MINNESOTA VALLEY TESTING LABORATORIES, INC.

MVTL

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MEMBER
ACIL

SUBMITTED BY:001141

SUBMITTED FOR: KENDALL UPCHURCH
Field: 85852112P4600

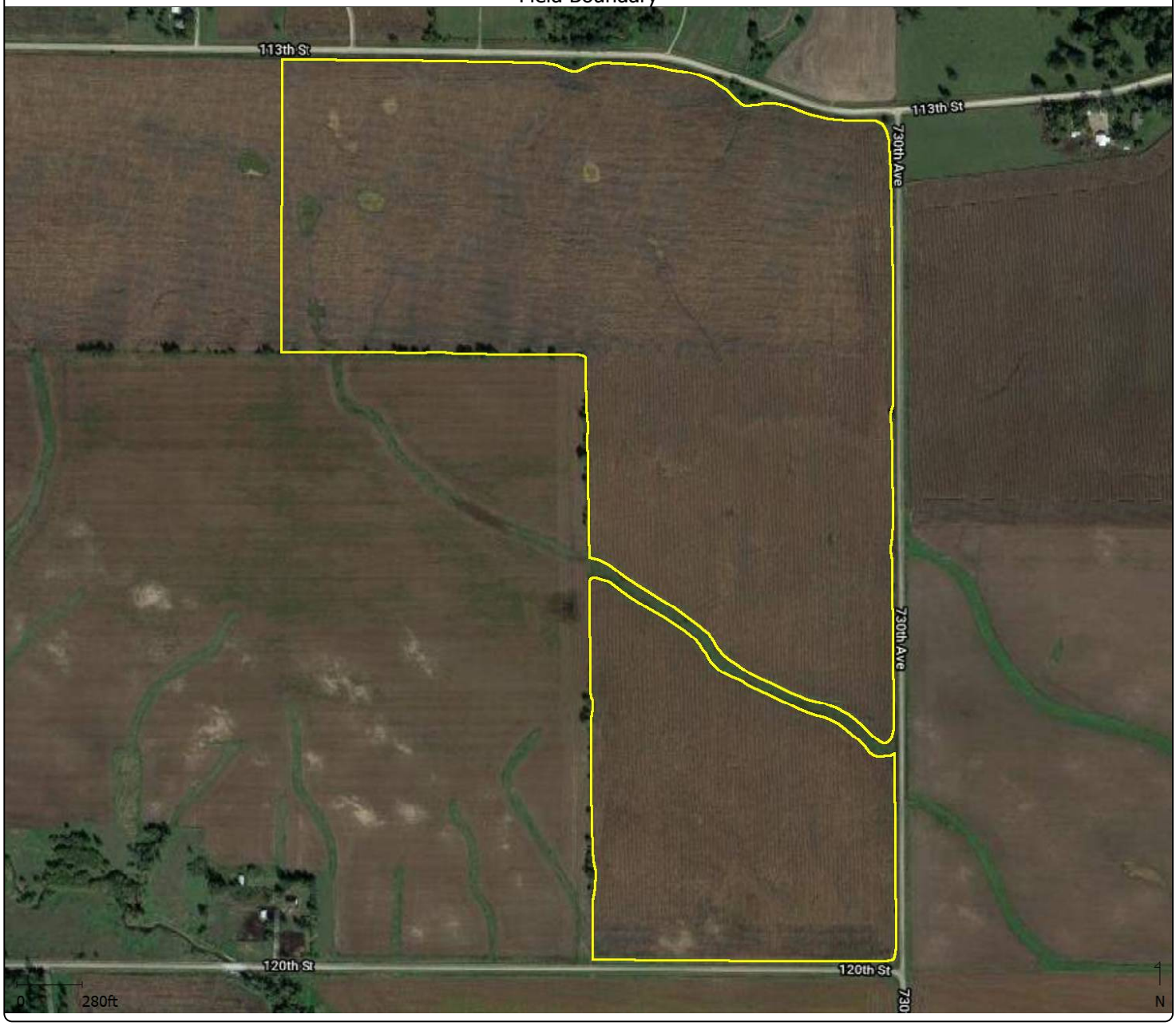
THE PINNACLE GROUP LLC
620 EAST COUNTRY CLUB RD
IOWA FALLS IA 50126

Date Received: May 2 2021
Report Date:
Work Order No: 202191-00195

Lab Num	Sample ID	Soil pH	Buff pH	OM %	B-I P ppm	Olsen P ppm	MehP ppm	Salts EC	MehK ppm	Zn ppm	Cu ppm	B ppm	S ppm	NO3 ppm	N-NH4 Cl ppm	lbs	BrayII ppm	CCE %
21-M14522	1	5.6	6.5	3.1			14		138									
21-M14523	2	5.8	6.7	2.6			14		98									
21-M14524	3	5.7	6.4	3.7			13		156									
21-M14525	4	5.4	6.4	2.8			8		103									
21-M14526	5	5.2	6.2	3.1			14		110									
21-M14527	6	5.1	6.2	3.0			20		142									
21-M14528	7	5.5	6.4	3.4			9		119									
21-M14529	8	6.0	6.7	3.3			11		125									
21-M14530	9	6.2	6.8	3.9			20		137									
21-M14531	10	7.1	7.2	4.7			19		151									
21-M14532	11	5.8	6.4	5.3			24		187									
21-M14533	12	5.4	6.4	3.9			11		132									
21-M14534	13	5.5	6.4	2.8			12		128									
21-M14535	14	5.6	6.3	5.3			18		143									
21-M14536	15	7.5	7.3	5.9			23		157									
21-M14537	16	5.7	6.4	4.3			20		161									
21-M14538	17	5.5	6.4	3.6			7		129									
21-M14539	18	5.4	6.2	4.1			20		133									
21-M14540	19	5.0	6.0	3.7			6		115									
21-M14541	20	5.5	6.4	3.8			12		141									
21-M14542	21	5.5	6.5	2.9			6		105									
21-M14543	22	5.8	6.3	6.4			109		335									
21-M14544	23	5.8	6.6	2.6			9		111									
21-M14545	24	4.9	5.9	3.8			10		128									
21-M14546	25	4.9	6.0	3.5			9		102									
21-M14547	26	4.9	6.1	3.0			10		120									
21-M14548	27	5.5	6.3	3.4			12		129									
21-M14549	28	5.3	6.2	4.4			24		132									
21-M14550	29	5.3	6.3	3.2			12		112									
21-M14551	30	5.4	6.2	4.4			12		126									
21-M14552	31	5.1	6.2	3.3			13		104									
21-M14553	32	5.9	6.7	2.8			38		123									
21-M14554	33	7.4	7.3	2.5			91		234									

Kendall Upchurch - 85852112P4600 - Crains Farm East (147.15 ac)

Field Boundary



Grower : Kendall Upchurch

Farm : 85852112P4600

Field : Crains Farm East

Year : 2021

Area : 147.15 ac

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Kendall Upchurch - 85852112P4600 - Crains Farm East (147.15 ac)

