# Nitrogen and phosphorus recalibration for modern varieties of sunflower (*Helianthus annuus*, L.) in the northern Great Plains of the U.S.A.


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## Abstract


Sunflower producers in the northern Great Plains are presently directed to N and P recommendations that originate from research performed in the late 1960s and 1970s. In 2014, one year out of a two-year study to recalibrate the N and P recommendations for modern varieties of sunflower was completed with 11 dryland sunflower field sites in North Dakota and three dryland sunflower field sites in South Dakota. Each field study site included N fertilizer rates of 0, 45, 90, 134, 179, and 224 kilograms per hectare and P fertilizer rates of 0, 34, 67, and 101 kilograms per hectare. Yield and oil measurements were analyzed using least significant difference (LSD) and quadratic polynomial correlation with N rates. Yield responses to N and P were observed at nine and two sites, respectively, out of 14 total sites. Sunflower oil content responded to N and P- at four and three sites, respectively, with the 101 kilogram per hectare rate yielding the greatest percent increase in oil, and the 45 kilogram per hectare N rate providing the greatest percent increase in oil over the check.


## Introduction

- Northern Great Plains states of North Dakota, South Dakota, and Minnesota produce more than 80% of total sunflowers in the United States on a yearly basis (USDA-NASS, 2015).
- Since development of first N and P recommendations, production practices of crop rotations and conservation tillage, as well as technologies of crop protection products and genetics-based solutions through defensive breeding (Hulke and Kleingartner, 2014) have advanced.
- Current yield-based recommendation formulas reflect linear responses to fertilizer (Franzen, 2010):

  *N-rate = (0.05 x Yield Potential (or Yield Goal)) – N credits*

  *P-rate = (0.0225 – (0.0014 x STP)) x YP (or YG)*
- Updated recommendations for corn (Franzen, 2014) and wheat (Franzen, 2009) in North Dakota have successfully utilized curvilinear yield response to fertilizer. Sunflower updated recommendations will include curvilinear yield response as well.

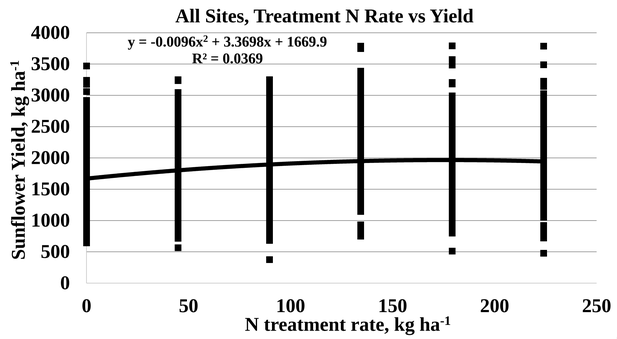
## Objectives

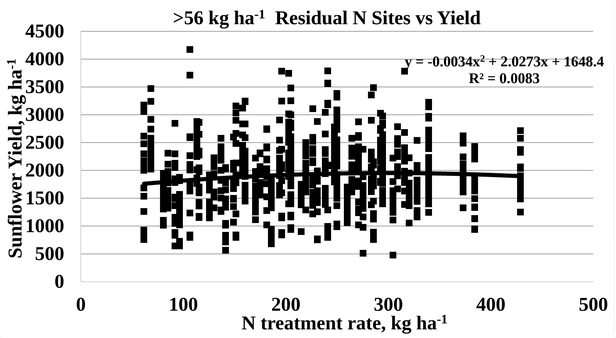
1. Develop modern N recommendations for sunflower grown in the northern Great Plains using general productivity history, documented responses, and economic analysis.
2. Develop modern P recommendations for sunflower grown in the northern Great Plains using general productivity history, documented responses, and economic analysis.

