



Sunflower Special Topics: Nutrient Requirements of Sunflower

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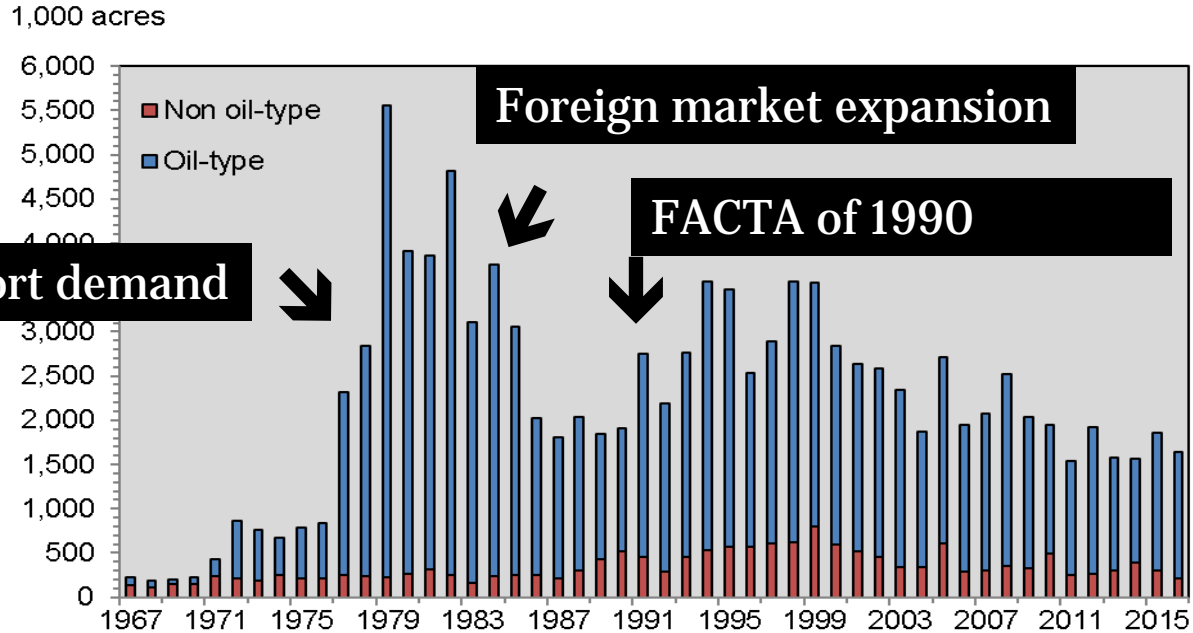
Outline

- Introduction
 - Total production
 - Geographic distribution
 - Economics
- Nutrient removal
- Nitrogen
- Phosphorus
- Potassium
- Sulfur
- Other nutrients



Introduction – Historical US Production

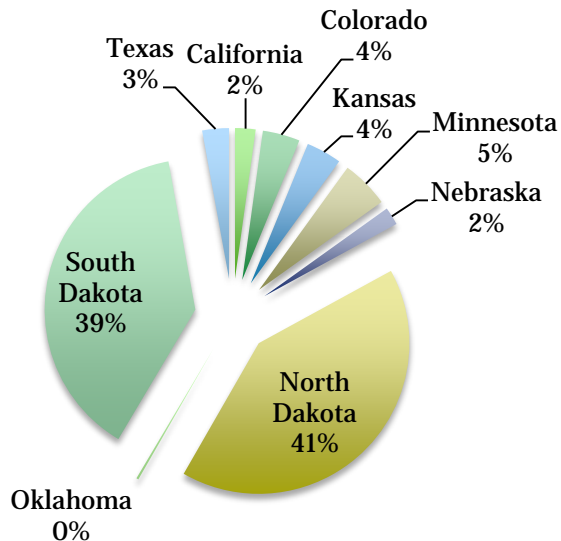
U.S. sunflower planted acres



Source: USDA, National Agricultural Statistics Service, Crop Production--Annual Summary.

