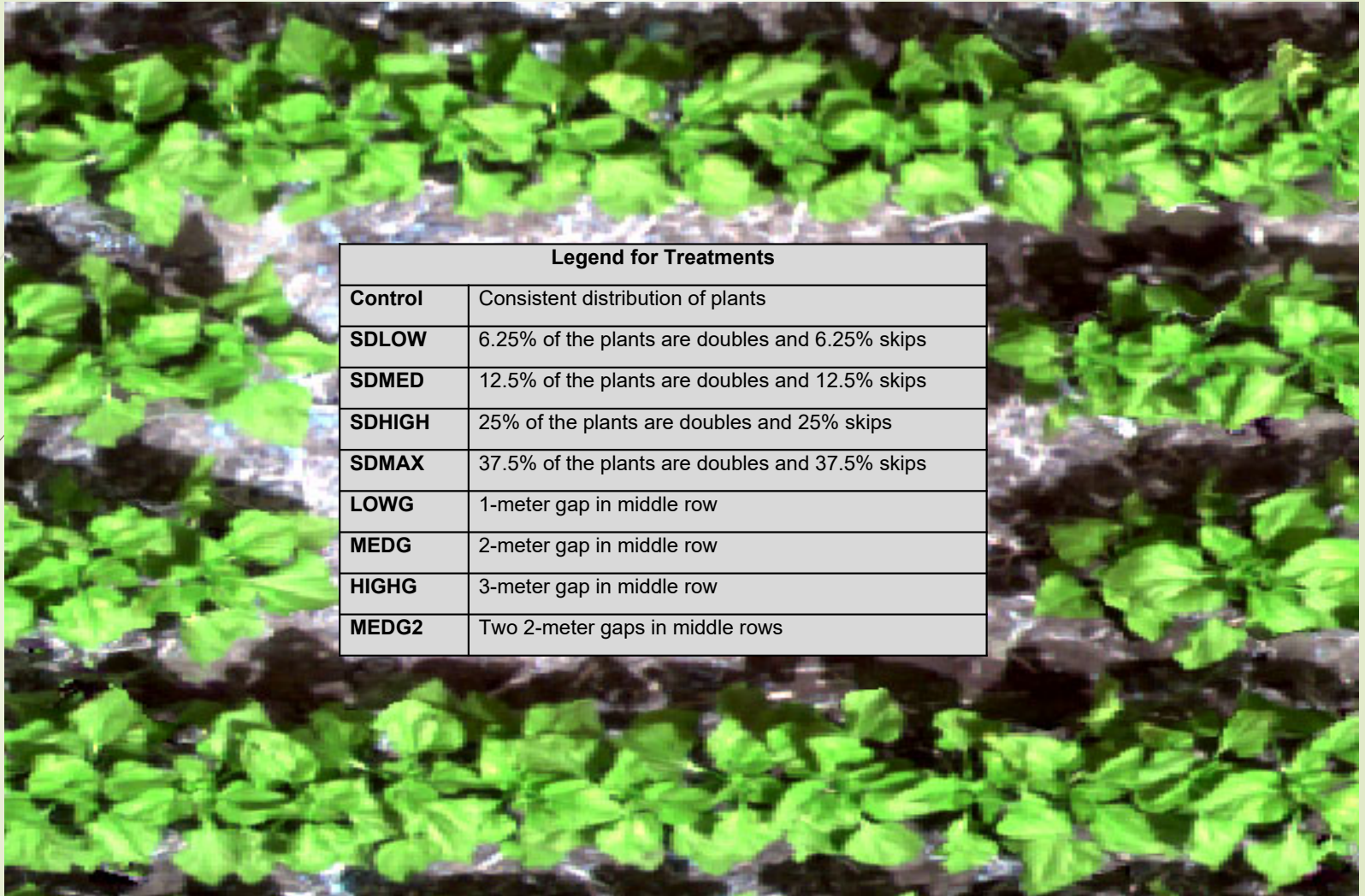# Impacts of Within-row Plant Spacing (Doubles, Skips, and Gaps) Given Consistent Population of Oilseed and Confection Sunflower (*Helianthus annuus* L.) with Phenotyping Using UAV Based Remote Sensing