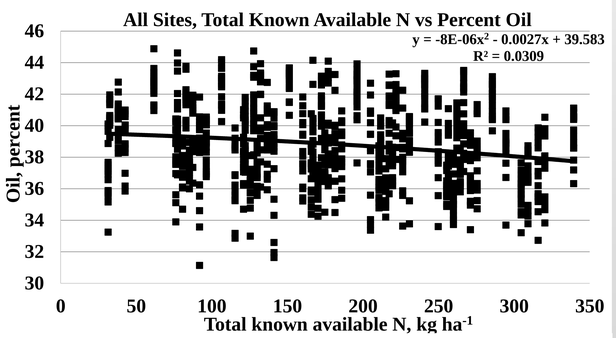
## Materials and Methods

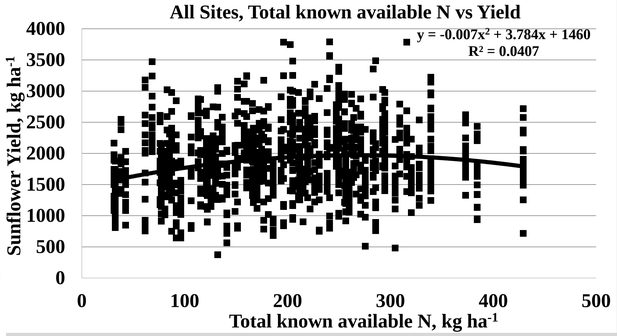
- The study was conducted over 14 total sites in two states, with 11 sites in North Dakota and three sites in South Dakota.
- Soil was sampled for residual nitrate-N to 61-cm depth; P sampled to 15-cm depth.
- The experimental design was a RCBD with four replications per site.
- The treatments were arranged in a split-plot with 6 N rates (0, 45, 90, 134, 179, and 224 kg N per hectare) applied preplant as ammonium nitrate in the main plots and 4 P rates (0, 34, 67, and 101 kg P per hectare) applied preplant as triple superphosphate in the sub-plots.
- Experimental unit size: 3 x 9.1 m.
- Sites planted, with cooperators' hybrid choice, and managed by cooperator (herbicide application(s), no additional fertilizer added).
- South Dakota sites were planted and managed by the South Dakota State team.
- Seed yield and percent oil were obtained.

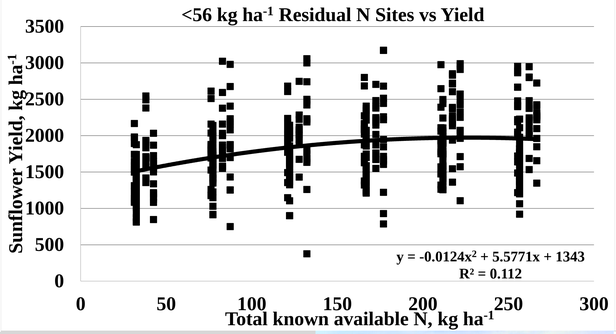
## Results



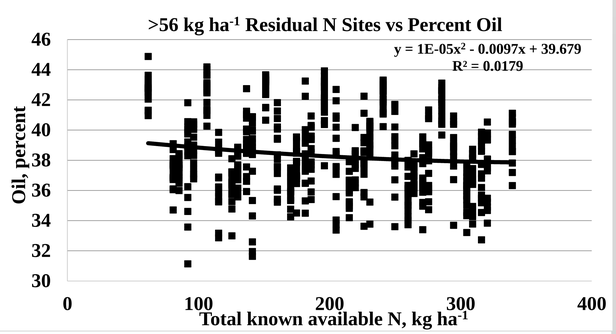
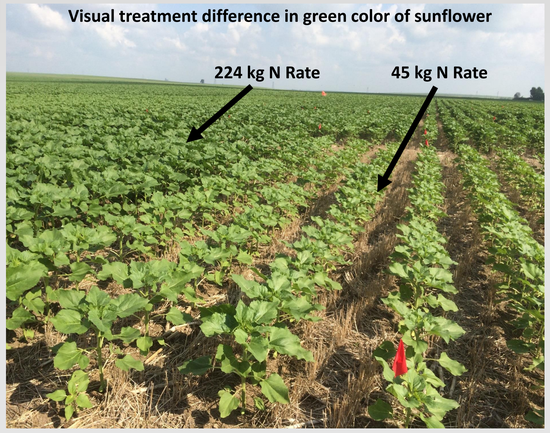




