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Application Summary

Competition Details

Competition Title:	2025 South Dakota Nutrient Research and Education Council Invited Proposals
Category:	SDAES
Cycle:	2025
Submission Deadline:	10/15/2024 5:00 PM

Application Information

Application Title:	The Effect of Fertilizer Placement in No-Till Fields On Corn Nutrient Uptake, Use Efficiency, and Yield
Application ID:	3454
Submission Date:	10/14/2024 12:55 PM

Personal Details

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Application Details

Proposal Title

The Effect of Fertilizer Placement in No-Till Fields On Corn Nutrient Uptake, Use Efficiency, and Yield

Proposal Abstract

In no-till systems, surface broadcasting fertilizers leads to stratification of P and K and may reduce nutrient availability and increase nutrient loss potential. Banding of P and K fertilizers below the soil surface has the potential to improve availability of P and K to corn roots and increase early season nutrient uptake, nutrient use efficiency, and corn growth. In South Dakota the effect of P placement was last studied in 1998-1999 where the banded P resulted in an average yield increase of 4 bu/ac. However, for K there is no recently published comparison of broadcasting vs. banding on corn production. The distance from the seed row where P and K fertilizer should be placed to optimize nutrient uptake and corn yield is also needed. The objective is to determine the effect of P and K fertilizer placement (surface broadcast vs. banding) on corn growth and yield and nutrient use efficiency.

2025 Total Budget Request

83,887

Acknowledgment

Acknowledgement of Terms and Conditions

[Acknowledged] I have read and agree to abide by the South Dakota Nutrient Research and Education Council Terms and Conditions attached to this RFP.

The Effect of Fertilizer Placement in No-Till Fields On Corn Nutrient Uptake, Use Efficiency, and Yield

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Co-PI: Péter Kovács, Assistant Professor, Precision Ag Cropping Systems, and Anthony Bly, SDSU, Soils Field Specialist

Summary

In no-till systems, surface broadcasting fertilizers leads to stratification of P and K and may reduce nutrient availability and increase nutrient loss potential. Banding of P and K fertilizers below the soil surface has the potential to improve availability of P and K to corn roots and increase early season nutrient uptake, nutrient use efficiency, and corn growth. In a recent summary of the literature across the U.S., application of banded fertilizer under the row or to the side increased corn yield by 5.2%. In South Dakota the effect of P placement was last studied in 1998-1999 where the banded P resulted in an average yield increase of 4 bu/ac. However, for K there is no recently published comparison of broadcasting vs. banding on corn production. The distance from the seed row where P and K fertilizer should be placed to optimize nutrient uptake and corn yield is also needed. This type of research is minimally done due to unavailability of research equipment. However, in the past year a variable rate fertilizer applicator has been developed at SDSU that can be used to apply fertilizer by broadcasting or banding with a coulter. This applicator can adjust the bands distance from under the seed row to the middle between two seed rows. Therefore, with this new equipment we can gain understanding of the best distance from the seed row to band P and K fertilizers. The goal of this project is to evaluate the efficacy of current SDSU fertilizer placement recommendations and update them as needed. The specific objective is to determine the effect of P and K fertilizer placement (surface broadcast vs. banding) on corn growth and yield and nutrient use efficiency. Research will be used to update and develop P and K placement recommendations for no-till corn systems. The project results will be shared annually with the cooperating producers and agronomists. This study will also be the basis of extension programming (presentations and fact sheets) regarding P and K recommendations and the effect of soil properties on P and K recommendations. Results will provide growers and agronomists with updated P and K management information. The approximate annual budget of this three-year project is $83,887

Goals and Objectives

The goal of this project is to evaluate the efficacy of current SDSU fertilizer placement recommendations and update them as needed. The specific objective of this project is to determine the effect of P and K fertilizer placement (surface broadcast vs. banding) on corn growth and yield and nutrient use efficiency.

