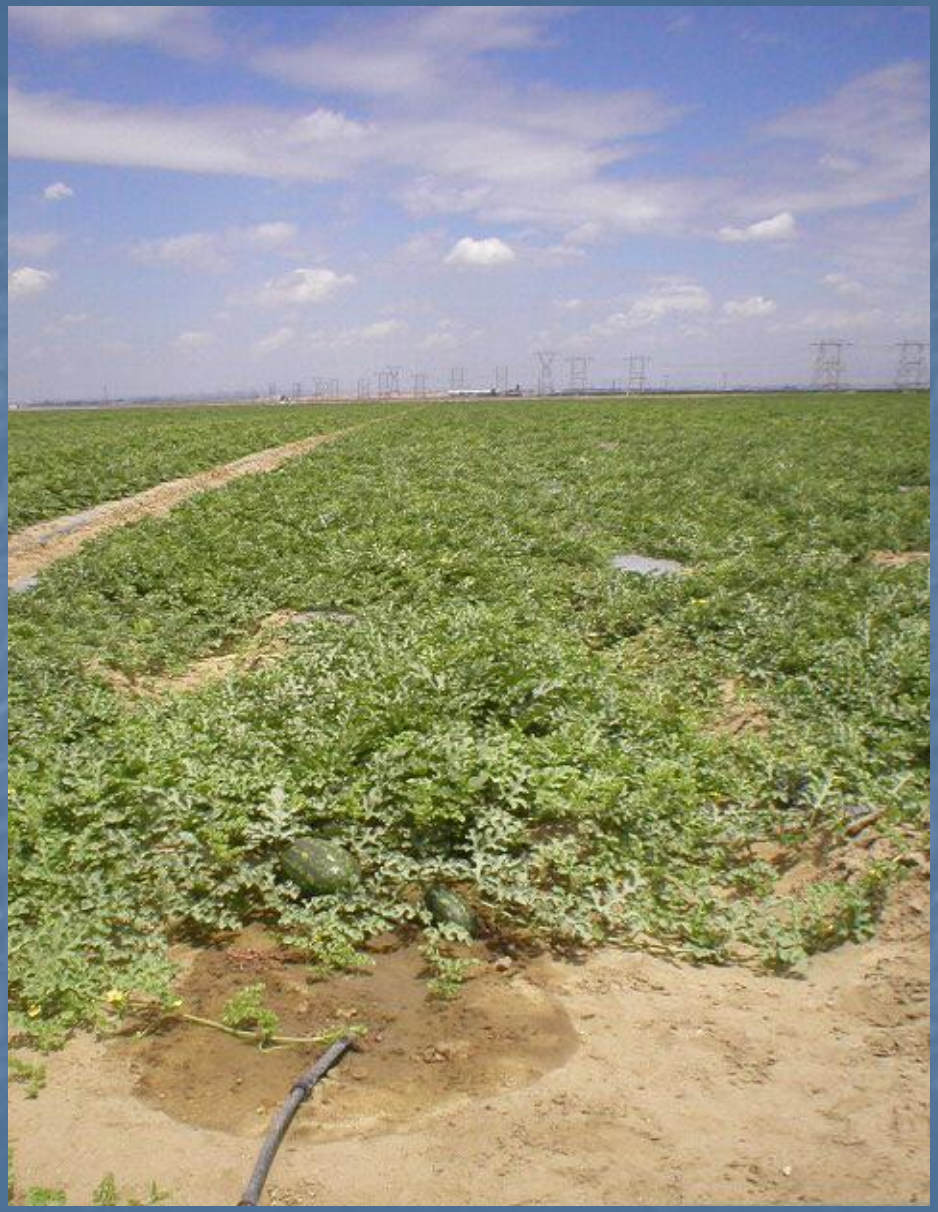
SEASONAL ROTATION

ROTATIONAL STRATEGY

- ALLOWS FIELDS TO FALLOW
- DECREASES DISEASE & NEMATODE PRESSURE ON ANY ONE CROP
- DEMINSHES THE LIKELYHOOD OF DEPLETING SOIL NUTRIENTS BY MONOCROPPING
- HELPS IMPROVE THE SOIL BY INCORPORATING CROP RESIDUE BACK INTO THE SOIL THUS INCREASING THE SOIL MICROBIAL ACTIVITY FOR FUTURE PLANTINGS




Cal-Organic
Healthy by Choice
Organic Cherry Tomatoes
Tomates Cerises Biologiques



How do we manage the fertility in our crops for yield & quality?