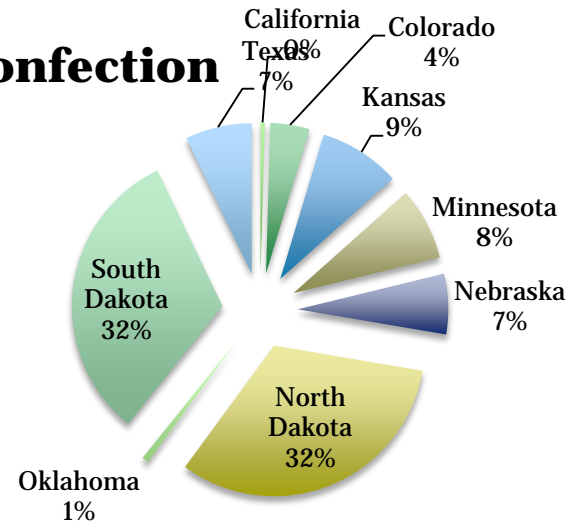
Introduction — Production Geography

Type: Oil



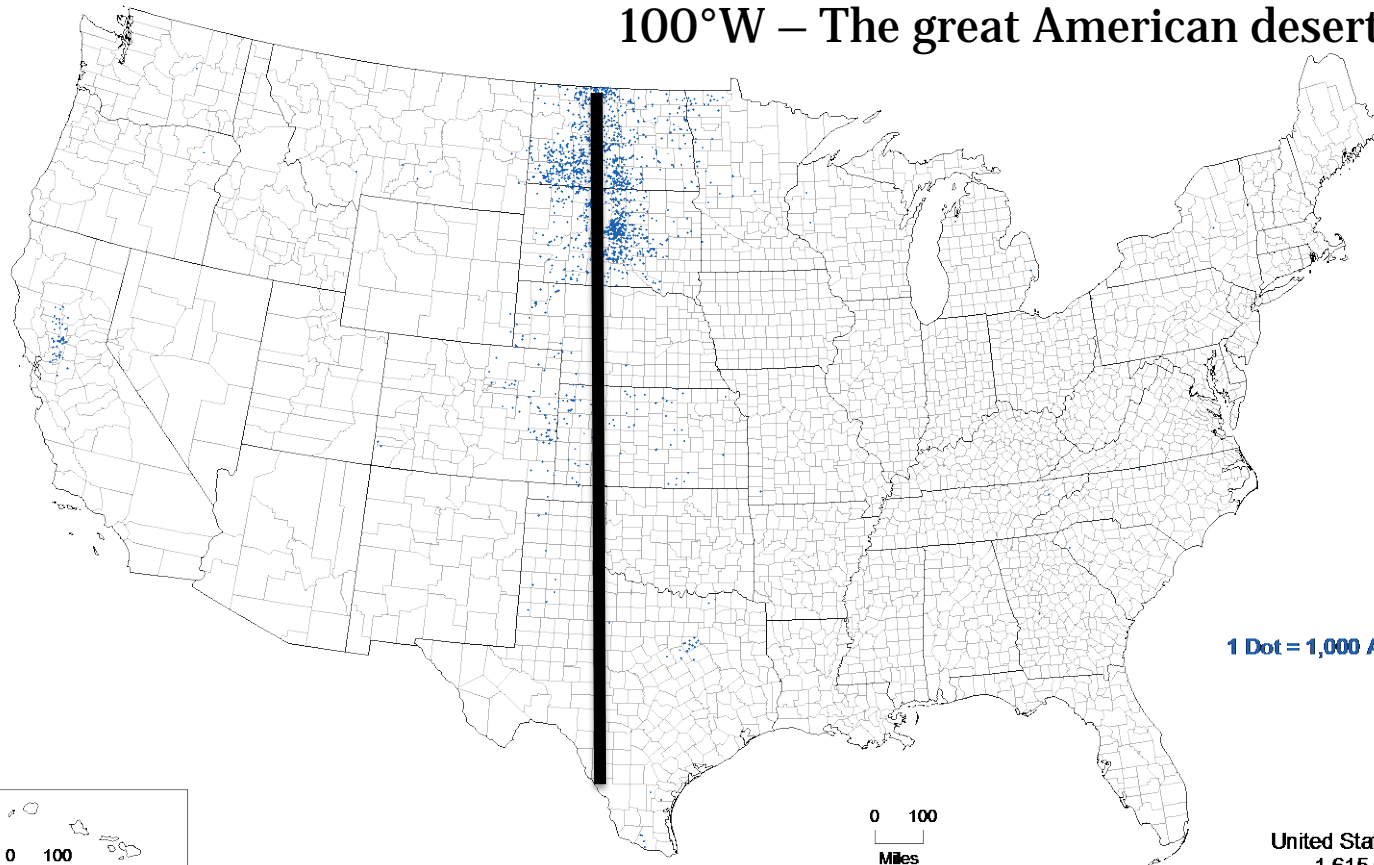
Total Acres: 1,550,500

Type: Confection



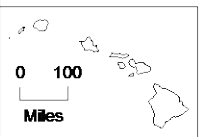
Total Acres: 308,000

100°W – The great American desert



1 Dot = 1,000 Acres

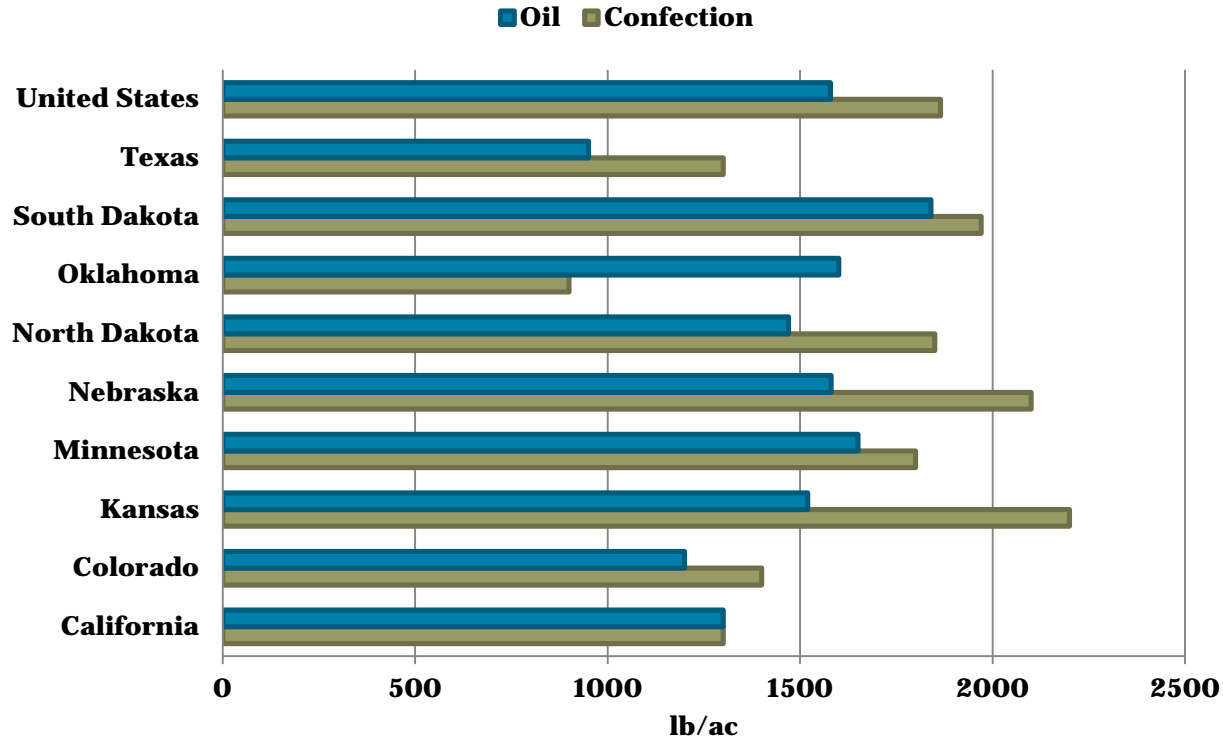
United States Total
1,615,056



12-M178
U.S. Department of Agriculture, National Agricultural Statistics Service

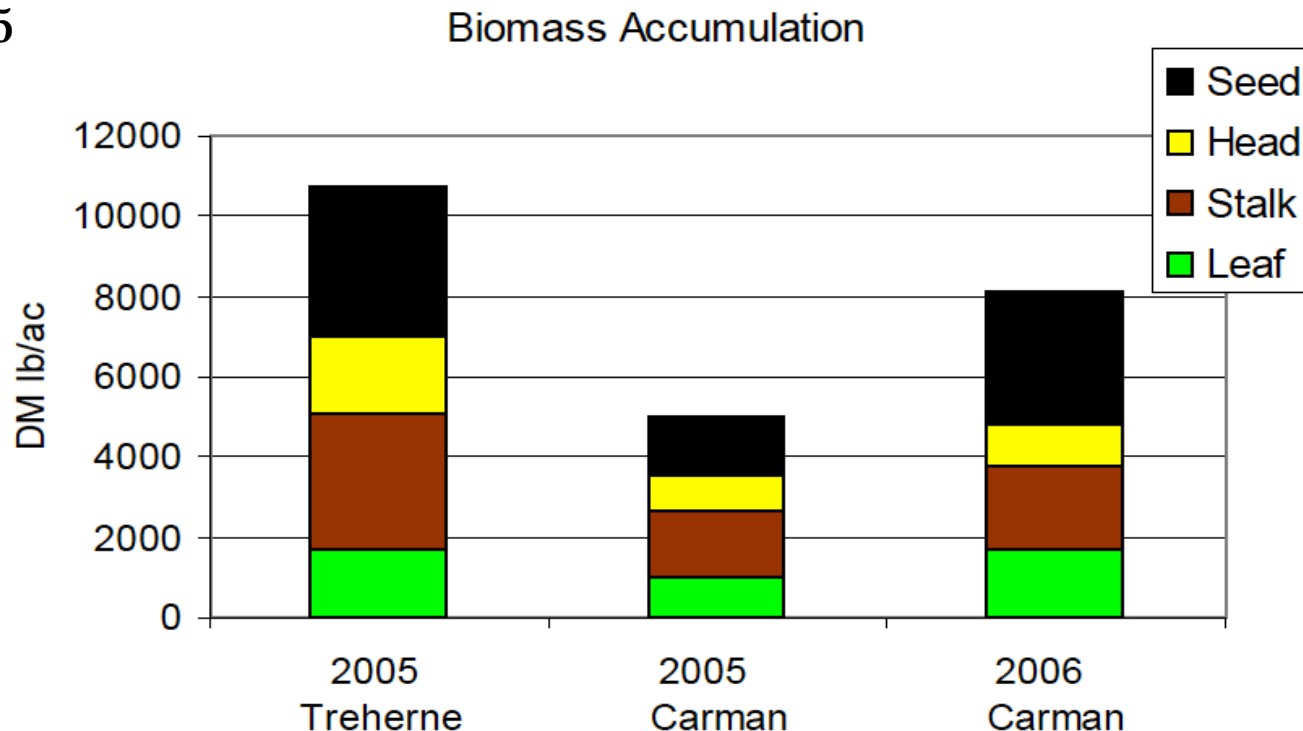
2012 Census of Agriculture

Introduction - Yield



Nutrient Removal by Sunflower

- Harvest Index = 0.35
 - 0.3 for stalk
 - 0.19 for leaves
 - 0.16 for head



Courtesy of John Heard, MAFRI

Nutrient Removal by Sunflower

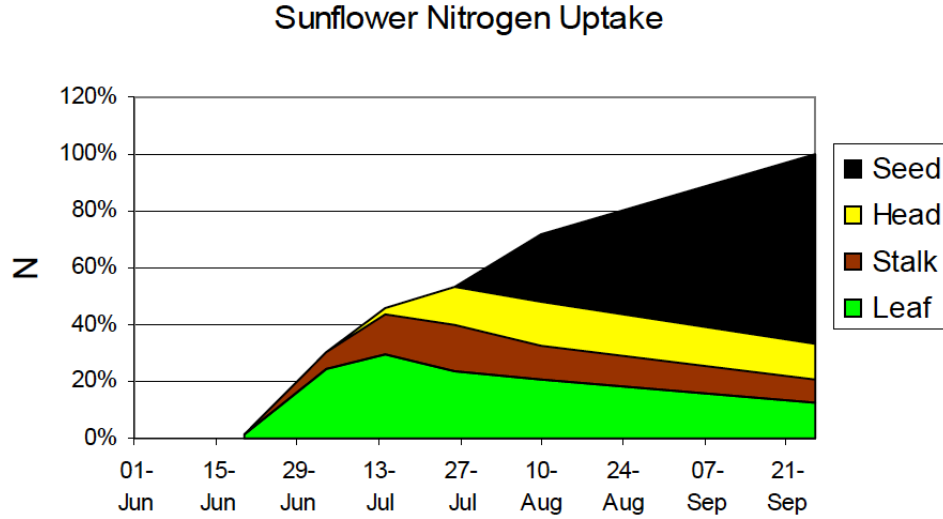
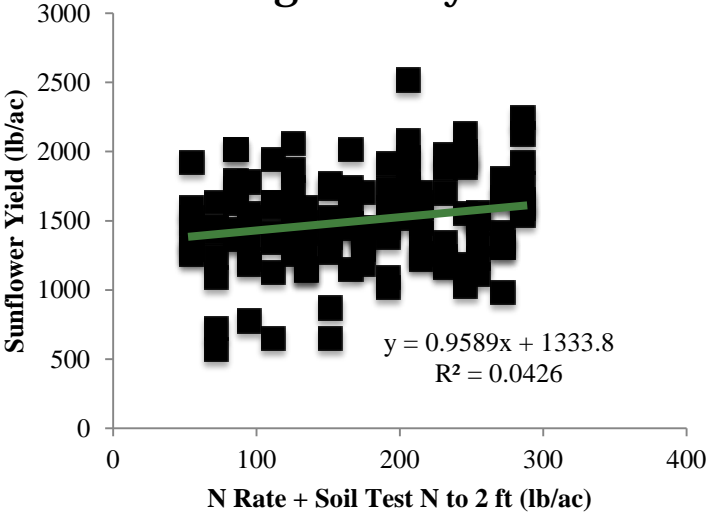
Source: HPSPH

Table 1. Nutrient content in a sunflower crop producing 1,000 lbs seed/acre.			
Element	Nutrient Removal lbs/acre		
	Seed	Stover	Total