Legend for Treatments	
Control	Consistent distribution of plants
SDLOW	6.25% of the plants are doubles and 6.25% skips
SDMED	12.5% of the plants are doubles and 12.5% skips
SDHIGH	25% of the plants are doubles and 25% skips
SDMAX	37.5% of the plants are doubles and 37.5% skips
LOWG	1-meter gap in middle row
MEDG	2-meter gap in middle row
HIGHG	3-meter gap in middle row
MEDG2	Two 2-meter gaps in middle rows

Yield 2019

- Confection yield n/s

- Texas Oilseed treatments were significant

- Unclear how the treatments impact yield

2019 Texas Oilseed Yield		
Treat	**Mean**	
SDMED	2833.3	A
SDHIGH	2686.8	AB
MEDG	2558.1	ABC
SDMAX	2541.2	BC
Control	2374.8	C
HIGHG	2313.4	C
Common letters indicate that treatments are not significantly different.		
CV = 7.36 LSD = 283		

Oilseed Quality

- Only significant at the Texas location

- Most likely not related to treatments

Oil % in Texas Oilseed		
Treatment	**Mean**	
MEDG	41.5986	A
SDHIGH	41.5546	A
Control	40.0464	B
SDMAX	40.0152	B
HIGHG	39.7328	B
SDMED	39.6413	B
Common letters indicate that treatments are not significantly different. LSD = 0.9201		

Confection Quality

- Seed size might attribute to yield compensation

- MEDG and HIGHG have fewer plants the rest of the treatments listed

2019 Least Square Means Confection Seed Size 22/64		
Treatment	Mean	
SDMED	0.58907	A
Control	0.61995	AB
SDMAX	0.63536	AB
SDHIGH	0.64134	AB
MEDG	0.68029	B
HIGHG	0.68871	B
Common letters indicate that treatments are not significantly different

CV = 9.58
LSD = 0.0738 | | |

Yield 2020

- MEDG2 is lower than the control

- No strong impact on yield

2020 MN Confection Yield		
Treatment	**Mean**	
Control	2104.4	A
LOWG	2064.7	AB
SDHIGH	2015.8	AB
SDMAX	2008.9	AB
HIGHG	2000.1	AB
SDLOW	1959.3	AB
MEDG	1956.3	AB
SDMED	1948.2	AB
MEDG2	1844.1	B
Common letters indicate that treatments are not significantly different		
CV = 7.61 LSD = 220.88		

Confection Quality

- Only significant for the 24/64 size at the MN location

- Further analysis with the TX data is needed

- Seed samples from 2019 and 2020 will be analyzed with image J as well

2020 Confection 24/64		
Treatment	**Mean**	
MEDG2	0.08018	A
SDMED	0.06279	AB
LOWG	0.05638	B
Control	0.05611	B
HIGHG	0.05442	B
SDHIGH	0.05037	BC
SDMAX	0.04948	BC
SDLOW	0.0454	BC
MEDG	0.02769	C
Common letters indicate that treatments are not significantly different.		
CV = 7.61 LSD = 0.0237		

