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# Irrigated Crop Diversification Corporation Program Report

2012 Southwest Field Projects

December 5, 2012

Heritage Inn, Moose Jaw

Gary Kruger PAg CCA  
Irrigation Agrologist



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# Program Overview

- Stand Termination/Tillage Demo
  - Val Marie, Rush Lake, Miry Creek ID
- Annual Forage Cereals Demo – Val Marie
- Soil Fertility Demo on Forages
  - Fall Banded PK Zn– Alfalfa Yield (Miry Creek ID)
  - Spring Band/Broadcast PK – Alfalfa Yield (Chesterfield ID)
  - Fall Broadcast PKS – Alfalfa Yield (Consul)
  - Soil Test vs Traditional Practice on Barley (Eastend)



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# Program Overview

- Irrigated Salt Tolerant Alfalfa Variety Demo (CSIDC)
- Liebig's Law Fertility Demo on Wheat – nutrient seed treatment & N + K (Luck Lake ID)
- Liquid & Granular Phosphate Demo on Canola (SSRID)
- Foliar Copper for Ergot Control on Spring Wheat (SSRID)
- N rate for Oats on Alfalfa Breaking (CSIDC)
- Irrigation Response of Lentil (CSIDC)



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# Key 2012 Events

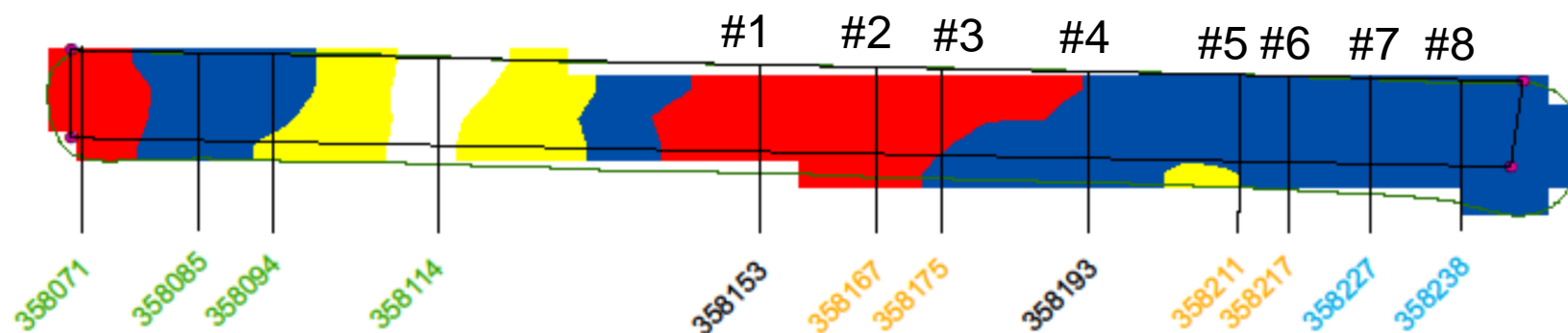
- Dry fall and mild winter with cool wet spring (12 + inches)
- Excellent growing conditions for forage (spring rain may have come a little late)
- Excellent crop in 2012 but less than 2011



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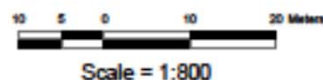
# Alfalfa Sampling Transects at CSIDC



- Transects
- Altered Transects
- New Transects
- Abandoned Transects
- Bounday Line

## Surface from VER


- Non-Saline
- Slightly Saline
- Moderately Saline
- Severely Saline
- Very Severely Saline



Regression  
 $Y = 12.52 X + 51.26$   
 $R \text{ Squared} = 0.90$



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 Saskatchewan Ministry of Agriculture	
Verticalal EM Fall 2010 SE 15-29-08-W3M	
CLIENT: G. Kruger	PROJECT: SE15
DESIGNED: SG, KF, EL, GW	FIGURE: Lower



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# Interpretation of EM38 Readings

Salinity Rating	Saturation Extract $EC_e$ (mS/cm)	EM38 Reading $EC_a$ (apparent conductivity)
Non-saline	0 - 2	0 - 50
Slightly Saline	2 - 4	50 - 75
Moderately Saline	4 - 8	75 - 125
Severely Saline	8 - 16	125 - 200
Very severely saline	> 16	> 200

Henry's Handbook of Soil and Water (2003), p. 80





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# Salt Tolerant Alfalfa Variety Demo

<b>Transect</b>	<b>Mean Vertical EM38 Reading</b>	<b>Salinity Rating</b>	<b>2012 Yield (t/ac)</b>
1	162	Severe	3.642
2	150	Severe	3.884
3	133	Severe	3.981
4	112	Moderate	4.129
5	106	Moderate	3.569
6	106	Moderate	4.119
7	98	Moderate	4.209
8	99	Moderate	4.086



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# Salt Tolerant Alfalfa Variety Demo

North Rep

Photos taken in 2011

South Rep



Variety	2012 Spring Stem Counts (shoots/m <sup>2</sup> )	2011 Forage Quadrat Yield (t/ac)	2012 Forage Harvester Yield (t/ac)
Halo	428	5.91	4.04
CW064027	280	5.44	3.35
AC Bluejay	475	5.05	3.80
Bridgeview	461	4.51	4.05

