DEPARTMENT OF PLANT AND SOIL SCIENCES

Student Research Abstracts

APRIL 15, 2026

DEPARTMENT OF
PLANT AND SOIL SCIENCES

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ENHANCING COMMON BERMUDAGRASS GERMPLASM FOR IMPROVED DROUGHT RESISTANCE, COLD HARDINESS, AND TURF QUALITY

Anit Poudel

ABSTRACT

Common bermudagrass (*Cynodon dactylon* var. *dactylon* Pers.) is extensively used in hybridization with African bermudagrass to produce high-quality and resilient interspecific hybrid turf cultivars. However, existing germplasm exhibits high environment-specific adaptability, with some showing strong drought resistance and others exhibiting superior cold hardiness. This research, therefore, focuses on broadening adaptability by combining both drought resistance and cold hardiness into individual genotypes. A diverse set of parental lines with contrasting phenotypes for drought resistance and winter hardiness was used in hybridization. A total of 1514 progeny were initially established in the greenhouse, of which 745 were selected based on their extensive and prolific root systems and further screened with simple sequence repeat markers to confirm their identities as targeted hybrids. Subsequently, 147 genotypes were advanced to field trial, along with drought-resistant and cold-hardy parental checks, in a randomized complete block design with 3 replicates. The experimental lines were evaluated for spring green-up, drought performance, and turf quality using visual ratings, UAV-based imaging, and a light box. Analysis of variance showed significant genotypic differences for all traits, with high heritability estimates, indicating strong genetic control and high potential for selection. A standardized multi-trait selection index and genotype-by-trait biplots identified five lines (382, 420, 595, 209, and 193) consistently performing top across multiple traits. These improved common bermudagrass genotypes have the potential to serve as elite parents in future interspecific crosses for the development of turfgrass cultivars with enhanced winter survivability and drought resilience.

Figures.

Figure 1: Aerial image of field nursery during spring green-up of 2025 (Red flag represents drought-resistant check and blue flag represents cold-hardy check).

Figure 2: Aerial image of field nursery during drought stress of summer 2025 (Red flag represents drought-resistant check and blue flag represents cold-hardy check).

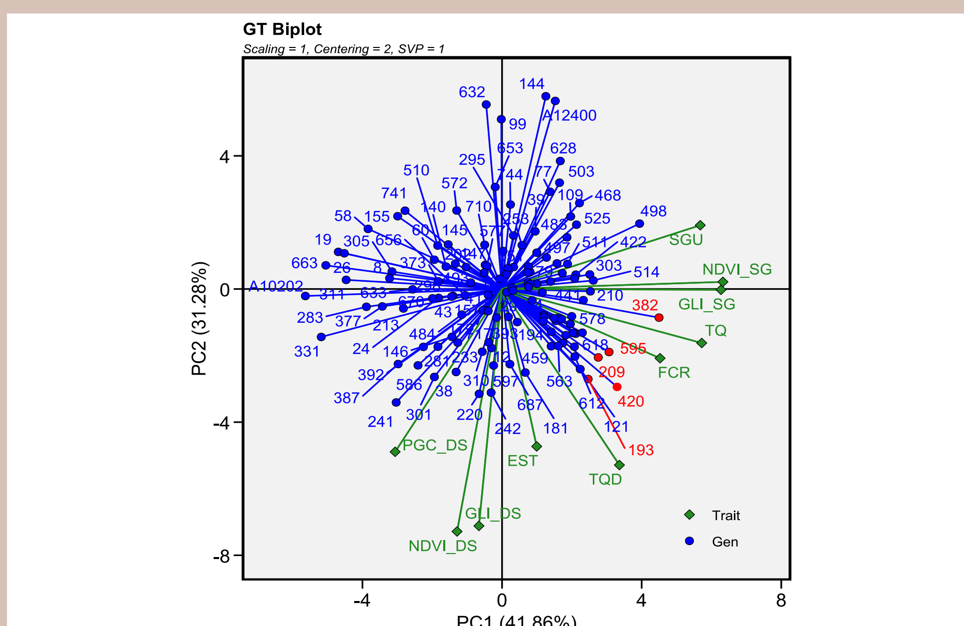

Figure 3: Genotype-by-trait biplots where the green color indicates trait vectors, and the genotypes are represented by blue and red color in which red indicating selected genotypes.