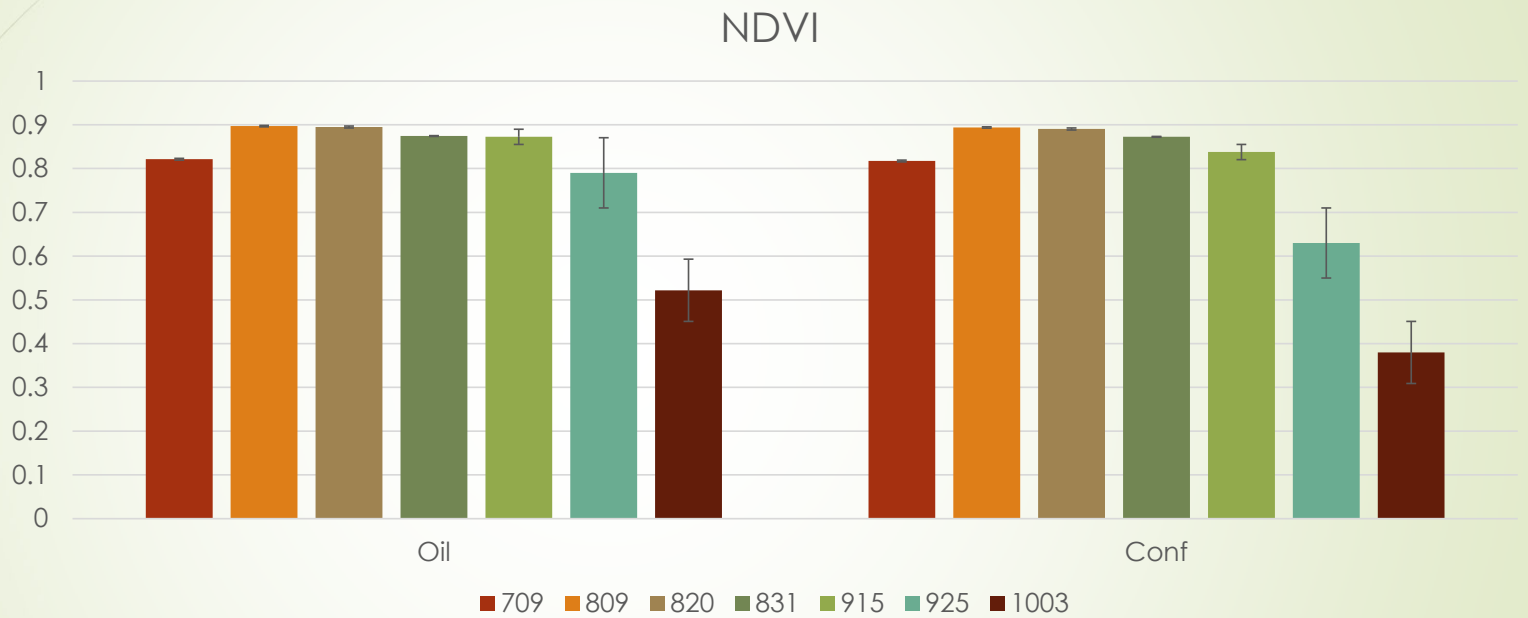# Remote Sensing

- Emergence