WL Research  
Haymaker recommends:

- 550 shoots/m<sup>2</sup>
  - No yield loss
- Less than 390
  - Replace stand



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# Alfalfa Stand Density Ratings

Age of Stand (yr)	Stand Density (Plants/sq.ft.)		
	Poor	Marginal	Good
1	< 10	10 - 11	15 +
2	< 8	8 - 10	10 +
3	< 6	6 - 8	8 +
4	< 4	4 - 5	5 +

Stem Density (stem/sq.ft.)	Recommended Action
➤ 55	Stem density not limiting yield
40-55	Some yield reduction expected
< 39	Consider replacing stand

Source: [http://www.wlresearch.com/stellent/groups/public/documents/web\\_content/ecmp0098718.pdf](http://www.wlresearch.com/stellent/groups/public/documents/web_content/ecmp0098718.pdf)



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# PK Fertilization of Established Alfalfa Chesterfield Irrigation District

Bill Coventry - Mantario

- Treatments

1) Control

2) P Broadcast

3) P Band

4) K Band

5) PK Broadcast

6) PK Band

Fertilizer application – May 2, 2011



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# Chesterfield Irrigation District – Soil Test Results

										NEUTRAL AMMONIUM ACETATE (EXCHANGEABLE)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
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NITRATE-N (FIA)										DTPA EXTRACTION									
Surface			Sub 1			Sub 2			Total	SULFUR S ICAP	ZINC Zn	MANGANESE Mn	IRON Fe	COPPER Cu	BORON B	EXCESS LIME RATE	SOLUBLE SALTS 1:1		
ppm	lbs/A	depth IN	ppm	lbs/A	depth IN	ppm	lbs/A	depth IN	lbs/A	ppm RATE	ppm RATE	ppm RATE	ppm RATE	ppm RATE	ppm RATE		mmhos/ cm	RATE	
6	11	0-6							11	10 L	1.7 M	3 VL	36 VH	1.1 M	0.6 L	L	0.3	L	

## SOIL FERTILITY RECOMMENDATIONS (POUNDS PER ACRE) by MIDWEST LABORATORIES

AMPLE ID	CROP		YIELD GOAL	SOIL AMENDMENTS				N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	Mg	S	Zn	Mn	Fe	Cu	B
	INTENDED	PREVIOUS		LIME LBS/A of CaCO <sub>3</sub>	LIME TONS/A 90 % ECCE	GYPSUM TONS/A	ELEMENTAL SULFUR LBS/A	NITROGEN	PHOSPHATE	POTASH	MAGNESIUM	SULFUR	ZINC	MANGANESE	IRON	COPPER	BORON
280085	ALFALFA - ton	ALFALFA - ton	4					–	75	180	--	14	0.7	2.8	--	--	1.2
	BARLEY FEED - bu	ALFALFA - ton	100					70	45	40	--	12	0.7	2.5	--	--	--



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# PK Fertilization of Established Alfalfa

## Chesterfield Irrigation District

### 2012 Pre Bloom Alfalfa Plant Tissue

Treatment	N (%)	P (%)	K (%)	S (%)	Zn (ug/g)	Mn (ug/g)	B (ug/g)
Control	4.4	0.34	2.3	0.33	37	24★	31
P Band	4.2	0.32	1.8★	0.29	29	19★	25★
P Broadcast	4.0	0.32	1.8★	0.30	27	19★	25★
PK Band	3.6★	0.28	1.9★	0.23★	30	32	16★
PK Broadcast	4.4	0.32	2.0	0.31	27	21★	28★
K Band	4.3	0.34	2.5	0.33	34	22★	32
Alfalfa Threshold	2.5	0.25	2.0	0.25	20	25	30

4.4 X 6.25 = 27.5% Protein

Samples collected June 15, 2012



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# Chesterfield June 1 Alfalfa Plant Tissue Sample