Conclusion

The selected top 5 progenies showed strong performance at multiple traits when compared to better parents, indicating successful combinations of drought resistance, cold hardiness, and turf quality. Though the average of top selections has a slight decrease in spring green-up rating than cold-hardy parental check, the overall gain in green leaf index during both stresses indicated the selected progenies combine drought resistance and cold hardiness. These five selected plants will be used as potential germplasm for crossing with African bermudagrass to improve quality traits, in addition to drought and cold resilience. While the selected progenies will go for the next cycle of crossing and selection, the nursery will be further evaluated in later years to select stable genotypes within temporal and environmental variations.

ENDARRA 81 TURF BERMUDAGRASS

Yanqi Wu, Charles H. Fontanier, Justin Q. Moss, Shuhao Yu, Mingying Xiang, Dennis L. Martin, and Nathan R. Walker

ABSTRACT

'Endarra' is a new, high-quality, interspecific hybrid turf bermudagrass (Cynodon dactylon x C. transvaalensis). This grass has been tested as 'OSU2081' over the years. As a sexually sterile plant, Endarra 81 is vegetatively propagated via sod, sprigs, and plugs. It has exhibited a significantly improved drought resistance as good as or better than TifTuf in a wide range of the southern United States. It has excellent fall color retention and maintains green color into late fall. It produces few seedheads, which is better than some popular drought-resistant varieties, like TifTuf. It has demonstrated excellent establishment characteristics, leaf spot disease resistance, fine leaf texture, high density, dark green color, and sufficient sod tensile strength for reliable, large-scale commercial production on farms.

EFFECTS OF IRRIGATION, SEEDING DENSITY, AND NITROGEN RATE ON CORN PRODUCTIVITY

Aicha Biaou, Sumit Sharma, Brian Arnall, Roy Grant, and Steve Phillips

ABSTRACT

In the semi-arid Oklahoma Panhandle, sustaining irrigated corn production requires management strategies that optimize grain yield while improving nitrogen (N) and water use efficiency, particularly under declining water availability from the Ogallala Aquifer. A two-year field study was conducted in 2024 and 2025 near Eva, Oklahoma, to evaluate the effects of irrigation level, N rate, and seeding density on corn grain yield, grain N uptake, nitrogen use efficiency, and yield-component expression. The study consisted of three split-plot trials representing fixed seeding densities of 59,300, 69,200, and 79,000 seeds ha^{-1}, with irrigation assigned to whole plots and N rate assigned to subplots. Nitrogen was applied at 0, 112, 196, and 280 kg N ha^{-1}, and irrigation treatments represented seasonal evapotranspiration replacement ranges of 87 to 103% in 2024 and 96 to 114% in 2025. Across both growing seasons, N rate consistently increased grain yield, grain N uptake, and several kernel-related traits, confirming that N supply was the dominant driver of crop productivity. Zero-N plots produced the lowest yields across all seeding densities, whereas the greatest grain yield and grain N uptake generally occurred at 196 or 280 kg N ha^{-1}. Irrigation effects were less consistent and more evident in 2024 than in 2025, indicating that crop response depended not only on total seasonal water supply but also on year-specific environmental conditions and within-field variability. Seeding density did not function as a simple yield-enhancing factor; rather, it influenced how yield was assembled through its component traits.

CAN RGB-BASED VARI SERVE AS A PROXY FOR MULTISPECTRAL-BASED NDVI FOR N RESPONSE DETECTION IN CORN SYSTEMS?