Our Fertility Approaches

- Sufficiency vs. Build-Maintenance
- We follow a build-maintenance approach in our fields that we own or control with long term leases.
- We want to remove limiting factors in our fields and build our soils for the next rotational crop.

- We soil sample every field before we plant to determine what fertility is needed for the next crop we're growing.
- A separate fertilizer recommendation is made for each field.

FERTILITY

- FIELDS SAMPLED
- SAMPLES ANALYSED
- RECOMMENDATIONS
- SUPPLIERS
- APPLICATORS N-P-K
- MICRO NUTRIENT APPLICATIONS

FRUIT GROWERS LABORATORY, INC.

Analytical Chemists
www.fglinc.com

November 4, 2011
Grimmway Enterprises
Attn: Farming Division
P.O. Box 179
Arvin, CA 93203

Description : McKittrick Rn 12-1W+12-2; 92.8
Project : #14528; Grimmway Enterprises

Lab ID : VI 1142698-001
Customer ID : 4-15953

Sampled On : October 26, 2011
Sampled By : ID Services
Received On : October 31, 2011
Depth : 0-18"
Meth Irrg. :

CARROT SOIL ANALYSIS

Test Description	Result	Units	Optimum Range	Graphical Results Presentation
				Very Low / Moderately Low / Optimum / Moderately High / Very High
Primary Nutrients				
Nitrate-Nitrogen	17.5	PPM	40 - 70	
Phosphorus	24	PPM	22 - 60	
Potassium (Exch)	260	PPM	80 - 450	
Potassium (Sol)	19	PPM	20 - 160	2%
Secondary Nutrients				
Calcium (Exch)	3330	PPM	2300 - 3100	
Calcium (Sol)	117	PPM	40 - 700	63%
Magnesium (Exch)	224	PPM	240 - 470	
Magnesium (Sol)	13.5	PPM	18 - 110	12%
Sodium (Exch)	40	PPM	0.0 - 220	
Sodium (Sol)	41	PPM	See SAR	19%
Sulfate	120	PPM	29 - 960	
Micro Nutrients				
Zinc	2.9	PPM	1.0 - 50	
Manganese	5.1	PPM	1.4 - 50	
Iron	20.9	PPM	8.0 - 100	
Copper	1.2	PPM	0.20 - 40	
Boron	0.48	PPM	0.30 - 1.0	
Chloride	11.0	PPM	3.5 - 210	
CEC	19.3	meq/100g	Variable	
% Base Saturation				
CEC - Calcium	86.0	%	60 - 80	
CEC - Magnesium	9.53	%	10 - 20	
CEC - Potassium	3.39	%	1.0 - 6.0	
CEC - Sodium	0.917	%	0.0 - 5.0	
CEC - Hydrogen	0.00	%	0.0 - 3.0	
				Strongly Acidic / Moderately Acidic / Near Neutral / Moderately Alkaline / Strongly Alkaline
pH	7.63	---	6.5 - 7.2	

Good — Problem — Indicates physical conditions and/or phenological and amendment requirements.

Note: Color coded bar graphs have been used to provide you with 'AT-A-GLANCE' interpretations.

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November 4, 2011

Grimmway Enterprises

Lab ID : VI 1142698-001
Customer ID : 4-15953
Description : McKittrick Rn 12-1W+12-2; 92.8

CARROT SOIL ANALYSIS

Test Description	Result	Units	Optimum Range	Graphical Results Presentation
Others				Satisfactory / Possible Problem / Moderate Problem / Increasing Problem
Soil Salinity	0.80	mmhos/cm	0.0 - 3.0	
SAR	1.0		0.0 - 6.0	
Carbonate	12	PPM	< 3.0	
Bicarbonate	305	PPM	See Gyp Req.	
Limestone	0.4	%	0 -0.1	
				0 / 1 / 2 / 3 / 4 / 5 / 6
Lime Requirement	0	Tons/AF	---	
Gypsum Requirement	< 0.50	Tons/AF	---	
				Very Low / Moderately Low / Optimum / Moderately High / Very High
Moisture	9.3	%	½ Satn. %	
				Loamy Sand / Sandy Loam / Loam / Silt Loam / Clay Loam / Clay / Organic
Saturation	39.2	%	20 - 60	

Good — Problem — Indicates physical conditions and/or phenological and amendment requirements.