Date Received 07-Jun-12

Test Package PM1

Plant Sample ID 106165

Appearance Healthy

Date Sampled 01-Jun-12

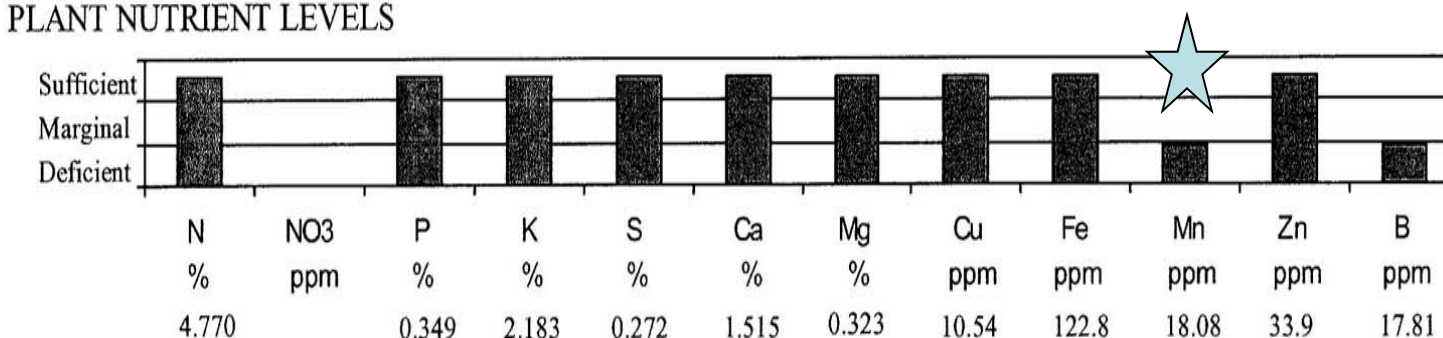
Crop **Alfalfa**

Plant Part **Whole Plant  
(aboveground)**

Growth Stage **Vegetative**

Variety

## PLANT NUTRIENT LEVELS



Sufficeint  
Above  
Marginal  
Above

4.5		0.25	2	0.25	0.5	0.3	3	45	25	20	30
4		0.2	1.5	0.2	0.25	0.2	2.5	40	20	15	20

## NUTRIENT RECOMMENDATION RATES (lb actual/ac)

Nutrient	N	P O <sub>2</sub> 5	K O <sub>2</sub>	S	Ca	Mg	Cu	Fe	Mn	Zn	B
	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0.15 - 0.45	0 - 0	0.3 - 0.35



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# PK Fertilization of Established Alfalfa Chesterfield Irrigation District

Treatment	Nutrient Applied (lb/ac)	Blend Analysis	Rate of Fertilizer (lb/ac)	2011 1 <sup>st</sup> Cut Hay Yield (ton/ac)	2012 1 <sup>st</sup> Cut Hay Yield (ton/ac)
Control	None	None	None	2.49 ton/ac	2.91 ton/ac
P Broadcast	16-75-0-0	11-52-0	144 lb/ac	3.48 ton/ac	2.58 ton/ac
P Band	16-75-0-0	11-52-0	144 lb/ac	3.29 ton/ac	2.71 ton/ac
K Band	16-0-75-0	10-0-47-0	160 lb/ac	3.40 ton/ac	2.10 ton/ac
PK Broadcast	16-75-75-0	6-28-28-0	270 lb/ac	3.08 ton/ac	2.75 ton/ac
PK Band	16-75-75-0	6-28-28-0	270 lb/ac	3.33 ton/ac	3.03 ton/ac



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# PK Fertilization of Established Alfalfa Chesterfield Irrigation District 2012 1<sup>st</sup> Cut Yields

- Broadcast P vs Band P  
2.58 ton/ac 2.71 ton/ac
- Broadcast PK vs Band PK  
2.75 ton/ac 3.03 ton/ac
- Banding benefit of 0.25 ton/ac



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# Manganese



- Symptoms occurred on sandy loam soil with high pH (8.1)
- High pH enhanced in 2012 by above average rainfall
- Low soil test at Miry Creek and Chesterfield
- Low Mn plant tissue test at Chesterfield



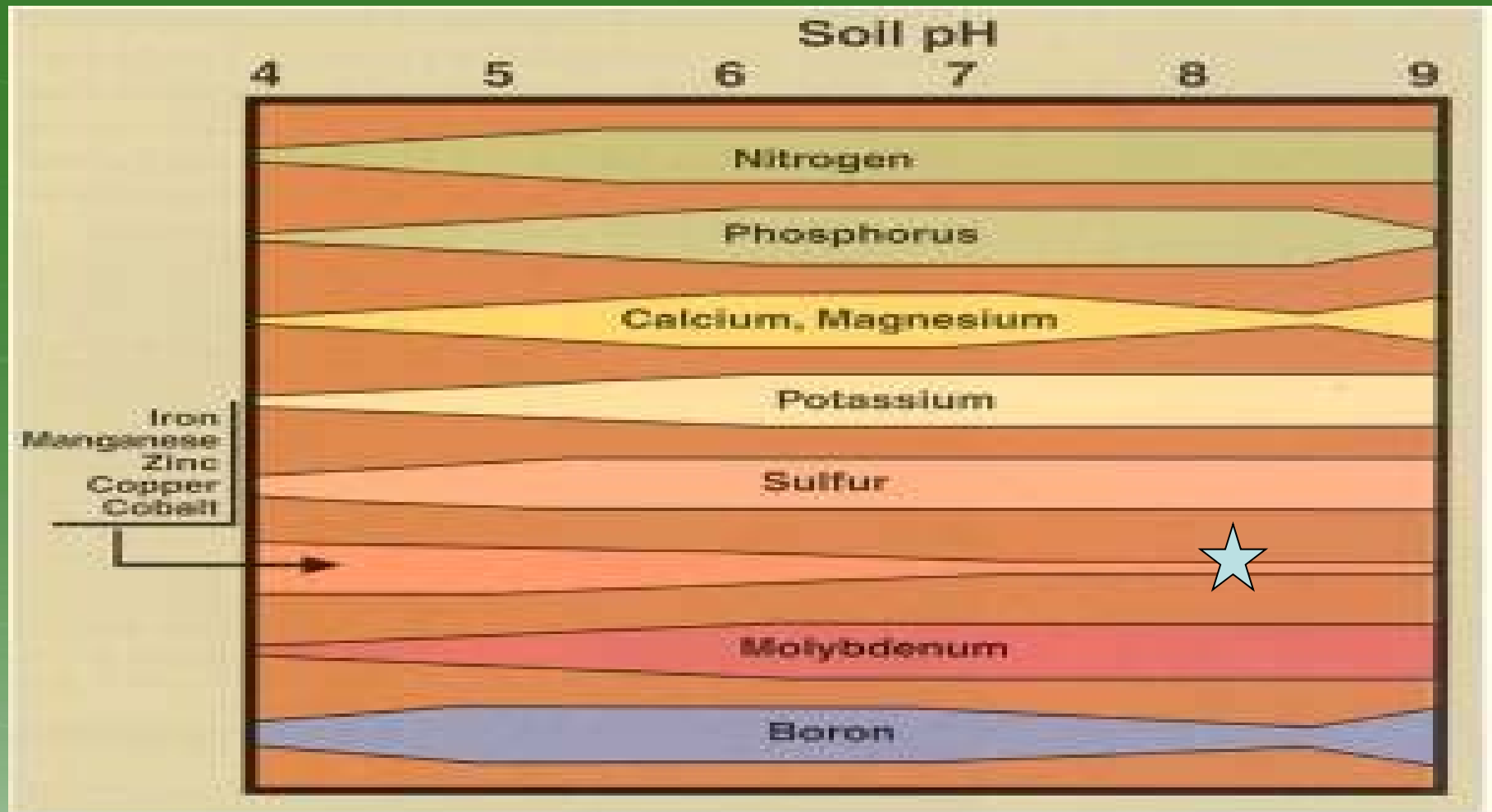
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# Soil pH and Nutrient Availability