- Maturity
- Thermal
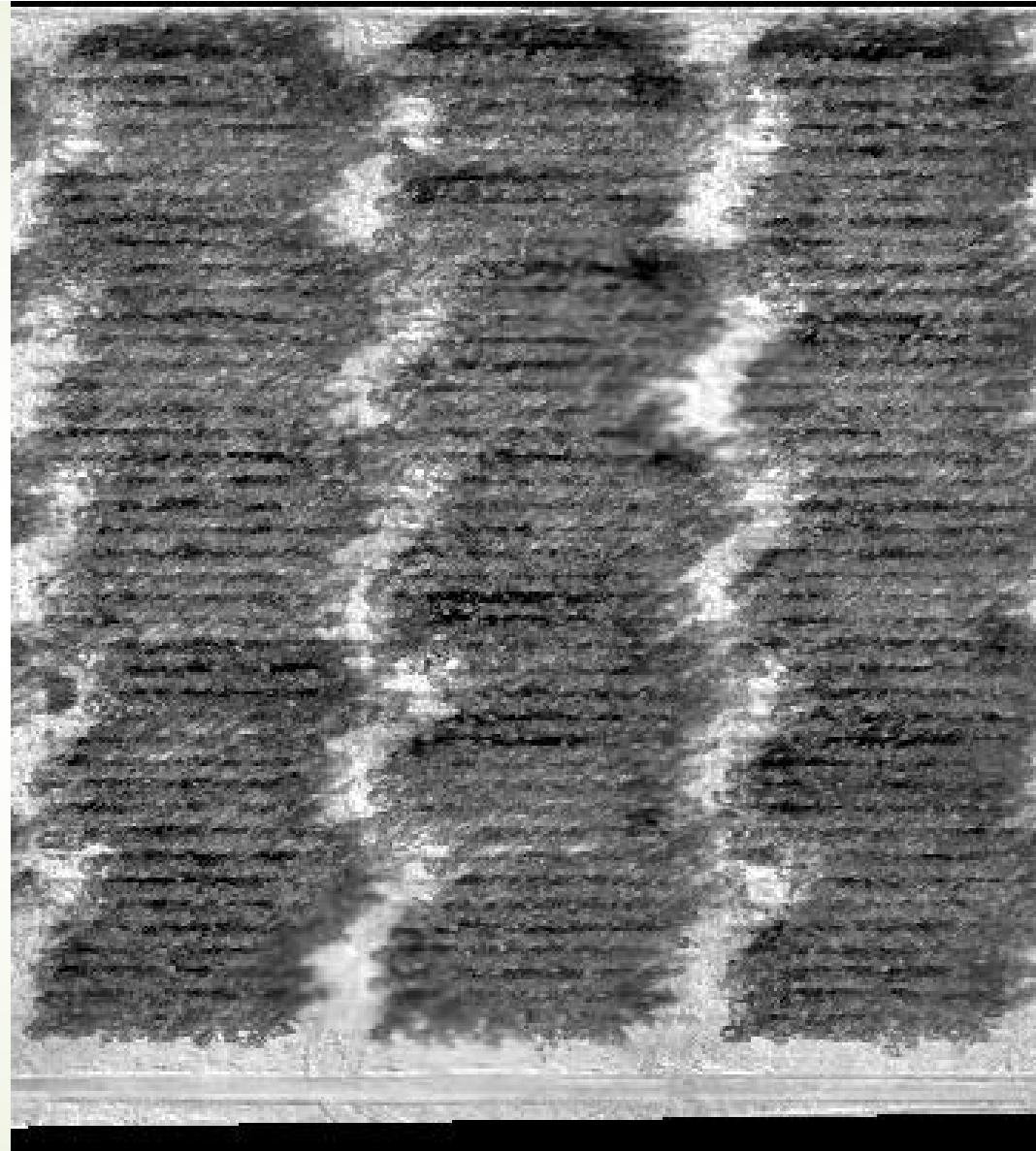
Emergence