Note: Color coded bar graphs have been used to provide you with 'AT-A-GLANCE' interpretations.

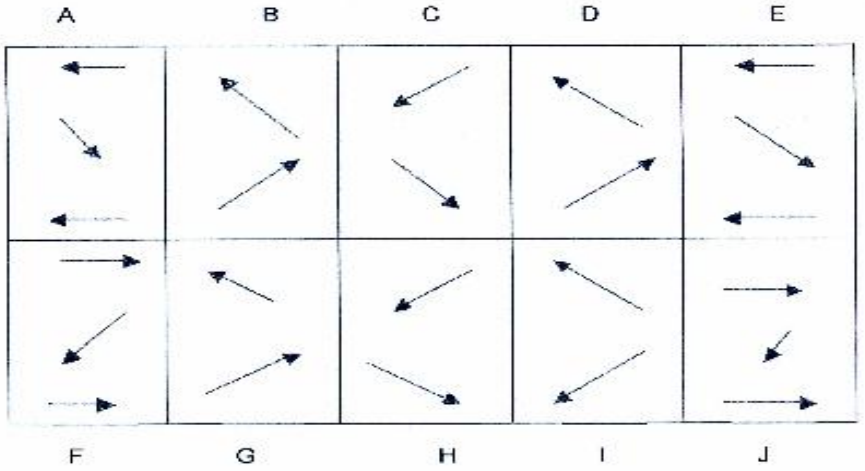
FRUIT GROWERS LABORATORY, INC.

Chad Lessard, Director of Ag. Services

CEL:EHB

NEMATODE SAMPLING

Typical Field Sampling Pattern



100 Acre Field, 10 Samples, 16 Cores Per Sample, 0- 18 “ Deep

NEMATODE RESULTS

NEMATODE SAMPLE ANALYSIS

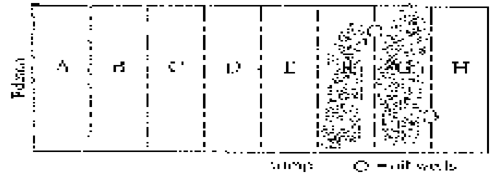
Jeff Bachlitis
Grimmway Enterprises
6900 Mt. View Rd.
Bakersfield, CA 93307

Martin Rios
Bakersfield

Lab #12369
Sampled By: ID Services
Date Sampled: 04/29/09
Date Processed: 05/01/09
Date Reported: 05/01/09

Kildeer Edison 37 09KBS7; 77.05 Acs. Preplant Carrots	Extraction Method SF	Plant Parasitic Nematodes: Stubby Root	Soil Ecology: BF + FF	Soil Ecology: WI
A		NPN	196	128
B		NPN	126	125
C		NPN	196	196
D		NPN	128	128
E		NPN	232	232
F		1	132	132
G		4	196	45
H		NPN	150	150

Field Information
16 cores/sample, 0-18" deep



Comments: (These are general comments only, not a Pest Control recommendation.)
Bacterial and Fungal Feeding Nematode counts under 100 are considered low.
When WI is approximately 1 or less consider cultural nematode management strategies.

Please review the sample map including listed landmarks. Contact the laboratory within 5 days of receipt if there is the possibility that the wrong field was sampled. If no notice is received, it is mutually agreed that the proper field was sampled.

