KANSAS FERTILIZER RESEARCH FUND PROPOSAL 2014 -2015

a. Project title

No-till and strip-till corn and soybean production with surface and subsurface fertilization

b. Principal investigator(s), department, email, and telephone number

Dorivar Ruiz Diaz, Soil Fertility Specialist, Dep. of Agronomy,
e-mail: ruizdiaz@ksu.edu, phone: 785-532-6183

David Mengel, Soil Fertility Specialist, Dep. of Agronomy,
e-mail: dmengel@ksu.edu , phone: 785-532-2166

Eric Adee, Agronomist, KRV experiment field, Dep. of Agronomy,
e-mail: eadee@k-state.edu , phone: 785-354-7236

c. Introduction and project justification

No-till farming provides many benefits including increased water use efficiency, and reduced soil erosion and on-farm energy use, with significant increase in the adoption of this system in recent years. However, some conditions of excessive residue accumulation, for example high yielding irrigated fields, may require some level of tillage or residue management. Strip-tillage aim to combine no tillage with conventional tillage so that residue is incorporated in a narrow band and soil is loosened for planting, providing a good alternative for residue management. In the same pass, the addition of fertilizer in a deep band (6-8 in) with strip-till allows for concentrated nutrients directly below the seed. Reduced tillage systems have shown to positively impact soil water relationships by increasing the number of macropores and water infiltration, and therefore, likely reducing water runoff. When moisture is held in the topsoil in response to reduced tillage, uptake of P and other immobile nutrients from the soil surface can be increased (Boomsma et al., 2007).

Broadcast fertilizer application can result in a more uniform distribution and likely affecting more soil volume. Crops have shown a response in low soil test P (STP) conditions (Bordoli and Mallarino, 1998) and medium to high STP (Mallarino et al., 1991). However, accumulation of P near the soil surface may result in higher lost potential with runoff with potential negative impact for surface waters. Furthermore, there is a possible decreased P availability due to increased soil-fertilizer interaction in soils with high P sorption capacity. Broadcast application may be more practical for some producers and suitable for some soils and tillage conditions. However, soils and tillage conditions and the interaction with P application methods should be evaluated across different soils and environments.

Results from previous studies also showed significant differences in N and P concentration and uptake among corn hybrids with different genetic background (Gordon and Fjell 1994). This suggests that possible differences in rooting system among corn hybrids can show a significant interaction with nutrient uptake from fertilizer application.

This study and others focused primarily on corn and under no-till system. However, the interaction of soybean root growth characteristics with tillage and fertilization has not been evaluated. Genotypic variation in root growth has been reported for cereal crops, and such variations include differences in the ability to establish a deep rooting system early in the season. Evaluations of genotypic variation in rooting systems in soybean are very limited. Genetic variation in the length and density of root hairs can affect acquisition of immobile nutrients such as phosphorus and potassium. Genetic variations in traits associated with root systems have shown substantial yield gains in low-fertility soils, with increase in phosphorus efficiency in dry bean (Lynch, 2007).

Corn production under strip-till has been evaluated extensively, however, there is very limited information for strip-till soybean production. Some soils and production conditions can benefit from the use of strip-till system when compared to no-till in Kansas. Furthermore, some corn hybrids and soybean varieties with different root growth characteristics may respond differently to the combination of tillage and fertilizer placement. Root characteristics can be critical for plant nutrient and water uptake as well as overall productivity and yield. However, the iteration of genetics as well as tillage and fertilizer placement on root growth characteristics has not been evaluated. Ultimately, producers may need to use the right corn hybrids and soybean varieties under certain combinations of tillage and fertilizer placement based on root characteristics to ensure optimum yields.

d. Project goals and objectives

1. Determine the effect of tillage (no-till and strip-till) and fertilizer placement on corn and soybean; and evaluate the interaction with genotypic variation in root growth.
2. Assessment of plant nutrient uptake and nutrient use efficiency with tillage and fertilizer placement combinations for two different corn hybrids and two soybean varieties.
3. Description of root system architecture for corn and soybean as affected by genetics and tillage/fertility management using field root sampling and large column studies with computer scanning software.
4. Training of graduate students in applied soil fertility and nutrient management research with a good understanding of the agronomic and environmental value of the right fertilizer placement and tillage.

e. Procedure

This project will be completed for two crops (corn and soybean) at 2-3 locations each year. Two tillage treatments (strip-till and no-till) will be combined with three fertilizer placements (1-deep band, 2-broadcast, and 3-control for N and P), application rates will be based on expected crop removal. Fertilizer sources will include liquid for deep-band and dry fertilizer for broadcast application. These treatments will be evaluated with two corn hybrids (conventional and drought tolerant). The soybean component will also use two contrasting soybean varieties selected based on root growth characteristics. Results from this study will provide information on the effect of tillage and fertilizer placement for contrasting hybrids and varieties, and the potential benefit of strip-till and deep-band fertilization to increase soybean yield in Kansas.