Soil Sample ID Map

Grower : Kendall Upchurch

Farm : 85852112P4600

Field : Crains Farm East

Year : 2021

Area : 147.15 ac

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Soil Type

Clarion	96.11 ac	65.1%
Coland	3.80 ac	2.6%
Cylinder	0.02 ac	0.0%
Harps	0.46 ac	0.3%
Lester	0.19 ac	0.1%
Nicollet	23.45 ac	15.9%
Terril	1.01 ac	0.7%
Webster	22.53 ac	15.3%

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Soil Sample ID Map

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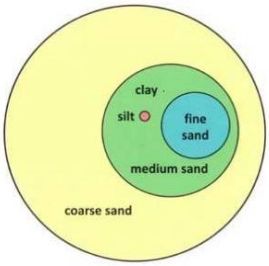
Soil Types

Soil types refer to the different sizes of mineral particles in a particular soil. Soils are composed of sand, silt, and clay. In the USDA textural classification triangle, the only soil in which neither sand, silt nor clay predominates in is called "loam". While even pure sand, silt or clay may be considered a soil, loam soil with a small amount of organic material is considered ideal soil.

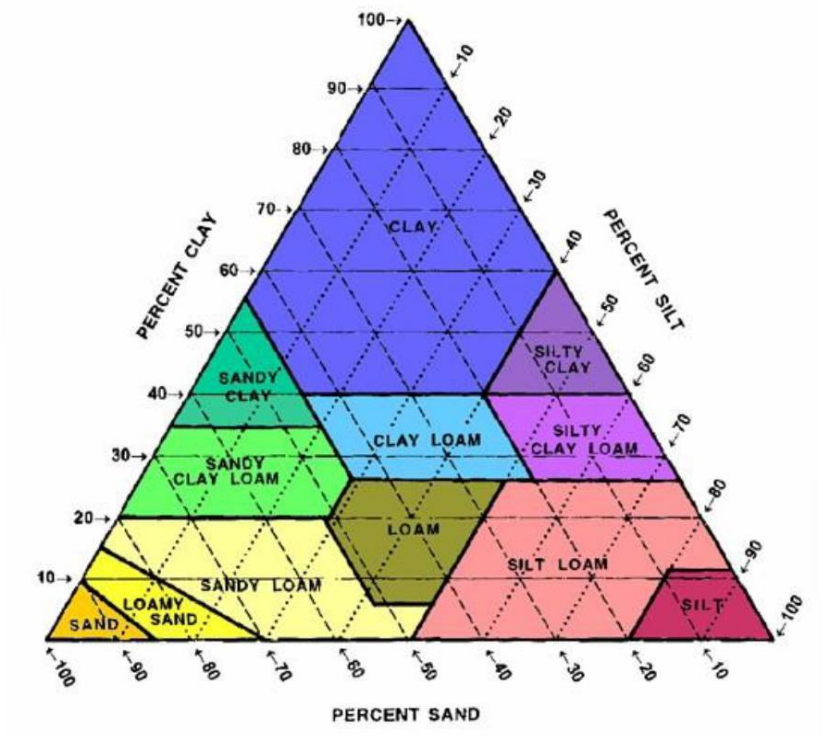
Each particle and their size, play an important role in the soil usage and structure. The largest particles, sand, determine aeration and drainage characteristics, while the smallest clay particles are chemically active, binding with water and plant nutrients. The ratio of these sizes determines soil type: clay, loam, clay-loam, silt-loam, and so on.

Particle Size of Soil Fractions

Diameter (mm)	Soil Particles
Less than 0.002	Clay
0.02 – 0.002	Silt
0.2 – 0.02	Fine Sand
2.0 – 0.2	Course Sand



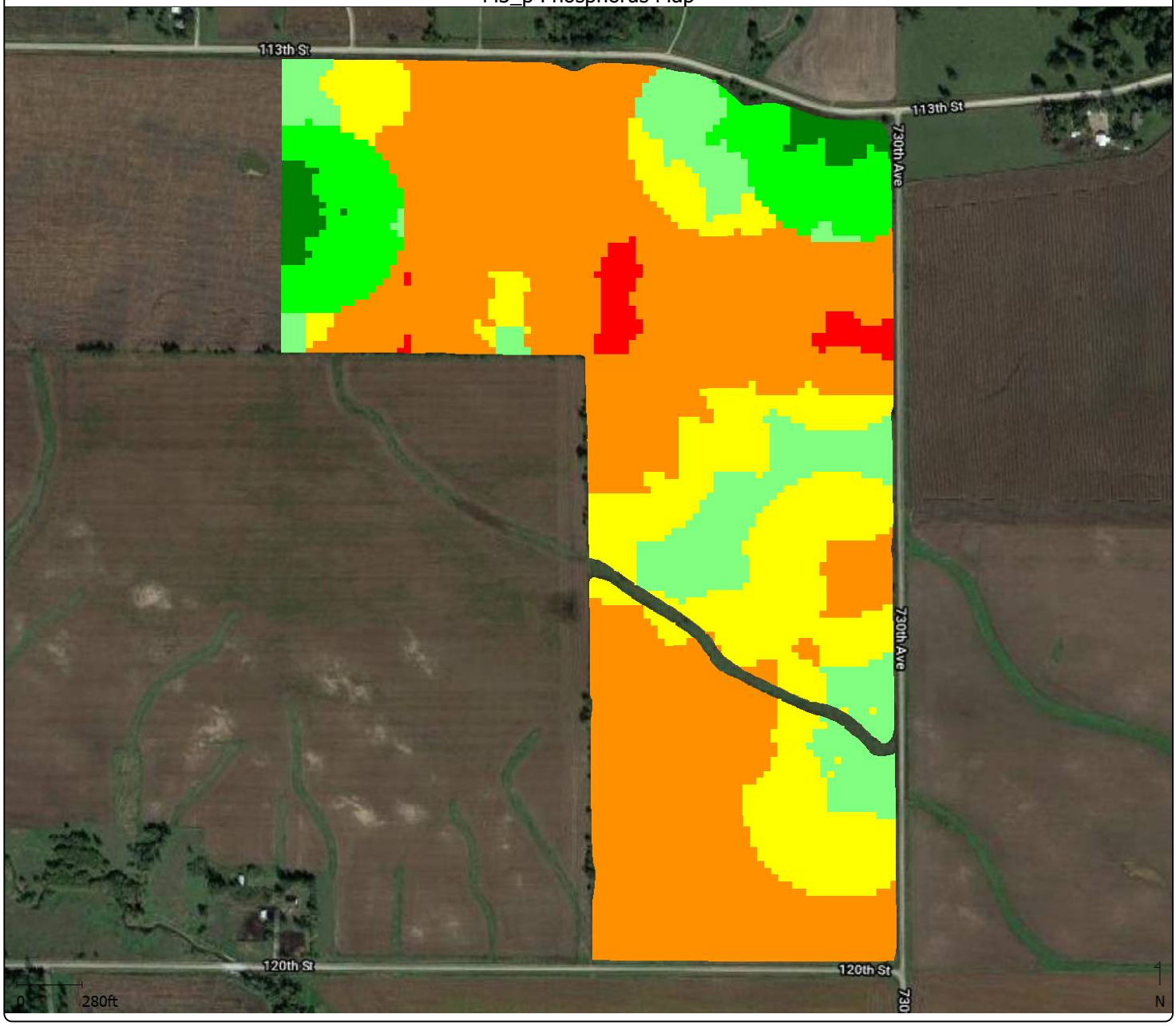
The USDA has broken these proportions into 12 basic soil textural classifications, which are based on the percentages of sand, silt and clay. These classifications can be determined by using the USDA soil textural classification triangle, shown below.