<http://www.extension.org/pages/9875/soil-ph-and-nutrient-availability>



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# Manganese

- Manganese deficiency
  - root rot noted when symptoms were visible
  - damage to alfalfa plant density already done
  - contributed to stand decline in alfalfa
  - yellowing symptoms self corrected when rains stopped and soils dried out
  - one possible mechanism for decline of alfalfa as stands age



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# Liebig's Law of the Minimum



- The yield potential of a crop is like a barrel with staves (nutrients) of unequal length.
- The capacity of the barrel is limited by the length of the shortest stave and can only be increased by lengthening that stave.
- When that stave is lengthened, another stave becomes the limiting factor.

[http://www.microsoil.com/  
liebigs\\_law\\_of\\_the\\_minimum.htm](http://www.microsoil.com/liebigs_law_of_the_minimum.htm)



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# Soil Analysis - Plot 13 at Miry Creek Fall 2010

SAMPLE IDENTIFICATION	ORGANIC MATTER		PHOSPHORUS						NEUTRAL AMMONIUM ACETATE (EXCHANGEABLE)						pH	CATION EXCHANGE CAPACITY	PERCENT BASE SATURATION (COMPUTED)							
									POTASSIUM	MAGNESIUM	CALCIUM	SODIUM	pH	CATION EXCHANGE CAPACITY			PERCENT BASE SATURATION (COMPUTED)							
									K	Mg	Ca	Na					pH	CATION EXCHANGE CAPACITY	PERCENT BASE SATURATION (COMPUTED)					
																			% K	% Mg	% Ca	% H	% Na	
L.O.I.	WEAK BRAY 1:7	STRONG BRAY 1:7	BICARBONATE P OLSEN	K	Mg	Ca	Na	1:1	C.E.C.	% K	% Mg	% Ca	% H	% Na										
PERCENT RATE	ppm	RATE	ppm	RATE	ppm	RATE	ppm	RATE	ppm	RATE	ppm	RATE	1:1	INDEX	meq/100g									
280081	2.2	L	8	L	44	H	12	M	322	H	1061	VH	4476	H	183	H	8.5		32.8	2.5	27.0	68.1		2.4

NITRATE-N (FIA)										DTPA Extraction														EXCESS LIME RATE	SOLUBLE SALTS 1:1	
Surface			Sub 1			Sub 2			Total	SULFUR S ICAP		ZINC Zn		MANGANESE Mn		IRON Fe		COPPER Cu		BORON B						
ppm	lbs/A	depth IN	ppm	lbs/A	depth IN	ppm	lbs/A	depth IN	lbs/A	ppm	RATE	ppm	RATE	ppm	RATE	ppm	RATE	ppm	RATE	ppm	RATE					
17	31	0-6							31	12	L	1.0	L	2	VL	15	M	2.3	VH	1.9	VH	M	0.6	L		

## SOIL FERTILITY RECOMMENDATIONS (POUNDS PER ACRE)

SAMPLE ID	CROP		YIELD GOAL	SOIL AMENDMENT				N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	Mg	S	Zn	Mn	Fe	Cu	B
				LIME	LIME	GYPSUM	ELEMENTAL	NITROGEN	PHOSPHATE	POTASH	MAGNESIUM	SULFUR	ZINC	MANGANESE	IRON	COPPER	BORON
	INTENDED	PREVIOUS		LBS/A of CaCO <sub>3</sub>	TONS/A 90 % ECCE	TONS/A	SULFUR LBS/A										
30081	ALFALFA - ton	UNKNOWN	3				20	--	40	--	--	9	1.8	2.3	--	--	--
	WHEAT SPRING -bu	UNKNOWN	50				20	85	25	10	--	5	1.3	1.8	--	--	--