Terms and Extraction Methods

NPN = No Plant Parasitic Nematodes Recovered
BF+FF = Bacterial & Fungal Feeding Nematodes
PP = Plant Parasitic Nematodes
WI = BF+FF/Total PP, excluding Pin
Approximate Extraction Efficiency, EE.
EE varies depending upon soil texture and moisture
Root Knot Larvae: SM = 52% Larvae + eggs; SF = 65% Larvae only
Lesion: SM = 50%

SM = Sieving Mist, Sample volume = 500 cc soil
SF = Sieving Sugar Flotation, Sample volume = 500 cc soil
WR = Washed Roots, Sample data standardized to 20 gm roots
FE = Stained Female Citrus nematodes; data standardized to 1 gm roots
DE = Direct Examination

Alan Butterfield - APCA #4-44-A, CCA #9994
12419 Lytle Ave. - McFarland, CA 93250-9629
Laboratory (661) 792-2031 - Cellular (661) 978-6290

We use a program developed in Excel to make recommendations based on nutrient parameters we establish for each crop we grow.

Fert. Recommendation

Grower: **OG** Date: 11/18/11 Season: **S/S** Grower:
Field: **McKittrick Rn 12-1W+12-2; 92.8**
Sample ID: **VI 1142698-001** Crop: **Carrots** Acres: **92.8** Yld/Acre: **38** Location:

Soil Analysis :

	CEC	pH	NO3-N	P	K	SO4-S	B	Cu	Fe	Mg	Mn	Zn	Ca	Na	OM
Value	19.3	7.6	18	24	256.1	119.6	0.5	1.2	20.9	223.6	5.1	2.9	3327	40.7	
Rating															

Base Saturation % :

	CA%	Mg%	K%	Na%	H%
Value	86.0	9.5	3.4	0.9	
Rating					

Soluble Nutrient Test:

	ECe	Excess L	Bicarb.	SP	SAR
Value	0.80	0.4	305.1	39.2	1.0
Rating					

Recommendation:

	N	P	K	S	B	Cu	Fe	Mg	Mn	Zn
lbs/acre	4	80	150	346	1	3		22	3	5

Fertilizer Mix Required:

	lbs/acre	
MAP (11-52-0)	**34**	4.76%
KCl (0-0-62)	**171**	24.03%
K-MAG (0-0-22-11Mg-22S)	**200**	28.11%
Sulfur (90% pastille)	**300**	42.17%
Boron 15% (Granubor)	**7**	0.94%
Rate:	**711** lbs/acre	100.00%
Total Fertilizer:	**33.01** tons	

Soil Ammendments:

	lbs/acre	
Compost		
Gypsum (75%)		For high sodium and/or low calcium
Sulfur (90% pastille)	**300**	For high sodium and/or high pH (included in mix)
Lime(Dolimite)		For low pH and/or low calcium
Sulfuric Acid		For high sodium & bicarb's and/or high pH

Dry Micros	lbs/acre
ZnSO4 36%	**14**
MnSO4 31%	**10**
FeSO4 30%	
CuSO4 25%	**12**

Liquid Micros	gals/acre
Zn EDTA 9%	1.38889
Mn EDTA 5%	0.96774
Fe EDTA 4.5%	
Cu EDTA 5%	1.19048
Structure	10

Variable Rate Technology

Field: Date: 11/18/11 Yld/Acre: **38**

Location: **Madera 15**

Recommendation:

Zone	Acres		N	P	K	S	B	Cu	Fe	Mg	Mn	Zn	Gypsum	Micro-Sul	Lime/ Dolimite
1	**41.6**	lbs/acre	21	101	298	2	2	3	1		3	5	2000		
2	**31.4**	lbs/acre	17	81	343	2	2	3			3	5	1500		
3	**5.7**	lbs/acre	21	101	313	2	2	3	1		3	5	600		
4	**1.1**	lbs/acre	17	80	196	2	2	1			3	5	600		
		lbs/acre													
		lbs/acre													
		lbs/acre													
		lbs/acre													
		lbs/acre													
		lbs/acre													

Total : 79.8

Fertilizer Required: Lbs/Acre

Zone	MAP	KCL	Boron	Iron	K-MAG	Mn	Zn	Copper	Lbs/A	Total Fert. T/A	Gypsum	Micro-Sul	Lime/ Dolimite
1	194	480	13	3		10	14	12	726	15.12	2000		
2	155	553	13			10	13	12	756	11.86	1500		
3	194	504	13	3		10	14	12	750	2.15	600		
4	154	316	13			10	14	4	511	0.28	600		