Aicha Biaou, Sumit Sharma, Brian Arnall, Roy Grant, and Steve Phillips

ABSTRACT

This study evaluated the performance of two unmanned aerial vehicle (UAV)-derived vegetation indices, the normalized difference vegetation index (NDVI) and the visible atmospherically resistant index (VARI), for detecting crop response to nitrogen and irrigation management in the Oklahoma Panhandle during the 2024 and 2025 growing seasons. Imagery was collected using a Sentera PHX fixed-wing UAV equipped with a multispectral and RGB sensor system. Vegetation index responses were analyzed by year, growth stage, and management treatment, and regression modeling was used to assess the predictive value of NDVI, VARI, and combined-index approaches. Across both seasons, both indices were more responsive to nitrogen than to irrigation, indicating that crop spectral status was influenced more strongly by N-related variation in canopy development and greenness than by the irrigation contrasts imposed in this study. In 2024, treatment separation was stronger and more consistent at later stages of canopy development, with particularly clear nitrogen responses at the highest seeding density. In 2025, spectral responses were weaker overall, reflecting lower yield potential and greater environmental interference, including later planting and weed pressure. NDVI generally exhibited more stable relationships with grain yield and grain N uptake, although VARI also captured meaningful crop variation, and the two indices were highly correlated across the growing season. These findings demonstrate that UAV-based vegetation indices can detect agronomically meaningful nitrogen responses under irrigated corn production and that RGB-based indices such as VARI can provide useful complementary information when interpreted in relation to growth stage and seasonal conditions.

HOW DO VARYING SEEDING DENSITIES AND IRRIGATION LEVELS AFFECT NITROUS OXIDE EMISSIONS IN CORN SYSTEMS?

Aicha Biaou, Sumit Sharma, Mary Foltz, Brian Arnall, and Steve Phillips

ABSTRACT

Nitrous oxide (N_2O) emissions from irrigated corn systems are influenced by soil moisture dynamics, nitrogen availability, and temporal changes in microbial activity, yet the extent to which changes in irrigation level and seeding density affect emissions in semi-arid production systems remains unclear. This chapter quantified daily, cumulative, and yield-scaled N_2O emissions from irrigated corn in the Oklahoma Panhandle under contrasting irrigation regimes and seeding densities. Field measurements were conducted during the 2025 growing season under a fixed nitrogen rate, with irrigation treatments centered around moderate evapotranspiration replacement levels and seeding densities spanning typical producer rates for the region. Gas fluxes were measured repeatedly through the season and analyzed using repeated-measures mixed models to evaluate treatment and sampling-date effects. Sampling date was the dominant source of variation in daily N_2O flux, indicating that emissions were governed primarily by short-term environmental conditions and post-irrigation or post-wetting dynamics rather than by the imposed structural management factors. In contrast, irrigation level and seeding density did not significantly affect daily flux patterns, cumulative emissions, or yield-scaled emissions across the range tested. These results suggest that when nitrogen rate is held constant and irrigation remains within a moderate, non-severely water-limiting range, temporal fluctuations in soil moisture and microbial activity can outweigh treatment-level differences in determining N_2O losses.

YIELD RESPONSE OF DIFFERENT CORN HYRBIDS TO LIMITED IRRIGATION IN THE CENTRAL HIGH PLAINS

Macie McPeak

ABSTRACT

The Ogallala Aquifer has been supporting farmers in the semiarid climate for generations, but declining groundwater levels jeopardize the sustainability of farming. As water availability and well capacities decline, understanding crop performance under limited irrigation conditions is increasingly important for maintaining productivity and profitability. This study evaluates the yield response of different corn hybrids with drought-tolerant traits to irrigation with limited well capacities in the Oklahoma Panhandle. Grain yield, harvest index, yield components, and water use efficiency are measured for the four corn hybrids under 200, 300, 400, and 500 Gallons Per Minute irrigation capacities. The hybrids were evaluated for two different planting populations of 22,000 and 28,000 seeds per acre. The experiment was conducted as split plot design nested in a main irrigation zone, where population was the main plot, and hybrids were split plot. Irrigation was not replicated due to large areas covered by the irrigation zones. This is the first year of a multiyear study, with initial results to be presented at the conference. The initial findings will focus on identifying hybrid and population interactions that optimize yield and efficiency under limited well capacities. Understanding these relationships will provide valuable insight for producers who are or will face water scarcity.