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## Demonstration Layout on Plot 13 at Miry Creek

Fertilizer Banded  
November 6, 2010

West Control

12-15 in. H<sub>2</sub>O =  
50-75 lb S/ac/yr

100 lb P<sub>2</sub>O<sub>5</sub>

Annual Alfalfa  
Removal = 30 lb S/ac

120 lb K<sub>2</sub>O

100 lb P<sub>2</sub>O<sub>5</sub> + 120 lb K<sub>2</sub>O + 4 lb Zn

100 lb P<sub>2</sub>O<sub>5</sub> + 120 lb K<sub>2</sub>O

East Control

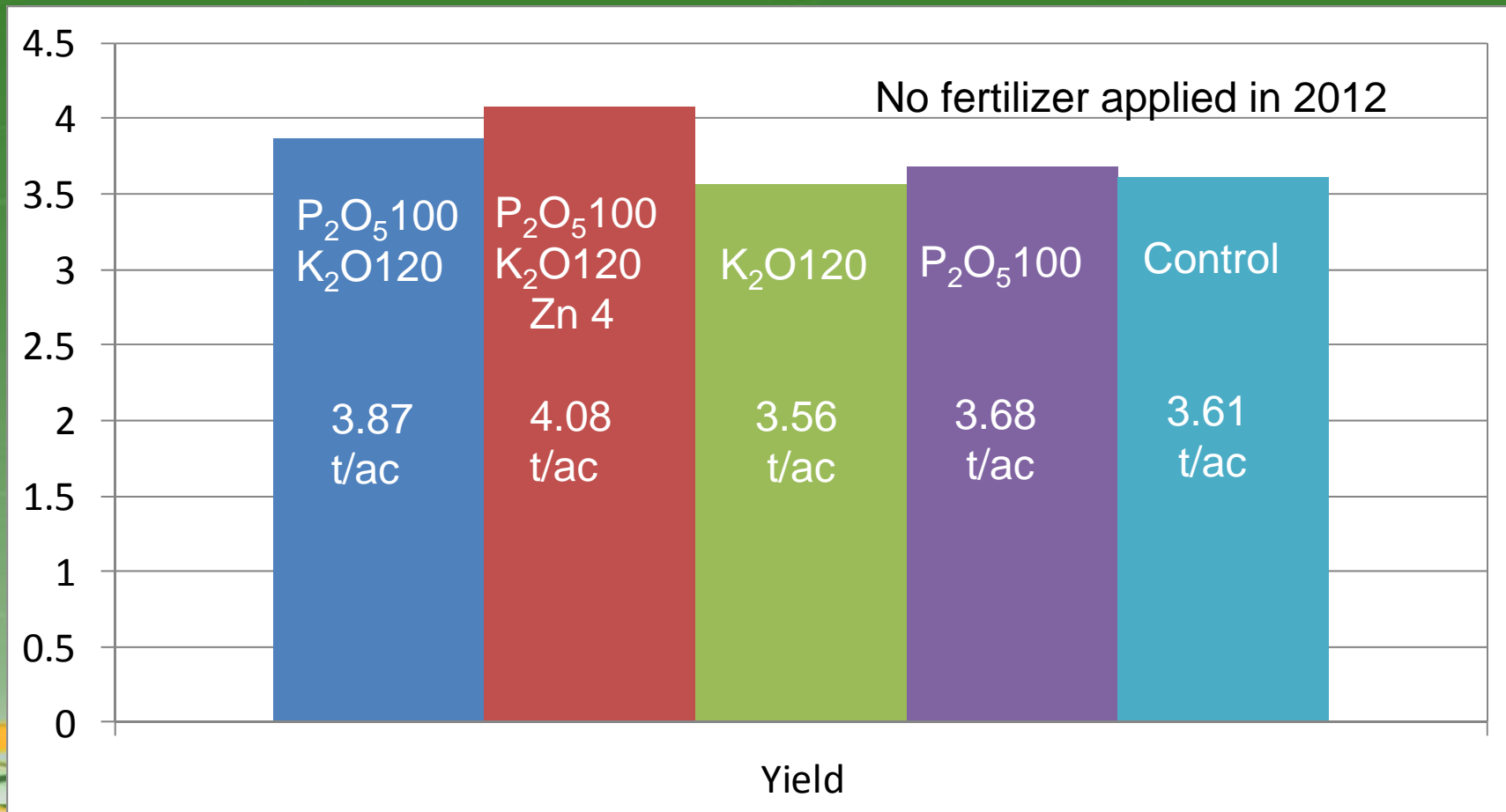


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# Miry Creek 2012 2-cut Alfalfa Yield (ton/ac)