Soil samples at the 0-6 inch depth will be collected from each replication and analyzed for routine soil properties. Analysis will include soil organic matter, soil test phosphorus, soil test potassium, and soil pH by standard methods. Total plant nutrient uptake will be evaluated during the growing season by tissue analysis for total N, P, and K at the V6, V10, and VT growth stage (above ground biomass for corn). Soybean whole plant samples will be collected at the V3 stage and the uppermost trifoliate at the R2-R3 stage and analyzed for total P, and K. these measurements will be used to estimate nutrient uptake and nutrient use efficiency with different fertilizer placement/tillage combination. At harvest, yield will be recorded for each plot and a grain sample will be collected and analyzed for nutrient content and removal.

Root architecture will be evaluated by digging plant samples at the V6, V10, and VT growth stage for corn and at the R3 stage for soybean. In addition, the hybrids and varieties selected for this study will be grown in large columns in the greenhouse for detailed root description and with the use of computer scanning software.

f. Duration of the project: The project will be conducted for 2 consecutive years.

g. Expected outputs and outcomes

The right fertilizer placement is a key factor to optimize yields and minimize environmental lost. However, in practice, the “right placement” is continually evolving, and can be affected by planting technology, tillage system, weather variability and many other factors. Genotypic variation in root growth can also affect significantly the right fertilizer placement especially under different tillage systems.

Currently there are no published studies that evaluated the interaction of soybean root system architecture and the interaction with tillage and fertilizer placement. Recent studies on corn suggest different plant response with different fertilizer placement with the same tillage (King, 2013). Corn hybrid and soybean variety selection can be associated with large genotypic variation of root growth and therefore nutrient uptake and nutrient use efficiency.

Furthermore, the interaction of hybrid and variety selection with tillage and fertilizer placement has not been evaluated. This study will contribute with new information on potential differences in nutrient uptake and possible difference and nutrient use efficiency of hybrids and varieties with contrasting root growth habits. Information from this study will provide valuable information for optimum corn and soybean management under different tillage and fertilizer placement.

Results will be delivered to Kansas producers and crop advisors in various ways. Information will be disseminated through field days, extension publications, and the KSU nutrient management webpage. Results of field experiments and any revised recommendations that arise will be summarized and distributed to the public via news releases. Brief articles will be prepared for publication periodically in the Kansas State University Agronomy eUpdates. Finally, results will be shared with county/district extension agents in the state who provide information to producers on a regular basis.

h. Project budget

	Funds requested		
	Year 1	**Year 2**	**Total**
Personnel:			
Graduate Student	24,672	24,672	49,344
Fringe benefits	1,382	1,382	2,763
Equipment:	0	0	0
Travel:	1,300	1,300	5,600
Supplies and Materials:	1,250	1,250	893
Other Expenses:			
Soil and tissue nutrient analysis	1,400	1,400	2,800
Total Request:	**30,000**	**30,000**	**60,000**

References

Boomsma, C., M. Cánepa, T. Vyn. 2007 Factors affecting the relative benefit of deep-banding versus broadcast application of phosphorus and potassium for corn and soybean, North Central Extension-Industry Soil Fertility Conference Proceedings. pp. 55-63.

Bordoli, J.M., A.P. Mallarino. 1998 Deep and shallow banding of phosphorus and potassium as alternatives to broadcast fertilization for no-till corn. Agronomy Journal 90:27-33.

Gordon W.B. and D.L. Fjell. 1994. Starter Fertilizer Interactions with Corn Hybrids Grown In a No-Tillage System.

King, E.W. 2013. Evaluation of phosphorus response to fertilizer placement and hybrid selection. MS thesis. Kansas State Univ. Manhattan, KS.

Lynch, J.P. 2007. Roots of the second Green Revolution. Aust. J. Bot. 55:493–512.

Mallarino, A., J. Webb, A. Blackmer. 1991 Soil test values and grain yields during 14 years of potassium fertilization of corn and soybean. Journal of production agriculture 4:560-567.