* Iowa State University Extension publication PM 1688, General Guide for Crop Nutrient and Limestone Recommendations in Iowa
* Minnesota Valley Testing Laboratory, MVTL Nutrient Analysis Guide

Kendall Upchurch - 85852112P4600 - Crains Farm East (147.15 ac)

M3_p Phosphorus Map



Grower : Kendall Upchurch

Farm : 85852112P4600

Field : Crains Farm East

Year : 2021

Area : 147.15 ac

Average M3_p : 19.70 ppm

Minimum M3_p : 6.000 ppm

Maximum M3_p : 109.00 ppm

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Soil P1
(ppm)

Above 99.00	VVV-High	(0.00 ac	- 0.0%)
65.00 - 99.00	VV-High	(3.01 ac	- 2.0%)
30.00 - 65.00	Very High	(12.67 ac	- 8.6%)
20.00 - 30.00	High	(17.49 ac	- 11.8%)
15.00 - 20.00	Optimum	(32.35 ac	- 21.9%)
8.00 - 15.00	Low	(79.18 ac	- 53.7%)
Below 8.00	Very Low	(2.87 ac	- 1.9%)

Phosphorus - P

Phosphorus Role in Plant Growth:

- Part of ATP molecule which circulates energy through the plant
- Part of Organic compounds found in plants
- Stores and transfers energy to drive reactions within cells that promote photosynthesis and respiration
- Enhances cell division/enlargement
- Promotes root formation, early plant growth, and hastens maturity
- Improves hardiness, seed quality, and disease resistance

Phosphorus (P) is an essential element classified as a macronutrient because of the relatively large amounts of P required by plants. One of the main roles of P in living organisms is in the transfer of energy. Organic compounds that contain P are used to transfer energy from one reaction to drive another reaction within cells. Adequate P availability for plants stimulates early plant growth and hastens maturity.

Soils may contain several hundred to several thousand pounds of phosphate per acre. However, much of the phosphate in soils is not available to growing plants (fixed). The amount of immediately available phosphorus in the soil is very small in comparison to the total P in soils.

Climatic and site conditions, such as rainfall and temperature, and moisture and soil aeration, and salinity affect the rate of P mineralization from organic matter decomposition. Organic matter decomposes releasing P more quickly in warm humid climates and slower in cool dry climates. Phosphorus is released faster when soil is well aerated and much slower on saturated wet soils.

Soils with inherent pH values between 6.0 and 7.0 are ideal for P-availability, while pH values below 5.5 and between 7.5 and 8.5 limits P-availability to plants due to fixation by aluminum, iron, or calcium often associated with soil parent materials.

Concentrations:

Mehlich-3 Test

Very Low – 0-8 ppm

Low – 9-15 ppm

Optimum – 16-20 ppm

High – 21-30 ppm

Very High – 31+ ppm

* Iowa State University Extension publication PM 1688, General Guide for Crop Nutrient and Limestone Recommendations in Iowa
* Minnesota Valley Testing Laboratory, MVTL Nutrient Analysis Guide

Kendall Upchurch - 85852112P4600 - Crains Farm East (147.15 ac)

K Potassium Map

Grower : Kendall Upchurch

Farm : 85852112P4600

Field : Crains Farm East

Year : 2021

Area : 147.15 ac

Average K : 138.36 ppm

Minimum K : 98.00 ppm

Maximum K : 335.00 ppm

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Soil K
(ppm)

	Above 440.00	VVV-High	(0.00 ac - 0.0%)
	340.00 - 440.00	VV-High	(0.00 ac - 0.0%)
	240.00 - 340.00	Very High	(1.38 ac - 0.9%)
	200.00 - 240.00	High	(3.48 ac - 2.4%)
	160.00 - 200.00	Optimum	(14.14 ac - 9.6%)
	120.00 - 160.00	Low	(85.37 ac - 57.8%)
	Below 120.00	Very Low	(43.19 ac - 29.3%)

Potassium – K

Potassium Role in Plant Growth:

- Stimulates early growth
- Enhancing protein production
- Improves seed quality, plant hardiness, and disease resistance

Potassium is referred to as the third major plant nutrient. Potassium is the only essential plant nutrient that is not a constituent of any plant part. Potassium is a key nutrient in the plants tolerance to stresses such as cold/hot temperatures, drought, and pest problems.

Plant leaves, when functioning properly, will contain about 2 percent or more potassium. Thus, when hay and silage are removed from a field, large amounts of potassium are also removed. However, when stover and straw are left in the field after grain harvest, much of the potassium in the plant is returned to the soil.

Potassium in soils can be divided into three general categories: **unavailable**, **slowly available**, and **readily available**

- **Unavailable**

90-98% of K found in the soil is unavailable for plant uptake. Most of this is found in soil minerals. For potassium in soil minerals to become available, mineral weathering must take place releasing K to a slowly available form. This takes too long to supply adequate potassium in a given season.

- **Slowly available**

This form of potassium is thought to be "trapped" or fixed between layers of clay particles making it unavailable for plant uptake. Plants cannot use much of this slowly available potassium in a single growing season. Slowly available K accounts for 1-10% of the total potassium in the soil.

- **Readily available**

Potassium that is water soluble or dissolved in soil water and held on the exchanges sites of clay particles (exchangeable K) is considered readily available for plant growth. This is the form of K that routine soil tests measure. Readily available K accounts for 0.1-2% of the total potassium in the soil.