- High winds and rain prevented drone imagery of emergence this year

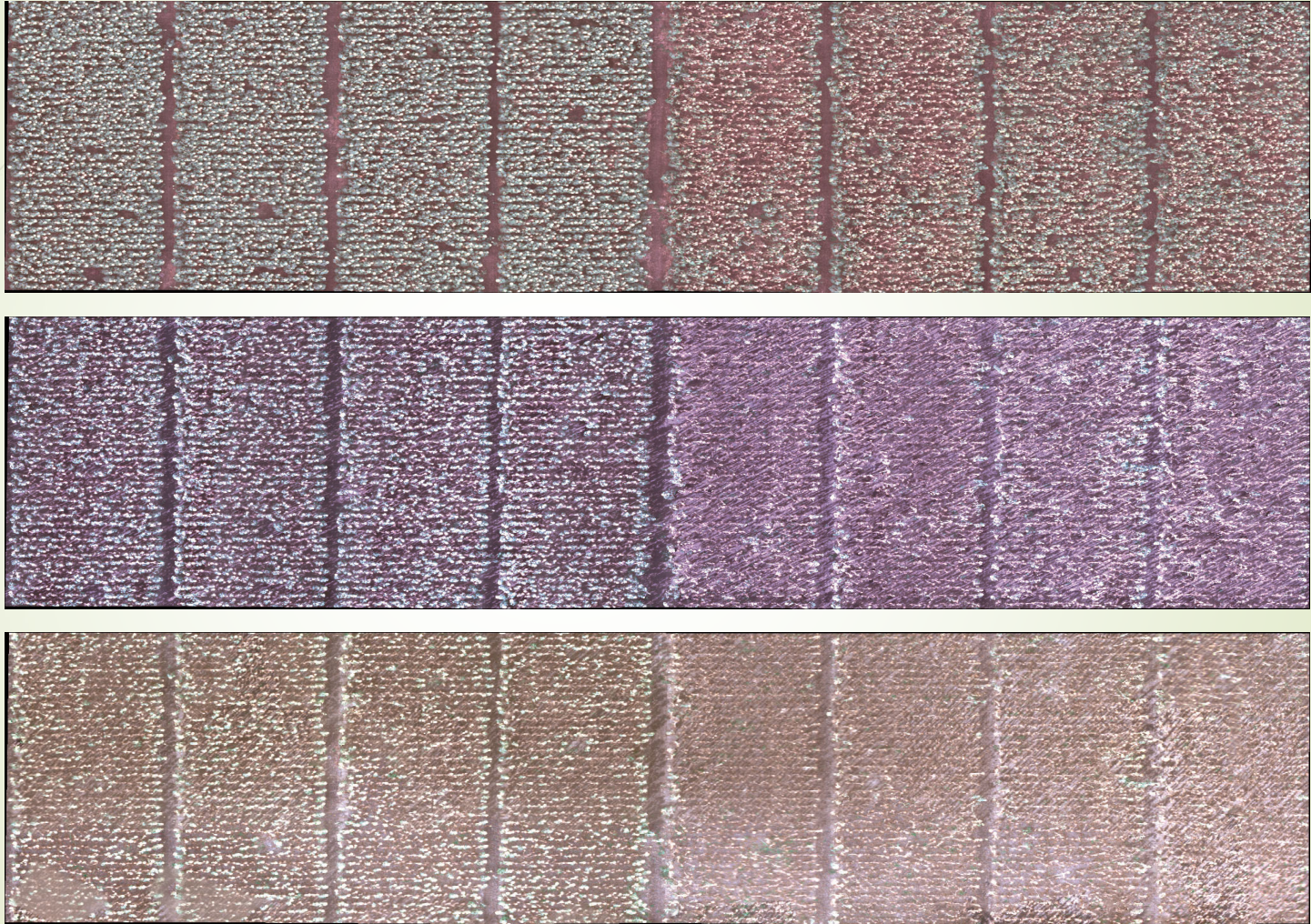- Time-lapse cameras are viable for backup data collection and ground truthing

Maturity

NDVI

Oil   Conf

■ 709   ■ 809   ■ 820   ■ 831   ■ 915   ■ 925   ■ 1003

➡ NDVI does drop as crop matures

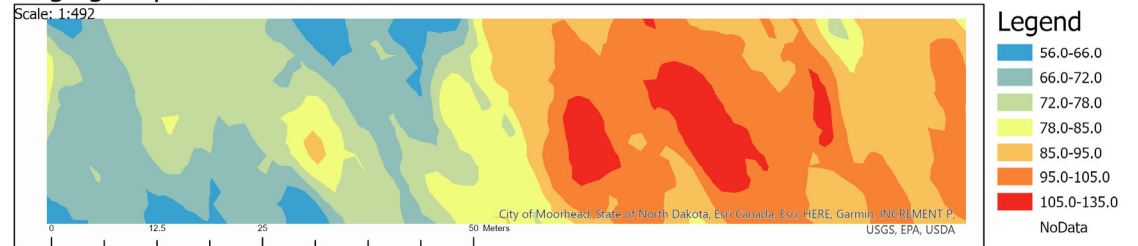➡ Will be compared against a chlorophyll index
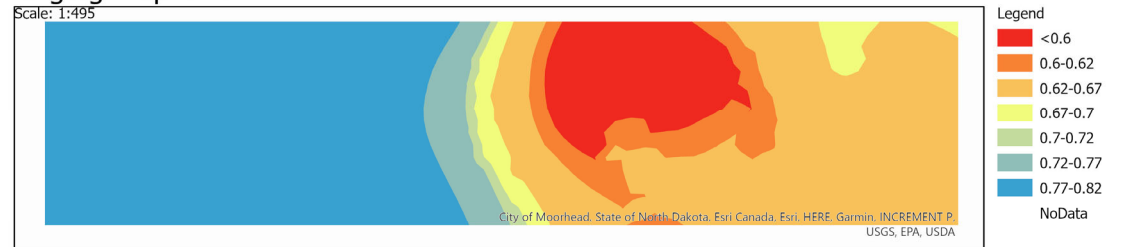
Top to bottom, 915, 925, 1003