EVALUATING THE IMPACT OF NITROGEN TREATMENT ON PECAN (CARYA ILLINOINENSIS): YIELD, NUT QUALITY, AND LEAF NUTRIENT CONTENT ANALYSIS ON KANZA, PAWNEE, AND MARAMEC VARIETIES

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ABSTRACT

Pecan [Carya illinoinensis (Wangenh.) K. Koch] is one of the world's major nut crops and currently ranks about sixth in global production. Over the past few years, demand has also increased noticeably. Now, Mexico produces roughly half of the global crop (around 51%), and the United States contributes another 41% (INC 2020).

Nitrogen is a key macronutrient for pecans, affecting both vegetative growth and fruiting (Pokhrel et al. 2025), but its precise impact is often hard to isolate in large commercial orchards where environmental conditions vary widely. For that reason, localized field trials can be extremely valuable for growers.

In this study, we evaluated how different rates of nitrogen (N) fertilization influence yield in three pecan cultivars, Pawnee, Maramec, and Kanza, over a four-year study (2022–2025). The trial was arranged as a randomized complete block design. Pawnee and Kanza received two treatments (full, half, and control), while Maramec also included a 2x full treatment along with 1.5x full rates. Yield data were analyzed using linear mixed-effects models with year and nitrogen treatment as fixed effects and individual tree as a random effect.

The results show Nitrogen use efficiency (NUE) declined with increasing rate of nitrogen (N) across all cultivars, with the highest NUE observed at the half N treatment. Increasing N modestly increased leaf nitrogen concentration but did not consistently enhance yield, which was primarily driven by year effects. Macronutrients, particularly total nitrogen and potassium, showed positive associations with yield in Maramec and Pawnee, while micronutrient–yield relationships were weak and cultivar-specific. Nitrogen significantly affected nut grading, with the full N rate maximizing the proportion of light, well-filled kernels, whereas higher rates in Maramec did not further improve nut quality.

Keywords: Pecan, Nitrogen, Yield, Leaf Nutrient, Kanza, Pawnee, Maramec, Nitrogen, fertilizer, Pecan Nut, Urea, Leaf analyzing, Nut grading.

AN EFFECTIVE ENZYME-LINKED IMMUNOSORBENT ASSAY-BASED METHOD FOR QUANTIFICATION OF GIBBERELLIC ACID IN PECAN (CARYA ILLINOINENSIS)

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ABSTRACT

Enzyme-linked immunosorbent assay (ELISA) is a reliable and low-cost method for quantifying gibberellic acid (GA) in plants but applying this method to certain plant tissues is challenging due to tissue hardness and/or contents rich in metabolites. Pecan (Carya illinoinensis) tissues in the bud and bark are examples of such tissues. This study aimed to establish an effective ELISA-based GA quantification method for these pecan tissues. We tested how different amounts of the tissues and the weight ratios of a tissue to the solvent methanol affected the detection of GA. We also tested whether heat-drying and freeze-drying and long-term storage of the fresh materials in -80 ☐C affected the detection of GA. Our results showed that using 0.0125± 0.0005 gram (g) of heat-dried or freeze-dried tissues and a relatively low tissue-to-methanol ratio consistently produced high GA concentrations in ELISA detection, and the levels of GA were stable in pecan samples stored long-term at -80 ☐C. Our results also showed that GA concentrations in buds were higher than in the bark. These findings indicate that our method is effective in detecting GA in small amounts of pecan tissues, and heat-drying of either fresh or freezer-stored samples can produce satisfying results of GA quantification. Moreover, the GA concentrations in the wood and bark were found to be positively correlated with the GA concentrations in the bud, which help estimate most part of variability of the GA concentration in the bud based on the GA concentration in the bark, as it may be challenging to experimentally determine the GA concentration in a small bud at an early developmental stage. The final spike-recovery test confirmed that both bark and bud extracts exhibited acceptable recovery percentages, indicating that matrix effects and phenolic interference did not significantly affect the results.