Concentrations:

Mehlich-3 **Dry** Test

Very Low – 0-120 ppm

Low – 121-160 ppm

Optimum – 161-200 ppm

High – 201-240 ppm

Very High – 241+ ppm

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Kendall Upchurch - 85852112P4600 - Crains Farm East (147.15 ac)

Organic Matter Map

Grower : Kendall Upchurch

Farm : 85852112P4600

Field : Crains Farm East

Year : 2021

Area : 147.15 ac

Average OM : 3.712 %

Minimum OM : 2.500 %

Maximum OM : 6.400 %

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Soil OM
(%)

	Above 6.00	VV-High	(0.00 ac - 0.0%)
	5.00 - 6.00	Very High	(11.23 ac - 7.6%)
	4.50 - 5.00	High	(10.87 ac - 7.4%)
	3.50 - 4.50	Optimum	(58.05 ac - 39.3%)
	2.50 - 3.50	Low	(67.42 ac - 45.7%)
	1.50 - 2.50	Very Low	(0.00 ac - 0.0%)
	Below 1.50	VV-Low	(0.00 ac - 0.0%)

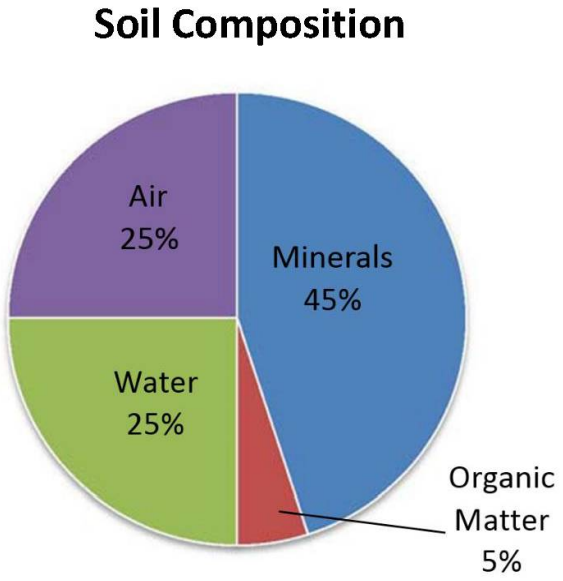
Organic Matter - OM

Organic Matters Role in Plant Growth:

- Stores and supplies such nutrients as nitrogen, phosphorus, and sulfur, which are needed for the growth of plants and soil organisms
- Aids the growth of crops by improving the soil's ability to store and transmit air and water
- Retains nutrients by providing cation-exchange and anion-exchange capacities
- Stabilizes and holds soil particles together, thus reducing the hazard of erosion
- Provides a carbon and energy source for soil microbes
- Makes soil more friable, less sticky, and easier to work
- Maintains soil in an uncompacted condition with lower bulk density

Soil organic matter is that fraction of the soil composed of anything that once lived. It includes plant and animal remains in various stages of decomposition, cells and tissues of soil organisms, and substances from plant roots and soil microbes. Well-decomposed organic matter forms humus, a dark brown, porous, spongy material that has a pleasant, earthy smell. In most soils, the organic matter accounts for less than about 5% of the volume.

Soil organic matter also improves tilth in the surface horizons, reduces crusting, increases the rate of water infiltration, reduces runoff, and facilitates penetration of plant roots. Soil organic matter can be lost through erosion. This process selectively detaches and transports particles on the soil surface that have the highest content of organic matter.



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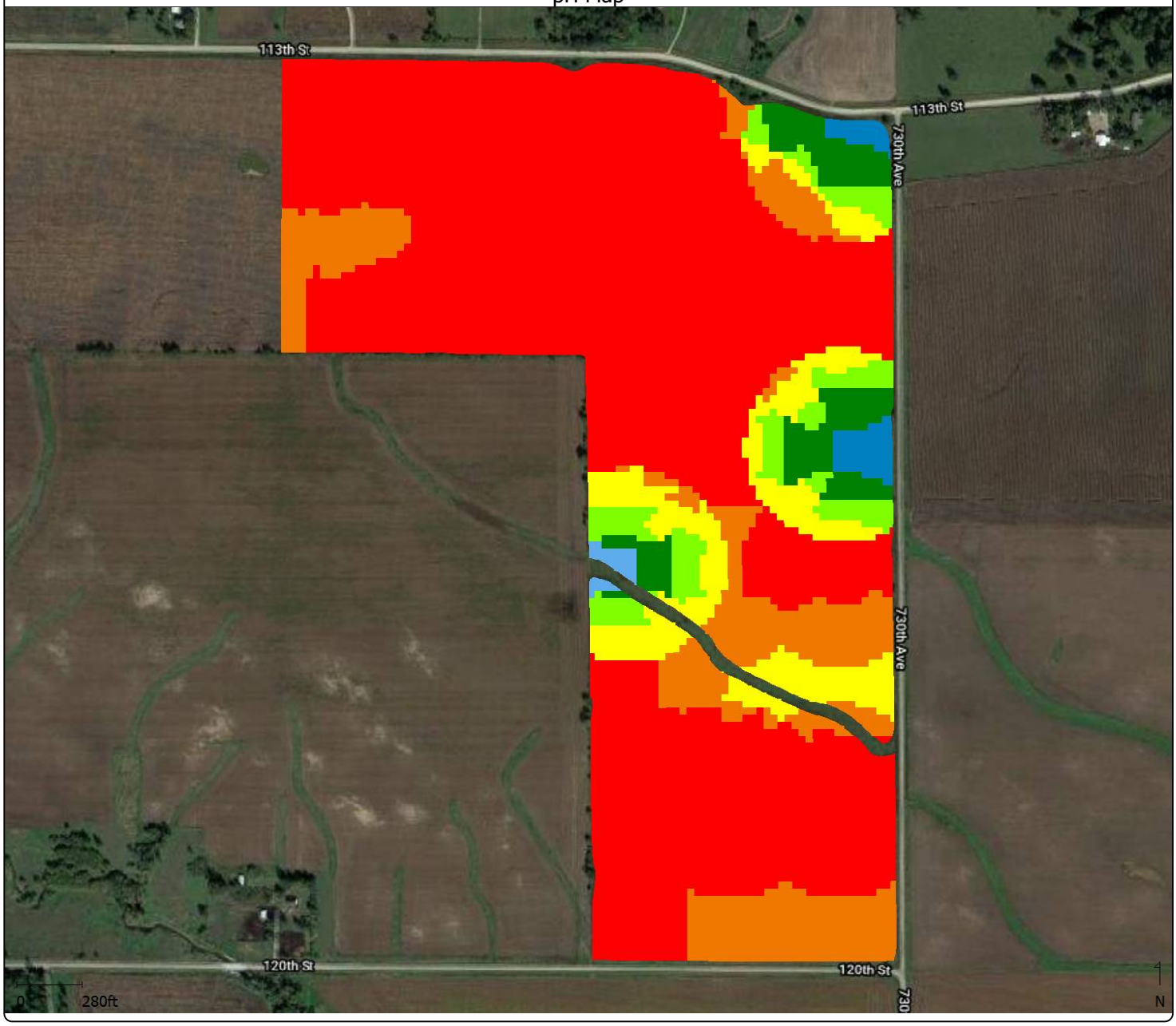
Kendall Upchurch - 85852112P4600 - Crains Farm East (147.15 ac)

pH Map



Grower : Kendall Upchurch

Farm : 85852112P4600

Field : Crains Farm East

Year : 2021

Area : 147.15 ac

Average pH : 5.642 (1)

Minimum pH : 4.900 (1)

Maximum pH : 7.500 (1)

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Soil pH
((1))

Above 7.30	Alkaline	(1.86 ac	- 1.3%)
7.00 - 7.30		(0.58 ac	- 0.4%)
6.50 - 7.00	Neutral	(6.25 ac	- 4.2%)
6.30 - 6.50		(6.25 ac	- 4.2%)
6.00 - 6.30		(11.71 ac	- 7.9%)
5.70 - 6.00		(20.91 ac	- 14.2%)
Below 5.70	Acidic	(100.00 ac	- 67.8%)

Soil pH

The pH of a soil refers to how acidic or alkaline the soil is. The letters “pH” mean “potential hydrogen.” The availability of nutrients is directly affected by soil pH. If the soil's pH is too high or too low, some nutrients become insoluble, limiting the availability of these nutrients to the plant root system.