Total: 29.40

Bin #:	**2**	**1**	**2**		**1**				VRT=9:	**9**	**9**	**9**
Ave lbs/a:	178	508	13	2		10	13	12				

Application

Field:
Date: **11/18/2011**
Total acres: **79.8**

Main Bin/Trailer #1				
Fertilizer:	**KCL**	**K-MAG**	Total lbs/a	Total tons
Ave lbs/acre:	508		**508**	**20.3**

Supp. Bin/Tailer #2				
Fertilizer:	**MAP**	**Boron**	Total lbs/a	Total tons
Ave lbs/acre:	178	13	**192**	**7.6**

Co-Op Bin			
Fertilizer:		Total lbs/a	Total tons
Ave lbs/acre:			

Amendments:		**Gypsum**			**Micro-Sul**			**Lime/ Dolimite**	
Zone	Acres	lbs/a	Total lbs/a		lbs/a	Total lbs/a		lbs/a	Total lbs/a
1	41.63	2000	83,260						
2	31.38	1500	47,070						
3	5.72	600	3,432						
4	1.08	600	648						
Totals:	**79.8**		**134,410**						
Total tons:			**67.2**						

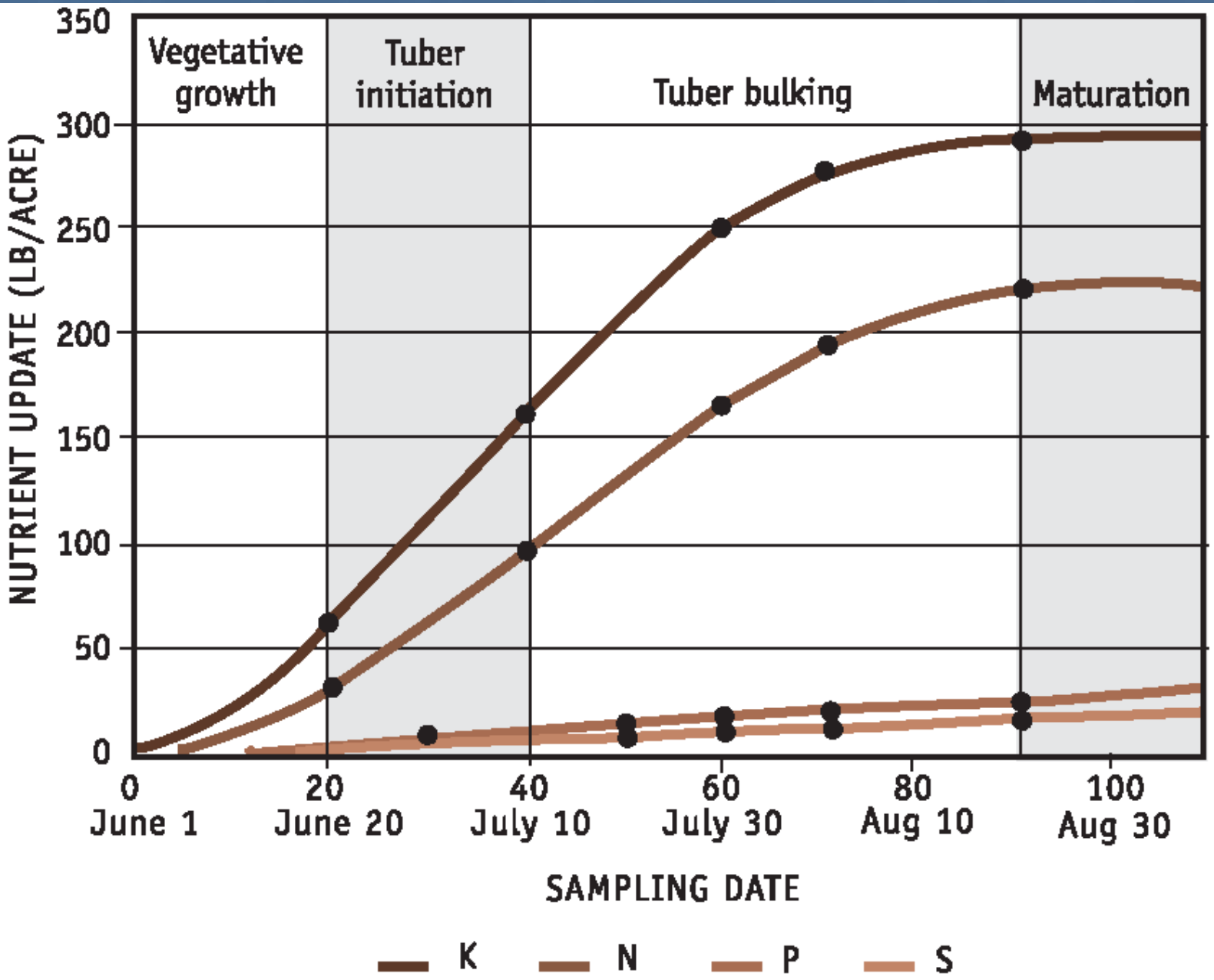
Export

Zone ID	Fert 1	Fert 2	Fert 3	Gyp	Micro-Sul	Lime
1	**207**	**480**	12	2000		
2	**168**	**553**	12	1500		
3	**207**	**504**	12	600		
4	**167**	**316**	4	600		

Charges

Veris	1/2 Veris	Full Prgm.

What we know and don't know about fertility needs/demand curves.


Vegetative growth
Tuber initiation
Tuber bulking
Maturation
NUTRIENT UPDATE (LB/ACRE)
350
300
250
200
150
100
50
0
0
June 1