Keywords: Bark, Bud, ELISA, GA quantification, Woody plant

VARIETY SELECTION AND NITROGEN MANAGEMENT FOR WINTER FORAGE PRODUCTION

Nicholas Ssebalamu and Steve Phillips*

ABSTRACT

Winter wheat (*Triticum aestivum* L.) is the major cool-season forage used in Oklahoma cattle operations. Unlike grain-only systems, wheat forage production (graze out or graze and hay) fundamentally alters N use dynamics by removing aboveground biomass and triggering compensatory tillering and regrowth which influences crop N needs. Graze out and hay systems differ in defoliation duration, biomass removal, and termination timing and may demand different top dress N rates to achieve comparable productivity. Furthermore, wheat varieties differ in morphological and physiological traits that influence grazing tolerance, post-grazing recovery, and biomass accumulation, and few studies have investigated variety-specific N rate responses across graze-out and hay management systems. This study addresses the primary objective to evaluate three commercial dual-purpose wheat varieties (Showdown, Green Hammer, and OK Corral) response to varying top-dress N rates under graze-out and graze and hay management. Field trials were established using a randomized complete block design with three replications at three locations in Oklahoma (Stillwater, Perkins, and Chickasha) during the 2025-2026 growing season, with individual plots measuring 12 ft by 5 ft wide. All plots received a uniform N application consisting of 40 lb N ac^{-1} pre-plant as urea incorporated, 50 lb ac^{-1} of DAP (18-46-0) applied in-furrow. Grazing was simulated by mechanical mowing initiated at 4 to 6-in canopy height and maintained at a 2.5-in height until first hollow stem. At hollow stem, four top-dress N rates (0, 30, 60, and 90 lb N ac^{-1} applied as urea) were applied to the graze out treatments, while four different top-dress N rates (0, 45, 90, and 135 lb N ac^{-1} applied as urea) were applied to the hay treatments. Mowing was terminated at first hollow stem for hay treatments with biomass collected at soft dough while mowing continued in the graze out treatments until vegetative growth ceased.

An on-farm trial was also established in a producer's field near Reed, Oklahoma, where a single 60-acre field was divided between two varieties (Doublestop and Iba). The

varieties were separated to allow evaluation of cattle gain by variety and to assess forage regrowth under comparable grazing pressure. Both varieties were grazed by calves until grazing was terminated at the hollow stem stage. Following grazing termination, N top-dress rates (0, 45, 90, and 135 lb N ac^{-1}) were applied to plots arranged in a randomized complete block design with five replications within each variety. The crop was then allowed to regrow and harvested for hay at the soft dough stage. Measurements will include grazing initiation date, cattle performance, forage regrowth, hollow stem date, and total biomass production. System-level economic returns will be calculated to determine variety-specific economically optimal N rates under this dual-purpose management system. Findings are expected to determine whether top-dress N recommendations should be differentiated by management goal and cultivar in forage-focused wheat systems; and define the variety and system-specific N rate thresholds that maximize economic returns of winter wheat forage production across Oklahoma.