Thermal

- Everything is related to everything else, but near things are more related than distant things. - Waldo Tobler

- Left half of the field is oilseed. Right half is confection

- Thermal and NDVI values are taken from drone imagery

- Disease incidence was noted for middle rows prior to harvest and provides QA/QC

- NDVI appears to be less sensitive than thermal imagery

- Potential confounding factors; leaf drop, early maturity, and grouping confection

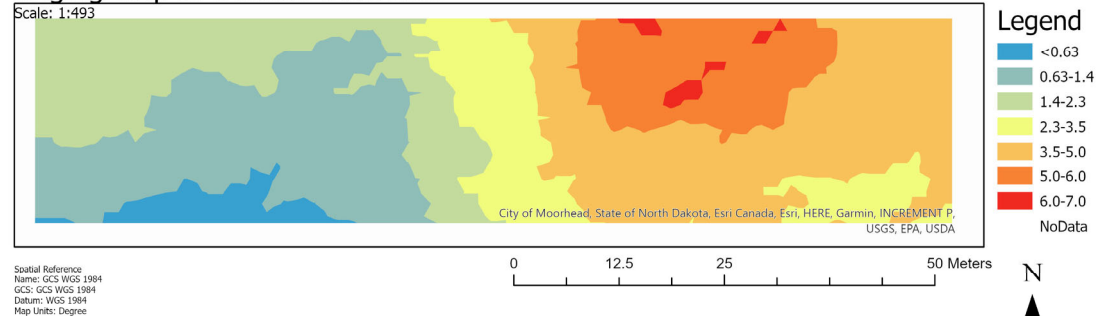- Will be repeated with a radiometric thermal camera next season

Kriging map of Thermal values
Scale: 1:492

Legend
- 56.0-66.0
- 66.0-72.0
- 72.0-78.0
- 78.0-85.0
- 85.0-95.0
- 95.0-105.0
- 105.0-135.0
- NoData

City of Moorhead, State of North Dakota, Esri Canada, Esri, HERE, Garmin, INCREMENT P, USGS, EPA, USDA

Kriging map of NDVI
Scale: 1:495

Legend
- <0.6
- 0.6-0.62
- 0.62-0.67
- 0.67-0.7
- 0.7-0.72
- 0.72-0.77
- 0.77-0.82
- NoData

City of Moorhead, State of North Dakota, Esri Canada, Esri, HERE, Garmin, INCREMENT P, USGS, EPA, USDA

Kriging map of Disease Incidence
Scale: 1:493

Legend
- <0.63
- 0.63-1.4
- 1.4-2.3
- 2.3-3.5
- 3.5-5.0
- 5.0-6.0
- 6.0-7.0
- NoData

City of Moorhead, State of North Dakota, Esri Canada, Esri, HERE, Garmin, INCREMENT P, USGS, EPA, USDA

Spatial Reference
Name: GCS WGS 1984
GCS: GCS WGS 1984
Datum: WGS 1984
Map Units: Degree

Thank you!

National Sunflower Association

Brent Hulke

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Brady Koehler

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Andre Gossweiler

Mike DeGreef

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