Nitrogen (N)	30	18	48
Phosphorus (P205)	12	3	15
Potassium (K20)	8	28	36
Sulfur (S)	2	4	6
Magnesium (Mg)	2	5	7
Calcium (Ca)	1.2	18.5	19.7
Zinc (Zn)	0.05	0.04	0.09



Essential Nutrients: Nitrogen (N)

- Sunflower is an efficient N user with an aggressive tap root
 - Numerous N rate studies unresponsive
 - Zero N rate often varies widely in most studies
 - Variability kills ANOVA
- Soil test N generally based on a 2' soil sample



Essential Nutrients: Nitrogen (N)

- Traditionally, N recommendations have been constructed as $\text{N Rate} = \text{Yield Goal (lbs/ac)} * \text{Some N coefficient} - \text{N credits}$
 - N coefficient is traditionally 0.05 but varies
 - Soil type is generally not a significant factor
 - Sidedress applications have not been shown economically effective
- General N application rates tend to average around 80 – 100 lbs N/ac in the northern plains
- High N rates tend to decrease yields due to potential increased lodging and/or disease
 - High N = more protein and less oil content

Example N recommendation calculation based on Kansas State University Recommendations

Sunflower Nitrogen Recommendations

Fertilizer N Required At Various Yield and Soil Organic Matter Levels Assuming Profile N Test Is Not Used (includes 30 Lb N/A residual default)¹

Yield Goal (Lb/A)	Soil Organic Matter Content (%)						
	1.0	1.5	2.0	2.5	3.0	3.5	4.0
	----- Lb N/A -----						
1,000	25	15	5	0	0	0	0
1,500	63	53	43	33	23	13	3
2,000	100	90	80	70	60	50	40
2,500	138	128	118	108	98	88	78
3,000	175	165	155	145	135	125	115

Example:
 Yield Goal = 1500 lbs/A
 SOM = 2.5%
 Profile N = 30 lbs N (default)
 Previous crop = wheat

$N \text{ Rec} = (1500 \times 0.075) - (2.5 \times 20) - 30$
 $= \mathbf{33 \text{ lb N/A}}$

$N \text{ Rec} = (\text{Yield Goal} \times 0.075) - (\%SOM \times 20) - \text{Profile N} - \text{Other N Credits}$

Essential Nutrients: Nitrogen (N)