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# Miry Creek 2012

## Plant Tissue and Yield Results

Treatment	Cost (\$/ac)	N (%)	P (%)	K (%)	Mn (%)	Zn (%)	Yield (ton/ac)	Relative Yield
P100K120	\$130	4.25	0.37	2.4	32	20	3.87	1.07
P100K120Zn4	\$155	4.36	0.38	2.3	34	28	4.08	1.13
P100	\$70	4.26	0.35	2.2	34	21	3.68	1.02
K120	\$60	3.45	0.32	2.3	29	24	3.56	0.99
Control	--	4.20	0.37	2.3	35	25	3.61	
Adequate		4.00	0.25	2.0	25	20		

Soil Sample suggested P, K, S, Mn, and Zn required – Only P, K, and Zn applied

Plant Tissue suggested P, K, S, Mn were adequate for first cut



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# Irrigated Annual Forage Cereal Demo@ Val Marie

Crop	Green Feed Yield (t/ac)
Barley – CDC Cowboy	2.16
Oats – Pinnacle	2.06
Spring Rye - Gazelle	1.71
Spring Triticale (awnless) - Tyndal	1.50



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# Stand Termination Tillage Strategies

- Objectives
  - 1) Reduce tillage passes required to prepare field for sowing back to alfalfa
  - 2) Improve water infiltration during irrigation

## Locations

Val Marie – Lynn Grant

Rush Lake – Darren Steinley

Miry Creek – Bob Stuart



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# Stand Termination Tillage Strategies Moisture Conservation

Treatment	Depth (cm)	Val Marie	Miry Creek
		Available Water (mm)	Available Water (mm)
CTS Tilled	0-30 cm	53	47
	30-60 cm	43	63
	60-90 cm	26	71
	Total	122	181
No Till	0-30 cm	53	44
	30-60 cm	49	50
	60-90 cm	50	53
	Total	152	147
		(-30) for Tilled	(+34) for Tilled





Broken Foxtail Barley  
Sod at Rush Lake



Breaking Alfalfa at  
Miry Creek



Tilling Barley Stubble  
at Val Marie



Salt Crystals on Surface of  
Soil Cores at Rush Lake





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# Stand Termination Tillage Strategies

Location	Treatment	Spring Stored Moisture (mm)	Green Feed Yield (ton/ac)
Val Marie	Unworked	153	2.47
	Worked 7 inches deep	122	2.50
	Worked 10 inches deep	---	2.77
Miry Creek	Unworked	147	2.56
	Worked 7 inches deep	181	2.46





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# 2012 Learnings

- Determine presence of hardpan within soil profile to indicate potential for benefit
- More effective during dry falls
- Moisture needed for following year to restore moisture for crop production
- Will effect persist for several years?
- Fuel cost high for process
- Iron (hardware) cost significant



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# Liquid and Granular Phosphate

P Soil Test - Conventional 50 lb  $P_2O_5$  for 100 bu  
- PRS Membrane 20 lb  $P_2O_5$  for 64 bu

Treatment	% P in Plant Tissue	Canola Yield (bu/ac)
No Granular, No Liquid	0.54	33.5
No Granular, 13 l/ac Liquid	0.47	33.9
No Granular, 22 l/ac Liquid	0.63	33.9
20 $P_2O_5$ /ac, No Liquid	0.73	33.1
20 $P_2O_5$ /ac, 13 l/ac Liquid	0.76	20.4* *Waterlogging
20 $P_2O_5$ /ac, 22 l/ac Liquid	0.61	33.4

Seeding Date – June 6



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# N rate for Irrigated Oats on Terminated Alfalfa Stubble

- High rates of N release under good moisture conditions
- Two varieties – Triactor and CDC Haymaker
- N rates – 0, 25, 50, 75, 100 and 125 kg/ha
- Seeding date – May 31, 2012



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# N rate for Irrigated Oats on Terminated Alfalfa Stubble

Oat Variety	Grain Yield (bu/ac)	Forage Yield (t/ac)
Triactor	114.8	6.23
CDC Haymaker	120.2	6.04

N rate (kg/ha)	Grain Yield (bu/ac)	Forage Yield (t/ac)
0 N	126.7 a	5.48
25 N	120.7 ab	6.47
50 N	121.9 ab	6.03
75 N	113.6 bc	6.40
100 N	113.9 bc	6.35
125 N	108.3 c	6.08
LSD (0.05)	11.1	NS



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# Sulphur

- Rain leaches S in sandy loam soil
- Roots of annuals need to reach deeper soil to access sufficient S
- Suspected for alfalfa at Consul, Miry Creek and Chesterfield based on soil test and based on plant tissue in 2011 at Chesterfield



<http://landresources.montana.edu/soilfertility/sdeficiency.html>



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# P, K, B, & S Fertilization

Treatment	Product Applied (lb/ac)	N (lb/ac)	P <sub>2</sub> O <sub>5</sub> (lb/ac)	K <sub>2</sub> O (lb/ac)	S (lb/ac)	Yield (ton/ac)
P Broadcast	17-34-0 @ 173 lb/ac	29	75	0	0	2.37
PK Broadcast	10-25-25-0 @ 298 lb/ac	29	75	75	0	2.69
PKS Broadcast	9-23-22-4 @ 332 lb/ac	29	75	75	15	2.48
PS Broadcast	14-36-0-7 @ 207 lb/ac	29	75	0	15	2.76



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# P, K, B, & S Fertilization