The acidity-alkalinity scale ranges from 0 to 14. Soils are referred to as being acidic, neutral, or alkaline, depending on their pH levels. A pH of 7 is neutral, while a pH lower than 7 is acidic, and a pH higher than 7 is alkaline (basic).

A logarithmic scale is used to measure a soil's pH. That is, a change of one unit in the pH scale represents a 10-fold change in acidity or alkalinity. A soil with a pH of 5.0 is 10 times more acidic than a soil with a pH of 6.0 and 100 times more acidic than a soil with a pH of 7.0. This is one good reason to be very careful in trying to increase or lower soil pH. Some factors, including soil type and organic matter, affect the amount of materials needed to change soil pH.

The effect of soil pH is great on the solubility of minerals or nutrients. Fourteen of the seventeen essential plant nutrients are obtained from the soil. Before a nutrient can be used by plants it must be dissolved in the soil solution. Most minerals and nutrients are more soluble or available in acidic soils than in neutral or slightly alkaline soils.

Fertilizers and rain affect soil pH. Organic matters, and soil microorganisms, are a few other factors that affect soil pH. Agricultural limestone normally is used to increase the soil's pH. Sulfur is normally used to lower the soil pH.

The addition of lime not only replaces hydrogen ions and raises soil pH, thereby eliminating most major problems associated with acid soils but it also provides two nutrients, calcium and magnesium to the soil. Lime also makes phosphorus that is added to the soil more available for plant growth and increases the availability of nitrogen by hastening the decomposition of organic matter. Liming materials are relatively inexpensive, comparatively mild to handle and leave no objectionable residues in the soil.

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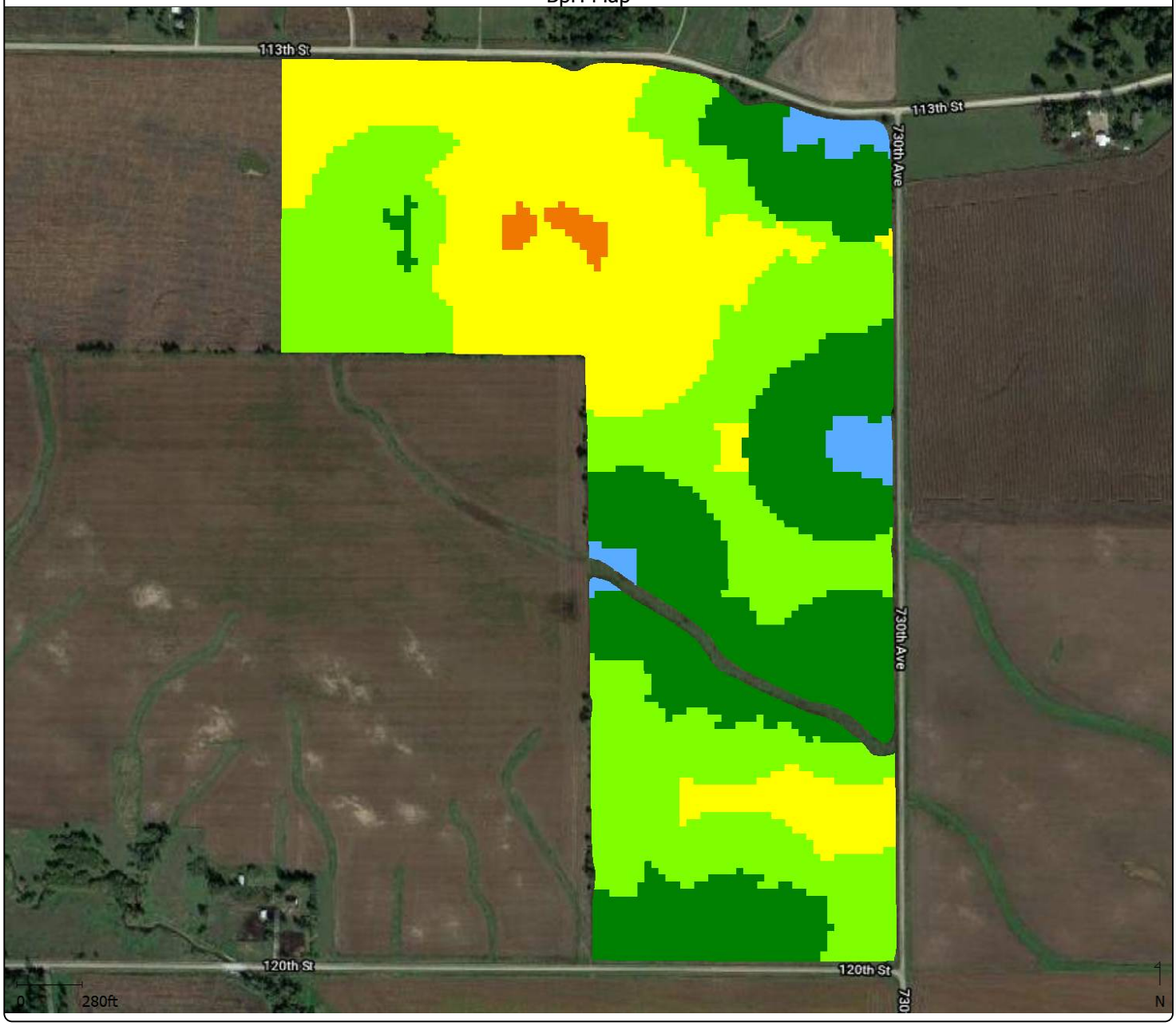
Kendall Upchurch - 85852112P4600 - Crains Farm East (147.15 ac)

BpH Map



Grower : Kendall Upchurch

Farm : 85852112P4600

Field : Crains Farm East

Year : 2021

Area : 147.15 ac

Average BpH : 6.433 (1)

Minimum BpH : 5.900 (1)

Maximum BpH : 7.300 (1)

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Soil BpH
((1))

Above 7.30	Alkaline	(0.00 ac	- 0.0%)
7.00 - 7.30		(3.56 ac	- 2.4%)
6.50 - 7.00	Neutral	(42.75 ac	- 29.0%)
6.30 - 6.50		(54.42 ac	- 36.9%)
6.00 - 6.30		(45.45 ac	- 30.8%)
5.70 - 6.00		(1.39 ac	- 0.9%)
Below 5.70	Acidic	(0.00 ac	- 0.0%)

Buffer pH - BpH

This is a value that is generated in the laboratory, it is not an existing feature of the soil. They generate this value to develop lime recommendations.