- More recent work in North and South Dakota suggests that yield goals are quadratic and not well predicted by a yield goal
 - i.e. yield gradually increases, then hits a plateau, then begins to fall off
 - In the Northern Great Plains, this rate was found to be around 150 lbs of total N, regardless of yield potential
 - A maximum of 150 lbs is recommended to reduce lodging losses
- Response to N was similar between till and no-till
 - No till required less overall N to reach max yield
- Alternative approach bases N rate on cost of N: return on seed

Response of Eastern No-till Sunflower Normalized Yield Within Each Experiment to Total Known Available N, 2012-2015

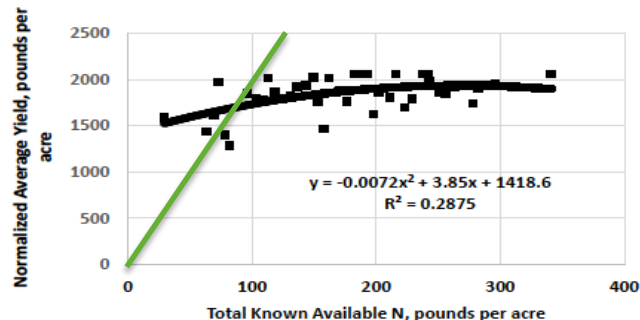
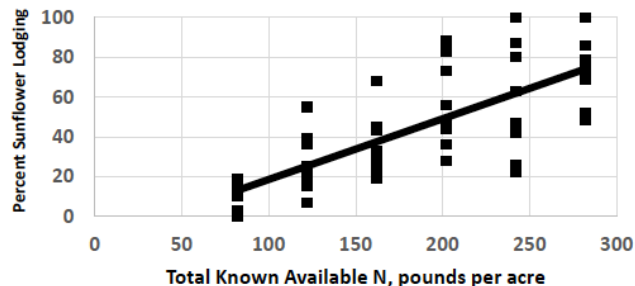


Figure 5. Eastern North Dakota oil-seed sunflower normalized yield within site response to total known available N rate, long-term no-till sites, 2012-2015.

Green line = N Rec @ YG x 0.05

Percent Sunflower Lodging with N Rate, Bottineau, ND, 2015



Updated NDSU N Rec

Table 3. Eastern long-term no-till oil-seed sunflower N recommendations based on N cost and sunflower price. For confection sunflower N rate, add 10 pounds N per acre to these values, except zero values.

Sunflower Seed	N Cost, \$ per Pound								
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
\$ per Pound	Total Known Available N, Pounds per Acre*								
0.09	84	22	0	0	0	0	0	0	0
0.12	117	68	24	0	0	0	0	0	0
0.15	137	97	61	24	0	0	0	0	0
0.18	150	117	86	55	24	0	0	0	0
0.21	150	132	105	77	50	24	0	0	0
0.24	150	142	119	95	71	47	24	0	0
0.27	150	150	130	108	87	65	44	24	0
0.30	150	150	139	118	99	80	61	42	24

* Total known available N includes soil test N to 2 feet, previous crop credit and fertilizer amendment N rate.