Justification

The placement of P and K fertilizer on the soil surface or incorporating them into the soil can affect their availability to plants and potential loss. In no-till corn fields in South Dakota, the two most common fertilizer application methods are to broadcast nutrients on the soil surface (36%) and banding fertilizer under the row (9%). Broadcasting fertilizer is faster and cheaper compared to banding fertilizer. However, broadcast application of fertilizer in no-till systems leads to stratification of P and K and may reduce fertilizer use efficiency. Reasons for this reduced efficiency may be due to fixation of nutrients in soils with a pH >7.4 or that surface

broadcasted fertilizer applications rely on rain to move the P and K into the soil profile enough for roots to take up the nutrients. Therefore, in no-till systems placing P and K below the soil surface during planting or after using banding equipment is often used to improve early season nutrient uptake, nutrient use efficiency, and corn growth. In a recent summary of the literature across the U.S., application of banded fertilizer under the row or to the side increased corn yield by 5.2% and was consistent across many environments. In South Dakota the effect of P placement was last studied in 1998-1999 where the banded P resulted in an average yield increase of 4 bu/ac. However, for K there is no recently published comparison of broadcasting vs. banding on corn production. An updated comparison on the effect of broadcast vs. banded P and K fertilizer is needed to update current SDSU recommendations.

In addition to needing to know the effect of placement of P and K fertilizer on or below the soil surface on corn nutrient uptake and corn production is the distance from the seed row the fertilizer should be placed to optimize nutrient uptake and corn yield. This type of research is minimally done due to unavailability of research equipment. However, in the past year a variable rate fertilizer applicator has been built at SDSU that can be used to surface broadcast and band using a coulter. This applicator can adjust the bands distance from under the seed row to the middle between to seed rows. Therefore, with this new equipment we can gain understanding on the best distance from the seed row to band P and K fertilizers.

Work Plan

Four study locations on farmers' fields will be chosen each year of this three-year proposal. Study locations will use no-till and be planted into corn. Sites will be determined by working with farmers and agronomists. Five nutrient rates will be applied for P and K (0, 30, 60, 90 and 120 lbs ac^{-1}) using two placement methods (surface broadcast and sideband). In the P rate plots, the K rate will be applied according to current SDSU recommendations and vice versa for the K rate plots. At two sites additional spacing treatments will be evaluated for the banding treatments where five distances from the row will be evaluated (0, 2, 5, 10, and 15 inches from seed row). Air temperature, precipitation, and other weather conditions will be monitored daily with a nearby weather station. Nitrogen fertilizer rates will be applied according to SDSU guidelines and pre- and post-emergent herbicides will be used for weed control as needed.

Data Collection

Soil samples will be taken before planting and fertilizer application from each replication at depths of 0–4 and 0–6 inches, sealed in a plastic bag, and stored in coolers with ice until they can be processed. Both the 0–4 and 0–6 in. samples will be analyzed for soil organic matter, pH, CEC and several P and K measurements. Phosphorus measurements include Bray P-1, Mehlich 3 P, Olsen P, H3A P, and total P while K measurements include ammonium acetate K, Mehlich 3 K, H3A K, water soluble K, and total K. These vary soil P and K measurements will be related to P and K fertilizer yield response results to determine which soil test P and K tests can be used to best predict when corn will respond to fertilization. This important as many laboratories are changing their default methods to test for P and K and only Olsen P, Bray-1 P and ammonium acetate K have results in South Dakota that can be used to inform farmers of the likelihood of seeing a response to P or K fertilization. The 0–6 in. depth samples will also be analyzed for C (organic and total C and permanganate oxidizable C) and soil health and enzyme measurements related to P or K cycling (soil respiration, alkaline phosphatase, acid phosphatase, and phosphodiesterase).

Plant samples will be obtained early in the season at V6 and again at plant maturity. Plant samples at V6 will be collected by clipping six plants at ground level. For the R6 sampling, ears will be removed and measured separately from the above ground vegetative matter (stover). Plant materials will be dried in a forced air oven (140^{o}F) until constant mass and weighed to determine dry matter yield. Corn ears will be shelled, and dry weights of grain and cob samples measured. Nitrogen concentration of the grain and vegetative matter will be measured after samples are ground to pass through a 0.08 in. sieve using the Dumas combustion method (Bremner, 1996). These analyses will be used to track the uptake of P and K by the plant and determine the effect of nutrient placement on P and K uptake. Harvest grain yield will be calculated by harvesting the center two rows of each corn plot and adjusting grain weight to 15.5% moisture.