The laboratory adds a chemical mixture called a buffering solution to each sample. This solution functions like an extremely fast acting lime. Each soil sample receives the sample amount of buffering solution; therefore the resulting pH is different for each sample. The laboratory looks at the difference between the original soil pH and the ending pH after the buffering solution has reacted with the soil. If the difference between the two pH measurements is large, it means that the soil pH is easily changed and a low rate of lime will be sufficient. If the soil pH changes only a little after the buffering solution has reacted, it means that the soil pH is difficult to change and a larger lime addition is needed to reach the desired pH for the crop.

	Depth of Soil to be Neutralized								
	2 inches			3 inches			6 inches		
	Target Soil pH								
Buffer pH	pH 6.0	pH 6.5	pH 6.9	pH 6.0	pH 6.5	pH 6.9	pH 6.0	pH 6.5	pH 6.9
	Amount of Calcium Carbonate to Apply (lb/acre)								
7.0	0	0	400	0	0	600	0	0	1,100
6.9	0	0	600	0	0	1,000	0	0	1,900
6.8	0	200	900	0	300	1,400	0	600	2,700
6.7	0	400	1,200	0	700	1,800	0	1,300	3,500
6.6	0	700	1,500	0	1,100	2,200	0	2,100	4,400
6.5	100	900	1,700	100	1,400	2,600	200	2,800	5,200
6.4	300	1,200	2,000	400	1,800	3,000	800	3,500	6,000
6.3	500	1,400	2,300	700	2,100	3,400	1,400	4,200	6,800
6.2	700	1,700	2,600	1,000	2,500	3,900	2,000	5,000	7,700
6.1	900	1,900	2,800	1,300	2,900	4,300	2,500	5,700	8,500
6.0	1,000	2,200	3,100	1,600	3,200	4,700	3,100	6,400	9,300
5.9	1,200	2,400	3,400	1,900	3,600	5,100	3,700	7,100	10,100
5.8	1,400	2,600	3,700	2,200	4,000	5,500	4,300	7,900	11,000
5.7	1,600	2,900	3,900	2,500	4,300	5,900	4,900	8,600	11,800

*For corn and soybean, soil pH 6.5 is recommended in soil association areas without calcareous subsoil and soil pH 6.0 is recommended in areas with calcareous subsoil's. Soil pH 6.9 is recommended for alfalfa and alfalfa-grass mixtures in all soil association areas. Soil pH 6.0 is recommended for other forage legumes or legume-grass mixtures and grasses in all association areas.

*Amounts were derived from the following calibration equations and rounded to 100 pounds:
lb of $CaCO_3$ to raise pH to 6.0 = [38619 - (5915 x Buffer pH)] x [Depth x 0.167]
lb of $CaCO_3$ to raise pH to 6.5 = [49886 - (7245 x Buffer pH)] x [Depth x 0.167]
lb of $CaCO_3$ to raise pH to 6.9 = [58776 - (8244 x Buffer pH)] x [Depth x 0.167]

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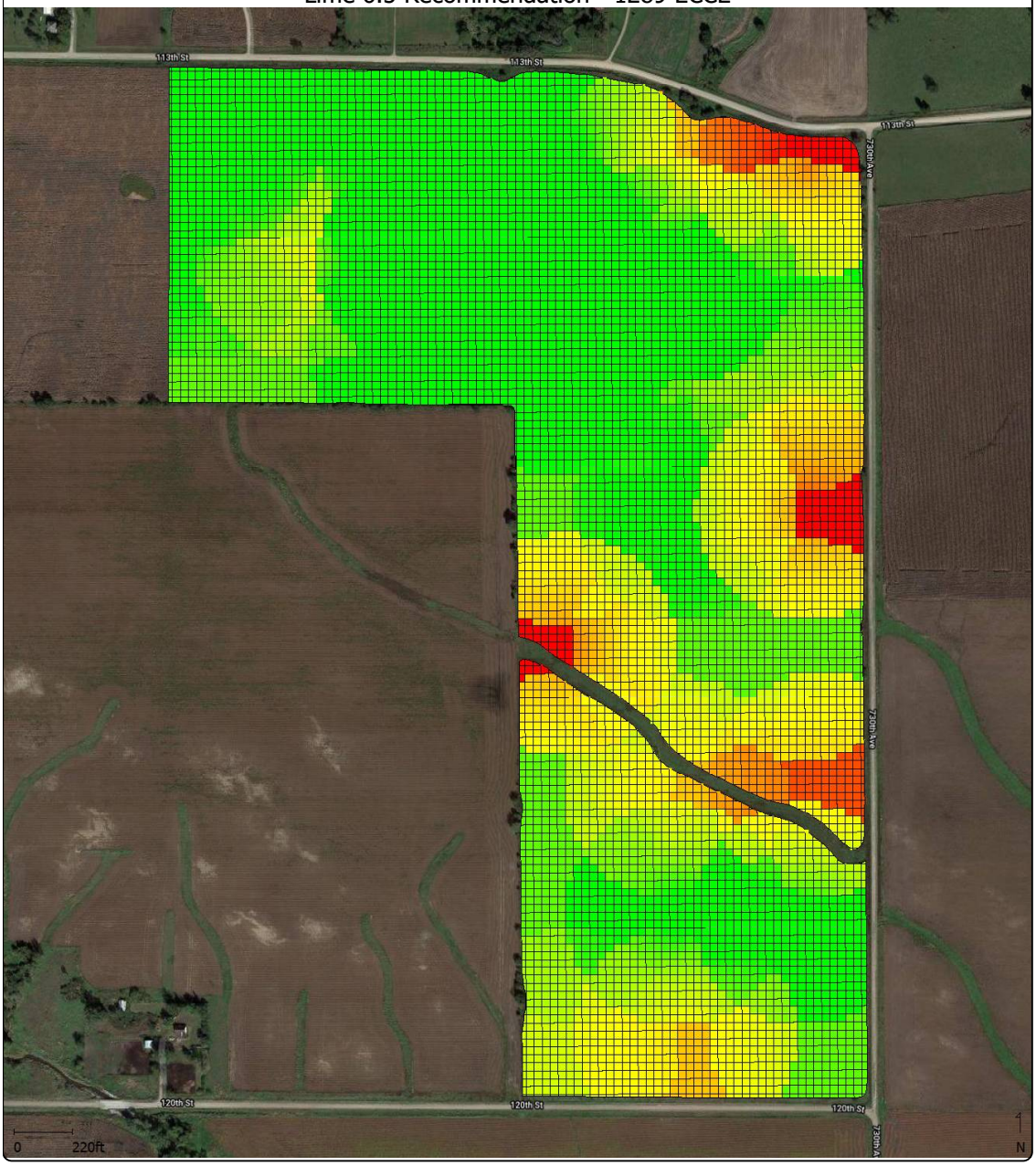
Kendall Upchurch - 85852112P4600 - Crains Farm East (147.15 ac)