Example based on Price of Seed: Cost of N

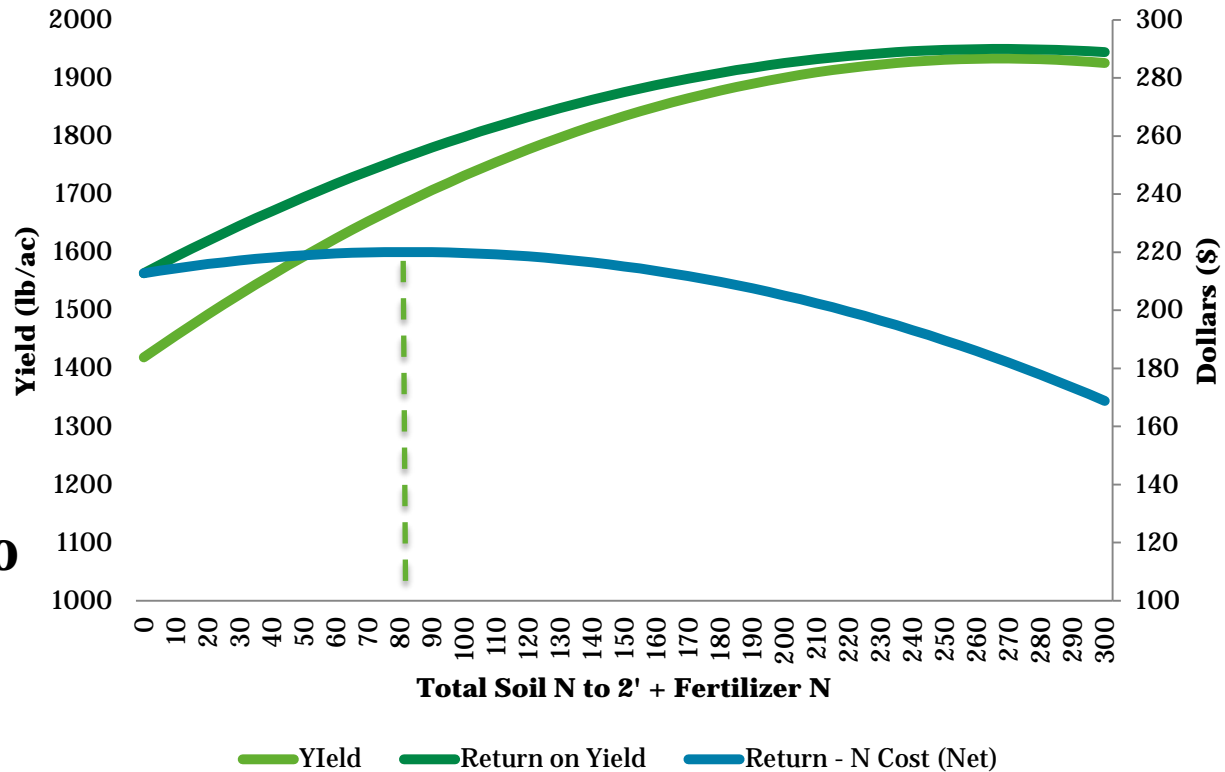
Seed Price (\$/lb) = 0.15

N Cost (\$/lb) = 0.40

Yield =
 $-0.0072X^2 + 3.85X + 1418.6$

Return = Yield x 0.15

Net = Return - Total N x 0.40



Current Sunflower N Fertility Recommendations (State Labs, 2016)

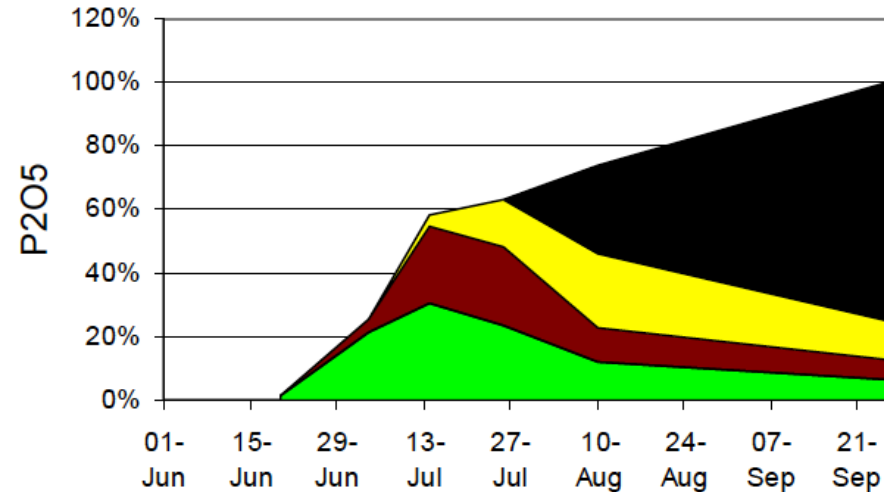
State	Standard Soil Sampling Depth for Soil Test (in.)	Current Base N Factor (lbs. N per lb. of yield)	N Credits from other Soil Parameters?
ND	24" (48"†)	None	STN‡, previous crop
SD	24" (48"†)	0.05	STN, previous crop
MN	24"	0.05	STN, legumes
Neb	?	?	STN, OM
KS	24"	0.075	STN, Legume/fallow, previous manure, OM, soil texture
CO	?	0.065	STN, ?
TX	6" (24"†)	0.05	None/STN
Calif	?	?	

†Soil sampling to lower depth as practical; ‡STN—Soil test nitrate-N.

Essential Nutrients: Phosphorus (P)

- Total P uptake is roughly 15 lbs (P₂O₅)/1000 lbs (6.6 lbs P/A)
 - 12 lbs P₂O₅/A in grain (5.3 lbs P/A)
 - 3 lbs P₂O₅/A in stover (1.3 lbs P/A
- Most P is translocated to grain from vegetative tissue

Sunflower Phosphorus Uptake



Source: HPSPH

Essential Nutrients: Phosphorus (P)

Kansas Rec:

- $P \text{ Rec} = [42 + (YG \times 0.01) + \text{Bray-P} \times -2.1] + (YG \times \text{Bray P} \times -0.0005)$

SDSU Rec:

- $\text{Bray-1} = (0.0225 - 0.0011 \times \text{STP}) \times \text{YG}$
- $\text{Olsen P} = (0.0225 - 0.0014 \times \text{STP}) \times \text{YG}$

Yield goal lb/a	Soil N plus fertilizer N required lb/acre-2'	Bray-1 Olsen	Soil Test Phosphorus, ppm				
			VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21 + 16 +
1000	50		20	15	10	0	0
1400	70		29	21	13	0	0
1800	90		37	27	17	10	0
2200	110		45	33	20	10	0
2600	130		53	38	24	10	0
3000	150		61	42	27	10	0