## Plant Tissue Analysis - Consul

Treatment	N (%)	P (%)	K (%)	S (%)	Cu (ppm)	Fe (ppm)	Mn (ppm)	Zn (ppm)	B (ppm)
P Broadcast	4.0	0.33	2.7	0.34	8	99	40	31	37
PK Broadcast	4.0	0.34	2.9	0.38	9	92	35	32	46
PKS Broadcast	4.2	0.35	3.0	0.34	9	67	31	32	42
PS Broadcast	4.2	0.32	2.9	0.36	9	68	30	32	43
<b>Threshold</b>	<b>4.5</b>	<b>0.25</b>	<b>2.0</b>	<b>0.30</b>	<b>8</b>	<b>50</b>	<b>20</b>	<b>20</b>	<b>30</b>



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# Conclusion

- Saline soil reduces crop growth but waterlogging is another constraint
- Soil and plant tissue testing are important tools for managing forage production
- The obvious solution is often not the complete solution. All growth factors need to be considered to provide the best solution!!



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# Acknowledgement

- ADOPT – Agricultural Demonstration of Practices and Technology
- Crop Production Services – Outlook
  - blending services

G-Mac's Ag Team – Leader and Eatonia

- fertilizer application

- Cargill AgHorizons Rosetown – supplies
- Salford Farm Machinery Ltd.- tillage
- Nexus Ag – Cu and Zn fertilizer
- United Agri Products – Mn fertilizer



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# Our Cooperators

- Greg Oldhaver – Cabri
- Russ Swihart – Consul
- Scott Sanderson – Consul
- Larry Verpy – Eastend
- Andy Perrault – Ponteix
- Pat Hayes – Val Marie



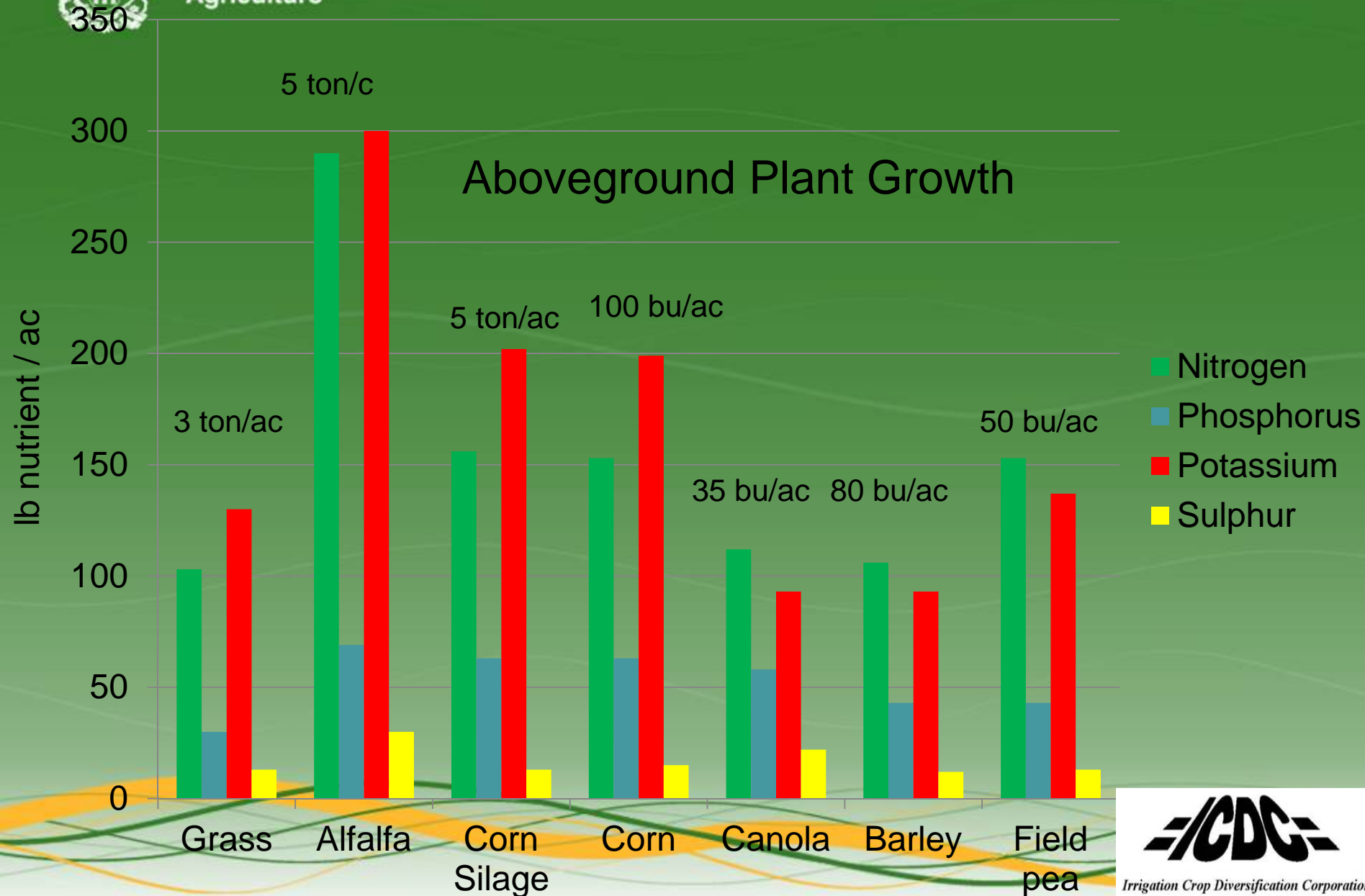
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# Nutrient Uptake