20
June 20
40
July 10
60
July 30
80
Aug 10
100
Aug 30
SAMPLING DATE
K
N
P
S

What Nutrients Do Carrots Use?

For a 40 ton/acre yield:

	N	P	K
Roots	120	64	240
Tops	100	8	200
Total	220	72	440

Carrot Nutrient Removal:

N	P	K
120	64	240

Amount of nutrients (lbs/a) removed from a 40ton/acre crop.

S	Ca	Mg
8	24	12

Lbs/a removed for 40 ton/acre crop

We use different combinations of macro & micro nutrients based on the crops demand, season, soil, yield goal and quality parameters.

Examples:

- SOP & MOP
- KMS, KMag
- KTS, ATS, CaTS
- UAN 32, CAN 17, AMS, Urea
- MAP, 10-34-0, Ortho liquids
- Micronutrients
- Soil amendments: S, Gyp, Compost, H_2SO_4, CaCl, etc.

- Carrots: N, a lot of K, Ca -
  high beta carotene, color, top health.
- Potatoes: Early N & Ca, K @ bulking -
  internal browning, hollow heart, diseases.
- Tomatoes: Early N, Ca @ bloom, K @ fruiting –
  blossom end rot, disease resist., solids, color.
- Garlic: Early N, K @ bulbing –
  uniform bulb growth, root plate, disease resist.


MATOES

How do we measure our success?

- Yield & pack out results
- Quality parameters- shelf life, color, size, shape, uniformity, etc.
- Tissue & soil samples
- Crop sampling in-season