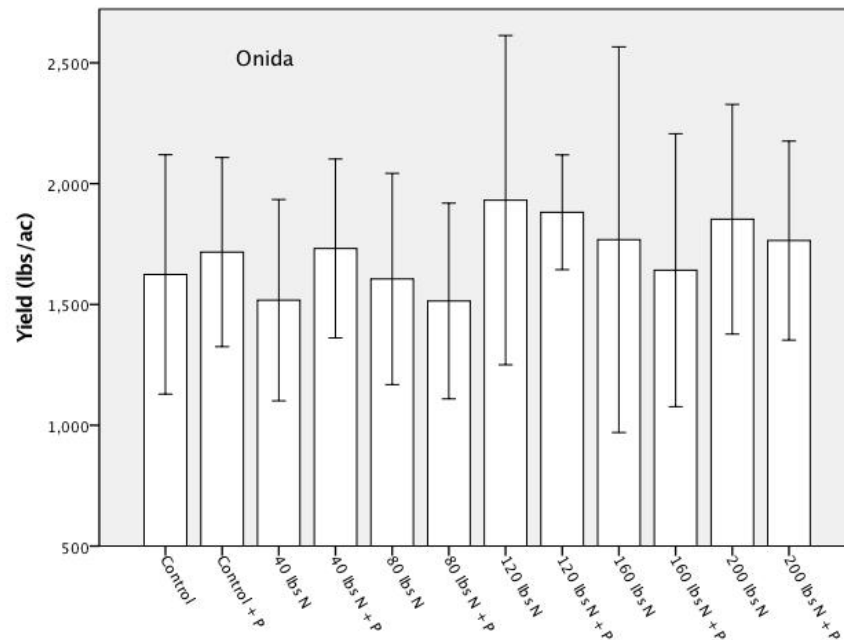
Yield Goal lb/a	Bray-1 P Olsen P	Soil Test Phosphorus, ppm				
		VL <5 <3	L 6-12 4-7	M 13-25 8-12	H 26-50 13-16	VH >51 >17
1000		30	20	15	0	0
1500		40	30	20	0	0
2000		50	40	25	10	0
2500		60	45	30	15	0
3000		70	55	35	20	0

Source: HPSPH

Essential Nutrients: Phosphorus (P)

- However, sunflower has been largely unresponsive to P in Northern Plains
- 40 site-years in western Nebraska found no effect from P rates
- 48 site-years in North and South Dakota found only 3 responses to P
 - Only one was economical (3 ppm)
- **NDSU recommendation is no P application necessary**

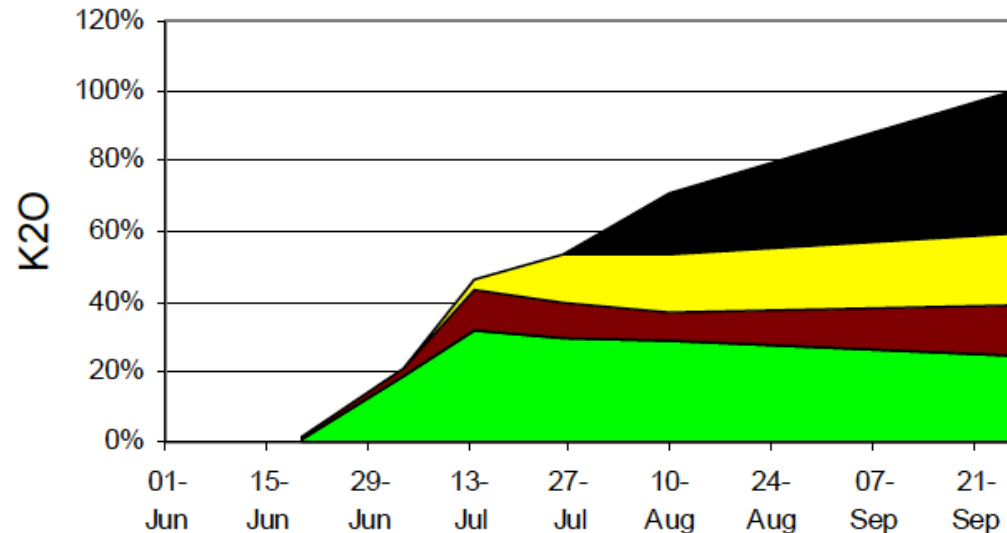
Olsen-P 10ppm
P Rate = 60 lbs



Essential Nutrients: Potassium (K)

- Total K uptake is roughly 30 lbs/A (36 lbs K₂O)/1000 lbs
- Most K is in crop residue

Sunflower Potassium Uptake



Essential Nutrients: Potassium (K)

- Little research has been conducted on sunflower uptake of K in northern plains
- NDSU recommends a flat 100 lbs K/A for STK below 150 ppm

KSU Recs:

Potassium Sufficiency Recommendations for Sunflower¹

Exch. K (ppm)	Yield Goal (Lb/A)				
	1,000	1,500	2,000	2,500	3,000
0-40	75	80	80	85	90
40-80	45	50	50	55	55
80-120	20	20	20	25	25
120-130	15	15	15	15	15
130+	0	0	0	0	0
Crop Removal ³	6	9	12	15	18

----- Lb K₂O/A -----

HPSPH Recs:

Soil Test Potassium, ppm¹

VL	L	M	H	VH
<40	41-80	81-120	121-160	>161

----- Lb K₂O/a -----

50	40	15	0	0
60	50	25	10	0
70	60	35	15	0
80	70	45	20	0
90	75	55	25	0

SDSU Recs:

Soil Test Potassium, ppm

Yield goal lb/a	VL	L	M	H	VH
	0-40	41-80	81-120	121-160	161+
1000	36	25	14	0	0
1400	50	35	20	0	0
1800	64	45	25	10	0
2200	78	55	31	10	0
2600	93	64	36	10	0
3000	107	74	42	10	0