Information from this project will be used to improve P and K fertilizer guidelines for corn. This information will help to reduce the potential for under- or over-application of P or K fertilizer in no-till fields, increasing profitability and decreasing the potential for negative environmental effects associated with over-application of P fertilizer. Results will be communicated at various field days, extension, and CCA events. Three of the project leaders have extension appointments, which will also help to communicate the updates and results of the project to producers, crop advisors, and other stakeholders.

Potential Impacts

- Knowledge gained related to the effect of P and K placement in no-till fields on corn P and K uptake and yields.
- Determination of the soil tests for P and K that can be used to best predict the response of corn to P and K fertilization.
- Improved P and K fertilizer recommendations regarding the comparison of broadcast vs. banded P and K fertilizer and the distance from the row the maximizes yield, nutrient use efficiency, and profit.
- Improved K fertilizer guidelines for corn that increases profitability and environmental stewardship.
- Extension programming (presentations and fact sheets) regarding appropriate soil tests to be used to make P and K fertilization decisions along with the placement of the fertilizer.
- Training of a graduate and several undergraduate students in soil fertility.

Timeline

Activity	**2025**				**2026**
	Jan-Mar.	**Apr-June**	**July-Sept**	**Oct-Dec**	**Jan-Mar**
Identify experimental field sites	**x**				
Soil samples for chemical, physical, and biological properties	x	x			
Fertilization and crop planting		x			
Plant sampling		x		x	
Harvest				x	
Sample and Data Processing, report writing			x	x	x

Project Budget and Justification

The budget of the project is $83,887. The cost will cover salaries for PIs, graduate student, and undergraduate student workers to help set up and maintain research sites, plant, apply fertilizer, collect data, process samples and data, and harvest. It will also cover the cost to

travel to the research sites, purchase tools to mark and sample the plots, analyze collected samples, and pay land/equipment usage fees.

Total Project Budget: $83,887

Personnel and Fringe: $27,919

Jason Clark	$5,630	Provide oversight of the project and personnel throughout the year along with data collection, analysis, and update of fertilizer recommendations.
M.S. Student	$30,232	M.S. student to help in trial establishment, sample and data collection, data analysis, and interpretation and writing of results.
Student help	$9,000	Undergraduate student wages to help aid in field and laboratory work.
Fringe Benefits	$1,147	Fringe benefits for full- and part-time personnel.

Travel and Accommodations: $6,000

Costs of travel from Brookings to the four field research locations. This includes approximately 11 trips to establish, maintain, and collect samples and travel to local, regional, and national extension and professional meetings for researchers and students to present results.

Materials & Supplies: $4,000

Costs of materials and supplies (plot flags, plot stakes, bags, seed, fertilizer, harvest materials, hand tools, etc.) for implementing and assessing treatments at all sites. Cost also includes laboratory supplies (i.e. chemicals, pipettes, filters, etc.) and computer and software supplies for researchers to complete soil and plant nutrient and statistical analyses.

Contractual: $29,200

$6,000 for soil physical, chemical, and biological measurements. These soil and plant analyses will be completed at labs within South Dakota State University and certified commercial laboratories.

$5,500 for plant analysis. These plant analyses will be completed at labs within South Dakota State University and certified commercial laboratories.

$3,200 is budgeted for land rental and user fees of university research farm fields.

$13,000 is budgeted for user fees associated with equipment use of hydraulic soil sampler, tractors, fertilization equipment, planters, plant and soil processing equipment, and combine to mark out research areas, sample soil, establish treatments, plant, maintain crops and research areas, and harvest crops along with advertising for recruitment of employees and graduate students.

$1,500 is budgeted for registration cost for researchers to attend professional conferences.

Tuition Remission:

$7,678 is budgeted for tuition remission for the Ph.D. student in accordance with SDSU and the SD Board of Regents program.

References

Bremner, J.M. 1996. Nitrogen-total. In: Sparks, D.L., editor, Methods of soil analysis. Part 3, Chemical methods. SSSA book series: 5. ASA, CSSA, and SSSA, Madison, WI. p. 1085–1122