**Table 1. Selected 2014 site information including pre-plant soil test values for $NO_3$-N and P.**

| Site ID | Texture | Tillage-Previous Crop | $NO_3$-N (kg N ha$^{-1}$) | $NO_3$-N Rank | Olsen-P (ppm 15 cm) | Soil-P Category* |
|---|---|---|---|---|---|---|
| A-ND | Silt loam | No-till-wheat | 43 | Low | 5 | L |
| B-ND | Silt loam | No-till-wheat | 33 | Low | 14 | H |
| BF-ND | Loamy sand | No-till-wheat | 38 | Low | 17 | VH |
| C-ND | Silt loam | Conventional till-corn | 205 | High | 21 | VH |
| DN-ND | Silty clay loam | No-till-corn | 149 | High | 32 | VH |
| DS-ND | Silty clay | No-till-corn | 32 | Low | 8 | M |
| HT-ND | Loam | No-till-corn | 85 | High | 19 | VH |
| HZ-ND | Loam | No-till-wheat | 92 | High | 18 | VH |
| H-ND | Fine sandy loam | No-till-wheat | 115 | High | 9 | M |
| NU-SD | Silt loam | No-till-wheat | 81 | High | 16 | VH |
| O-SD | Silt loam | No-till-wheat | 96 | High | 10 | M |
| P-SD | Silt loam | No-till-wheat | 61 | High | 17 | VH |
| VC-ND | Loam | No-till-wheat | 33 | Low | 14 | H |
| W-ND | Loam | Conventional till-corn | 68 | High | 12 | H |

*Soil-P categories with percent chance of response with addition of fertilizer P: L: Low, 50-80%; M: Medium, 20-50%; H: High, 10-20%; VH: Very High, <10%.





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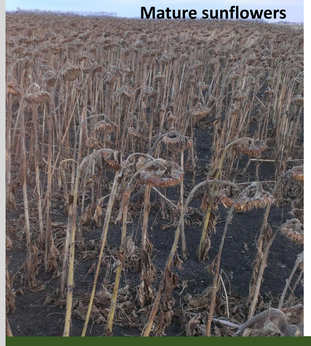


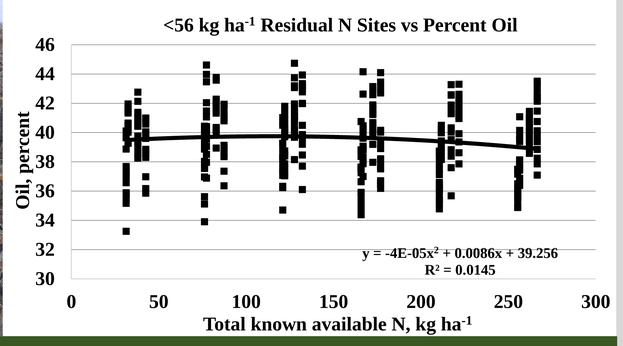


## Summary

- Poor yield-N relationships reflect specific production issues including lodging, bird damage, and downy mildew.
- High residual N impacted yield and oil responses the greatest, limiting N influence from treatments resulting in observed $R^2$ values.
- Response to P for yield and oil occurred on one site with low soil-P and three others with high/very high soil-P. Overall, P appears micronutrient-like given the lack of response from first-year results.
- Shape of the yield and oil response curves, particularly for the high residual N sites, suggest that deep residual N (below 60 cm) is providing substantial N for sunflower.
- Experiments located on sites with lower residual N indicate that modern varieties of sunflower require more N per kilogram of yield than formulas for the northern Great Plains currently recommend.
- Second year results, 2015, will provide a more extensive dataset needed to adequately formulate new recommendations.

## Acknowledgements


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