Canadian Fertilizer  
Institute, 2001



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# Zinc

- Zinc band has deeper green color
- Important for land leveled or eroded soils
- Need to address P, K and S status before considering zinc
- Band application more effective than broadcast
- 4 lb/ac treatment likely adequate for life





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# Sulphur



- Affected plants are lime green on newer growth
- S does not translocate well within the plant
- Patchy symptoms due to sulphate distribution at depth
- Easily corrected with broadcast application of 20 lb/ac sulphate in blend

<http://www.channel.com/Agronomics/Pages/Consider-Alfalfas-Heavy-Fertilizer-Use.aspx>



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# Manganese

- Soil applications effective for only one year in high pH soils.
- Correction of Mn chlorosis very rapid with foliar applications (1 hour)
- Will set up project in 2013 with Mn to verify yield response
- Observed 0.4 ton/ac alfalfa in New Jersey



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# Potassium

- Soil supply depleted by high forage uptake and limited nutrient return to soil (hay removal)
- Observed at Chesterfield in 2012
- Monitor plant tissue K



Source: [enst.umd.edu](http://enst.umd.edu)

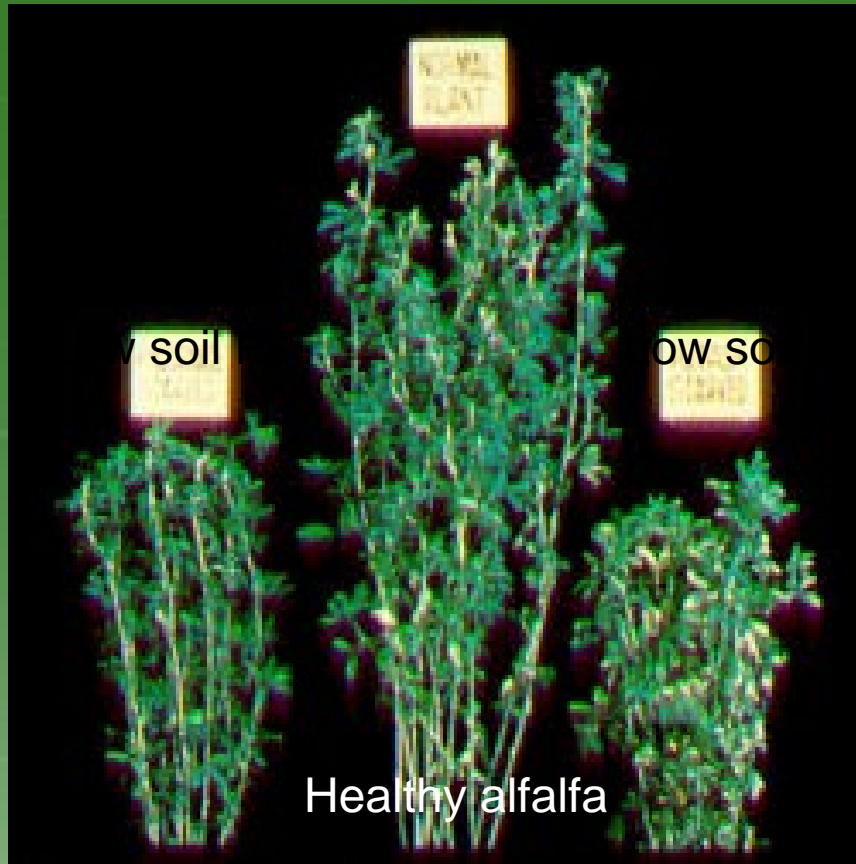


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# Phosphorus



- Deficient plants are stunted
- Leaves are small and bluish green (dark)
- Thin and weedy stands
- May be yellowish in color similar to N or S deficiency

- <http://www.agf.gov.bc.ca/cropprot/alfalfadis.htm>



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# General Fertilization Prescription for Forages

- Alfalfa – Broadcast P @ 50-75 lb  $P_2O_5$ /ac/yr  
in fall or spring
- Grass – Broadcast N @ 100 lb N/ac/yr  
in fall or spring
  - Problems with this approach
    - Variable yield response
    - Adjustment needed for previous year's nutrient removal
    - Focus needed on balanced nutrient supply
    - Soil has a memory!!!



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# Considerations

- Soil has a memory
  - Cropping history
  - Grazing pressure
  - Erosion events
  - Land leveling
  - Manure and fertilizer applications
- Yield goal
- Soil texture
- Soil pH
- Soil salinity
- Soil density
- Anticipated moisture  
(stored soil + rainfall + irrigation)





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# Tools to help

- Soil testing
- Plant tissue analysis (feed testing)



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# Conclusion

- Forages need more than P to produce optimum forage yield
- Soil testing and plant tissue analysis are powerful tools to lead you to the answers for your fields



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