CARROT TISSUE ANALYSIS - SUMMARY OF CRITICAL LEVELS

04-Nov-11

Nutrient	Puregro Sufficient	Albion Laboratories Optimal	Plant Analysis Handbook II Sufficient	Plant Analysis Handbook II Sufficient	H.W. Otto Univ. Cal Normal Range	Soil Testing & Plant Analysis Oscar Lorenz Common Nutrient Ranges	Fruit Growers Laboratory Critical Levels	Fruit Growers Laboratory Critical Levels	A & L Laboratory Sufficiency
Nitrogen (%)	3.0-4.0	3.00-3.50	2.10-3.50	3.00-3.50	See	2.10-3.50	See	See	3.01-6.00
Phosphorus (%)	0.30-0.60	0.20-0.40	0.20-0.50	0.20-0.40	Below	0.20-0.30	Below	Below	0.20-0.50
Potassium (%)	3.00-4.50	2.50-3.00	2.50-4.30	2.90-3.50		2.50-4.30			3.01-5.00
Calcium (%)	1.20-1.80	1.00-2.00	1.40-3.00	1.00-2.00		1.40-2.00	1.3-3.0	2.0-4.0	1.50-2.90
Magnesium (%)	0.30-0.60	0.25-0.60	0.30-3.0	0.25-0.60		0.43-0.53	0.29-0.60	0.31-0.65	0.20-0.50
Zinc (ppm)	25-100	20-70	25-250	20-250	30-150[2]	20-50	40-150	40-150	26-50
Manganese (ppm)	30-100	50-200	60-300	50-200	40-400	190-325	40-300	40-300	51-200
Boron (ppm)		30-75	30-100	30-75	30-75	29-35	30-100	30-75	30-49
Sodium (%)	0.66-4.00	<0.50					0.65-4.6	0.65-4.6	
Sulfur (%)	0.25-0.46	0.30-1.00							0.21-0.60
Copper (ppm)		5-15	5-15[1]	5-15	5-50	4.5-7.0	5-30	5-30	4-7
Iron (ppm)	30-100	50-200	50-350	50-300	50-500	120-335	59-400	59-400	101-300
Chloride (%)	0.50-1.50								
Molybdenum (ppm)			0.50-1.15	0.50-1.40					
Lithium (ppm)									
Aluminum (ppm)		<250							
Comments:	Petiole, Midgrowth	Leaf + petiole? DRIS	Midgrowth	Mature	When plants are half grown based on weight of carrots.	Midgrowth	Midgrowth	Mature (Root Thickening)	Solutions July/August 1989

1 - Higher values tolerated if fungicides used.
2 - It now appears that carrots should be above 30 ppm for best growth.

Nutrient		Puregro Sufficient
NO_3-N (ppm)	Early	12000-15000
	Mid	7500-11000
	Late	3500-8000
PO_4-P (ppm)	Early	2500
	Mid	2500
	Late	2000
K (%)	Early	6.0
	Mid	6.0
	Late	4.5
Comments:		Petiole, Midgrowth

Nutrient		H.W. Otto Univ. Cal Deficient	 Sufficient
NO_3-N (ppm)	Early		
	Mid	5000	10000
	Late		
PO_4-P (ppm)	Early		
	Mid	2000	4000
	Late		
K (%)	Early		
	Mid	4.0	6.0
	Late		
Comments:		When plants are half grown based on weight of carrots.	

Nutrient		Fruit Growers Laboratory Critical Levels
NO_3-N (ppm)	Early	
	Mid	8000-12000
	Late	10000-15000
PO_4-P (ppm)	Early	
	Mid	3000-5000
	Late	3000-4500
K (%)	Early	
	Mid	5-7
	Late	5-7
Comments:		Late refers to FGL's description of root thickening

Fruit Growers Laboratory

Petiole Analysis Optimum Ranges

Description	Unit	Mid Growth	Mature (thickening)
Nitrate-Nitrogen	ppm	8000 - 12000	10000 - 15000
Phosphate - P	ppm	3000 - 5000	3000 - 4500
Potassium	%	5 - 7	5 - 7
Calcium	%	1.3 - 3.0	2.0 - 4.0
Magnesium	%	0.29 - 0.60	0.31 - 0.65
Zinc	ppm	40 - 150	40 - 150
Manganese	ppm	40 - 300	40 - 300
Iron	ppm	59 - 400	59 - 400
Copper	ppm	5 - 30	5 - 30
Boron	ppm	30 - 100	30 - 75
Sodium	%	0.65 - 4.6	0.65 - 4.6

Challenges of Organic Farming

- Limited choices of fertilizers & amendments.
- Slow release curves and decay series.
- Temperature dependant.
- Crop dependant- length of growing season, depth of rooting, type of crop such as leafy green vs. fruiting or bulbing.
- Soils dependant- soil textures, pH

DISEASES

- BACTERIAL SPECK ON ORGANIC TOMATOES SSJV WINTER 2009
- DOWNEY MILDEW ON ORGANIC SPINACH SSJV SPRING 2009

NEMATODES

FIELD DAY AT IRVINE RESEARCH STATION

- NEMATODE DAMAGE ON CARROTS

- RESISTANT CULTIVARS CONTINUALLY BE BRED, GROWN AND EVULATED TO MEET FUTURE AGRICULTURAL NEEDS

The Future of Vegetables?