Lime 6.5 Recommendation - 1289 ECCE



Target Rate (Mass)
(lb/ac)

6,000	(60.94 ac)
5,900	(2.99 ac)
5,800	(2.22 ac)
5,700	(1.76 ac)
5,600	(1.43 ac)
5,500	(13.98 ac)
5,400	(1.65 ac)
5,300	(2.03 ac)
5,200	(2.01 ac)
5,100	(1.92 ac)
5,000	(2.27 ac)
4,900	(1.96 ac)
4,800	(1.78 ac)
4,700	(1.46 ac)
4,600	(1.47 ac)
4,500	(1.66 ac)
4,400	(1.83 ac)
4,300	(3.83 ac)
4,200	(1.81 ac)
4,100	(1.88 ac)
4,000	(1.37 ac)
3,900	(1.46 ac)
3,800	(1.43 ac)
3,700	(1.50 ac)
3,600	(1.61 ac)
3,500	(1.78 ac)
3,400	(2.12 ac)
3,300	(1.74 ac)
3,200	(1.98 ac)
3,100	(1.36 ac)
3,000	(1.52 ac)
2,900	(1.23 ac)
2,800	(1.51 ac)
2,700	(0.95 ac)
2,600	(1.29 ac)
2,500	(0.85 ac)
2,400	(0.85 ac)
2,300	(0.87 ac)
2,200	(0.53 ac)
2,100	(2.43 ac)
2,000	(0.53 ac)
1,900	(0.44 ac)
1,800	(0.36 ac)
1,700	(0.42 ac)
1,600	(0.55 ac)
1,500	(0.62 ac)
1,400	(0.45 ac)
1,300	(0.27 ac)
1,200	(0.21 ac)
1,100	(0.16 ac)
1,000	(1.50 ac)
900	(0.15 ac)
800	(0.11 ac)
700	(0.10 ac)
0	(2.45 ac)

Grower : Kendall Upchurch
Farm : 85852112P4600
Field : Crains Farm East
Year : 2021
Product : Lime 6.5
Area : 147.15 ac
Average Rate : 4,866.1 lb/ac
Minimum Rate : 0.00 lb/ac
Maximum Rate : 6,000.0 lb/ac
Total Amount : 716,025 lb

pinnacle
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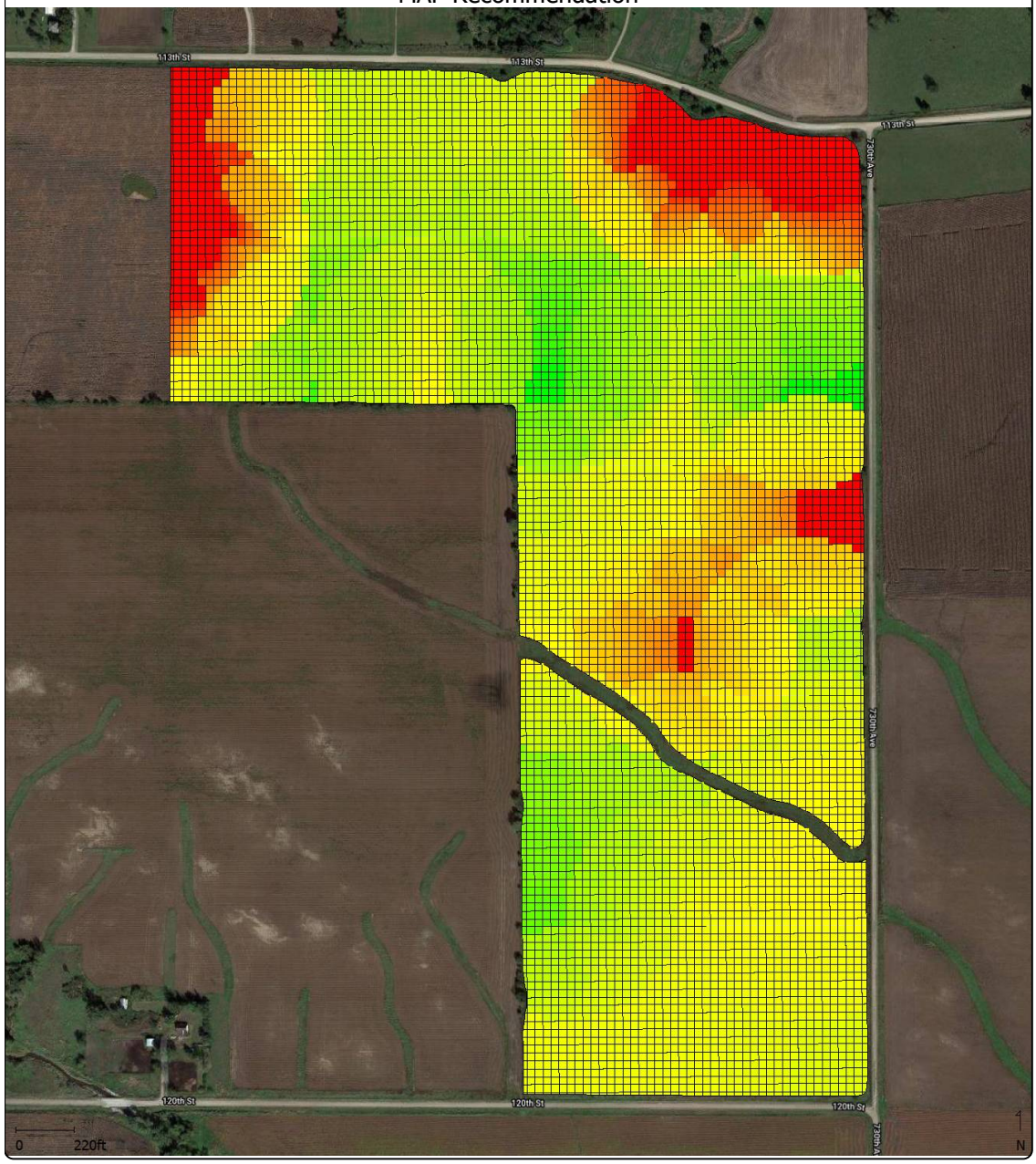
Kendall Upchurch - 85852112P4600 - Crains Farm East (147.15 ac)

MAP Recommendation



Target Rate (Mass)
(lb/ac)