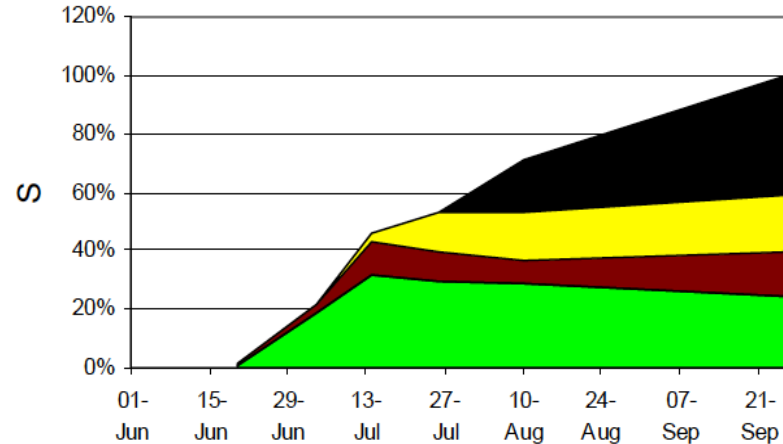
..... lb K₂O/acre

SDSU K Rec = (0.041 – 0.00027 x STK) x YG

Essential Nutrients: Sulfur (S)

- Total S uptake is roughly 6 lbs/A/1000 lbs
- Majority is in the residue
- Not a lot of guidance from university recommendations
 - Likely due to a historical lack of response

Sunflower Sulphur Uptake



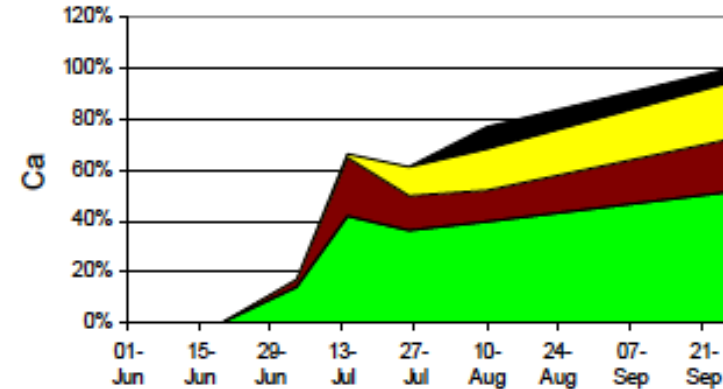
KSU recommendation

Sunflower Sulfur Recommendation (Lb/A) = $(0.005 \times Y \text{ Goal}) - (2.5 \times \% \text{ OM}) - \text{Profile Sulfur} - \text{Other Sulfur Credits}$

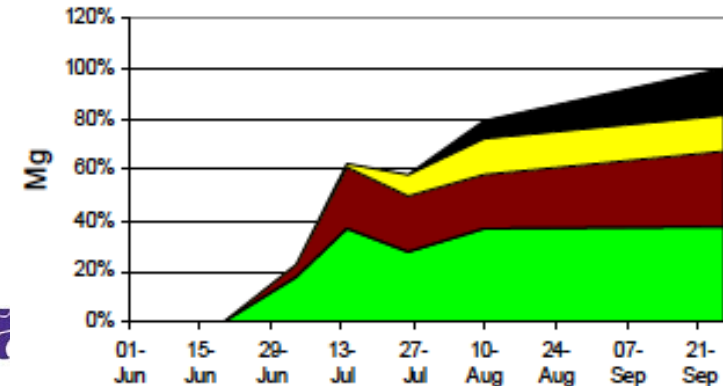
Essential Nutrients: Other/Micronutrients

- Lack of response to micronutrient studies
 - Likely due to deep taproot
- Sunflower may be most susceptible to boron deficiency
 - NDSU research saw no response to soil levels as low as 0.2
- Generally micronutrient application is not recommended

Sunflower Calcium Uptake



Sunflower Magnesium Uptake



References

- **North Dakota State University Sunflower Recommendations** – Available at: <https://www.ag.ndsu.edu/extensionentomology/recent-publications-main/publications/A-1331-sunflower-production-field-guide>
- **South Dakota State University Sunflower Recommendations** – Available at: <https://igrow.org/up/resources/EC750.pdf>
- **Kansas State University Sunflower Recommendations** – Available at: <http://www.bookstore.ksre.ksu.edu/pubs/mf2586.pdf>
- **High Plains Sunflower Production Handbook (HPSPH)** - http://www.agmrc.org/media/cms/Sunflowers_C84E1143C31B9.pdf
- Nutrient uptake graphs courtesy of John Heard, MB Agriculture, Food and Rural Initiatives

Questions?



Comments?





Sunflower's aggressive root system

Depth and amount of soil water extraction

Source: HPSP

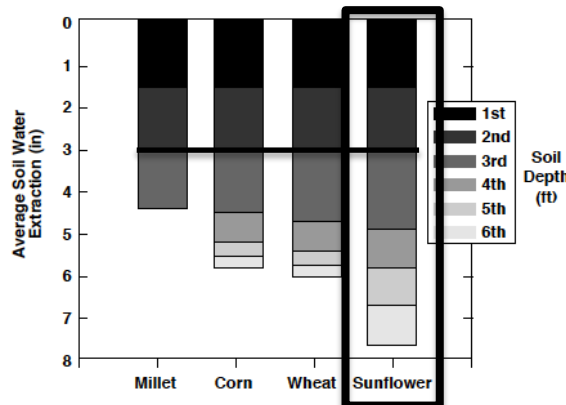


Figure 5. Typical soil water extraction by depth for proso millet, corn, winter wheat, and sunflower, Akron, CO.

Time course of median and maximum depth of root growth

(Merrill et al., 2002)