285.0(1.14 ac)
280.0(0.10 ac)
275.0(0.40 ac)
270.0(0.73 ac)
265.0(1.90 ac)
260.0(4.06 ac)
255.0(3.71 ac)
250.0(5.31 ac)
245.0(7.00 ac)
240.0(7.60 ac)
235.0(8.11 ac)
230.0(8.50 ac)
225.0(8.37 ac)
220.0(5.22 ac)
215.0(6.23 ac)
210.0(6.41 ac)
205.0(13.25 ac)
200.0(5.75 ac)
195.0(3.10 ac)
190.0(7.36 ac)
185.0(1.94 ac)
180.0(2.35 ac)
175.0(2.96 ac)
170.0(3.21 ac)
165.0(2.31 ac)
160.0(2.26 ac)
155.0(2.91 ac)
150.0(2.23 ac)
145.0(2.05 ac)
140.0(2.09 ac)
135.0(1.70 ac)
130.0(1.57 ac)
125.0(1.31 ac)
120.0(0.88 ac)
115.0(0.90 ac)
110.0(0.69 ac)
105.0(0.92 ac)
100.0(0.50 ac)
0.0(10.54 ac)

Grower : Kendall Upchurch
Farm : 85852112P4600
Field : Crains Farm East
Year : 2021
Product : MAP
Area : 147.15 ac
Average Rate : 192.94 lb/ac
Minimum Rate : 0.00 lb/ac
Maximum Rate : 285.00 lb/ac
Total Amount : 28,390 lb

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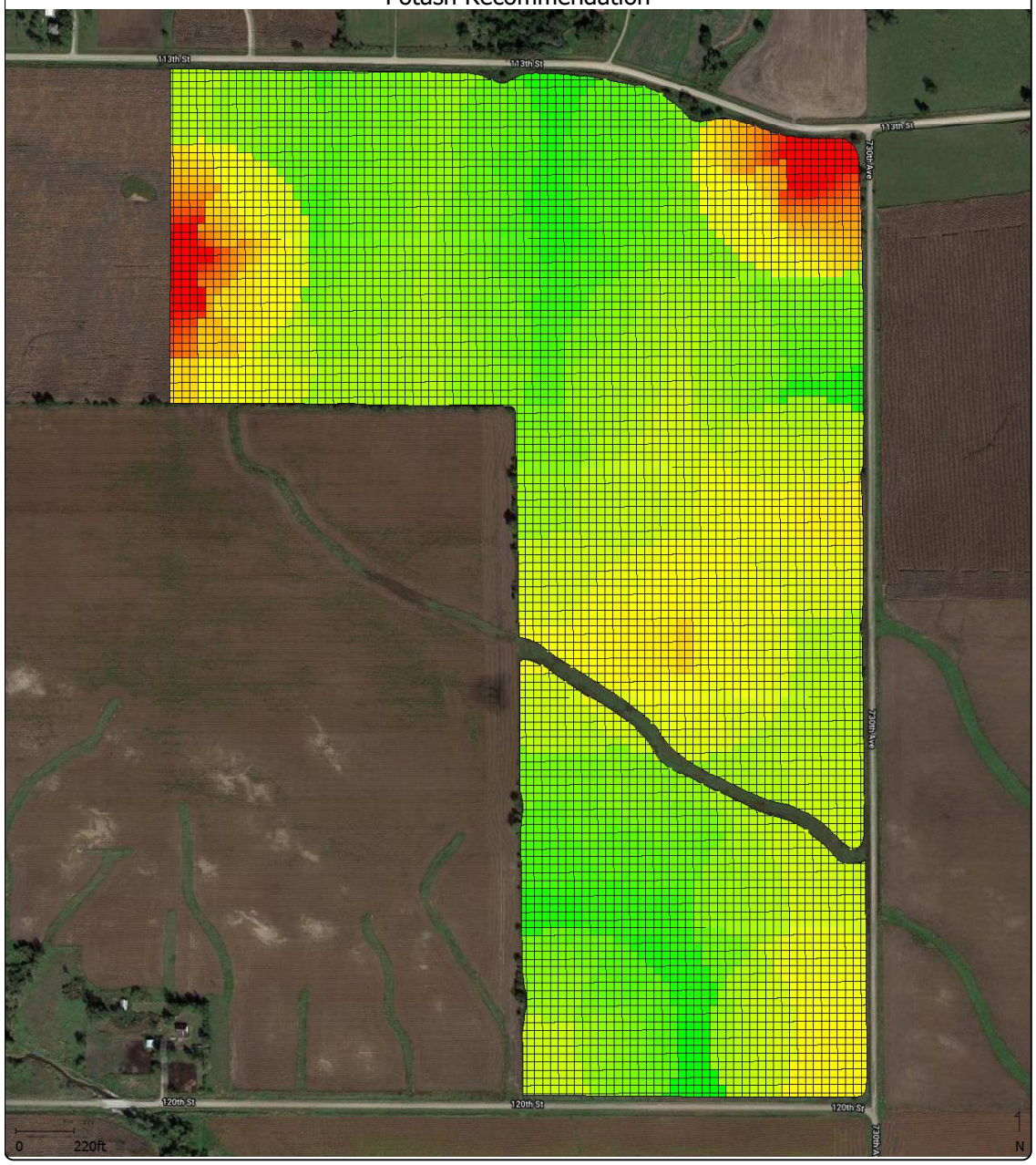
Kendall Upchurch - 85852112P4600 - Crains Farm East (147.15 ac)

Potash Recommendation



Target Rate (Mass)
(lb/ac)

335.0(0.94 ac)
330.0(5.17 ac)
325.0(2.78 ac)
320.0(5.70 ac)
315.0(7.95 ac)
310.0(9.99 ac)
305.0(12.22 ac)
300.0(10.18 ac)
295.0(9.92 ac)
290.0(5.95 ac)
285.0(6.85 ac)
280.0(6.61 ac)
275.0(5.19 ac)
270.0(3.98 ac)
265.0(5.42 ac)
260.0(3.49 ac)
255.0(5.19 ac)
250.0(2.03 ac)
245.0(2.11 ac)
240.0(2.91 ac)
235.0(3.62 ac)
230.0(3.79 ac)
225.0(3.35 ac)
220.0(2.27 ac)
215.0(1.84 ac)
210.0(1.46 ac)
205.0(3.11 ac)
200.0(2.22 ac)
195.0(0.93 ac)
190.0(0.60 ac)
185.0(0.37 ac)
180.0(0.62 ac)
175.0(1.08 ac)
170.0(0.48 ac)
165.0(0.66 ac)
160.0(0.50 ac)
155.0(0.33 ac)
150.0(0.44 ac)
145.0(0.34 ac)
140.0(0.45 ac)
135.0(0.30 ac)
130.0(0.34 ac)
125.0(0.38 ac)
120.0(0.32 ac)
115.0(0.40 ac)
110.0(0.26 ac)
105.0(0.30 ac)
100.0(0.22 ac)
0.0(2.00 ac)

Grower : Kendall Upchurch
Farm : 85852112P4600
Field : Crains Farm East
Year : 2021
Product : Potash
Area : 147.15 ac
Average Rate : 269.06 lb/ac
Minimum Rate : 0.00 lb/ac
Maximum Rate : 335.00 lb/ac
Total Amount : 39,590 lb

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