Keywords: dual-purpose wheat; graze-out; hay-off; nitrogen rate; forage quality; crude protein; economically optimal nitrogen; Southern Great Plains

THE EFFECT OF NITROGEN FERTILIZER RATE AND WINTER GRAZING SYSTEM ON BEEF CATTLE PERFORMANCE

Caleb Snodgrass

ABSTRACT

Winter feeding costs are a major challenge for cow-calf producers in Oklahoma due to the dormancy of warm-season perennial grasses, increasing the reliance on hay and supplementation. This study evaluated the alternative winter grazing methods of stockpiling bermudagrass and sod-seeding cereal rye across three different nitrogen rates. The study was conducted in southeast Oklahoma in a bermudagrass pasture that had been homogeneously grazed during summer months before being broken out into twenty-one 1.2-hectare paddocks representing the replicated treatment structure. The treatments were established at the beginning of September each year and left to stockpile forage until the first killing freeze. Three mature, bred angus cows were then placed on each paddock for grazing until biomass was no longer sustainable. Forage samples, live weights, and fecal samples were collected on a weekly basis for the duration of the study. The results indicated that nitrogen had no effect on cow performance and all treatments showed adequate cow weight maintenance prior to supplementation. The sod-seeded rye treatments consistently provided longer grazing durations than the stockpiled bermudagrass, largely due to spring grazing. All treatments, except for sod-seeded rye with 90 kg N ha^{-1} were more cost-effective than the control. These findings suggest that both winter grazing systems can be more cost-effective than feeding hay for the entirety of winter and sod-seeded rye systems with moderate nitrogen inputs provide the most grazing and cost-effectiveness.

Figures and Tables

Figure 1. Forage yield response to nitrogen rate in the stockpiled winter grazing systems, 2024-2025.

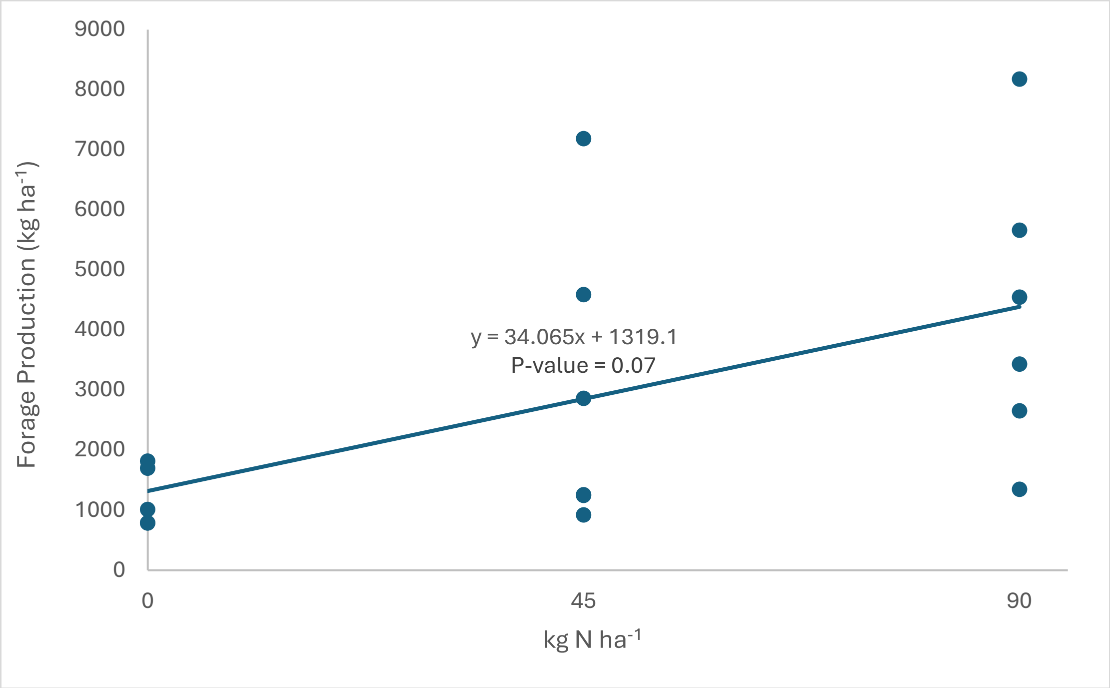


Figure 2. Forage yield response to nitrogen rate for the sod-seeded winter grazing system, 2024-2025.

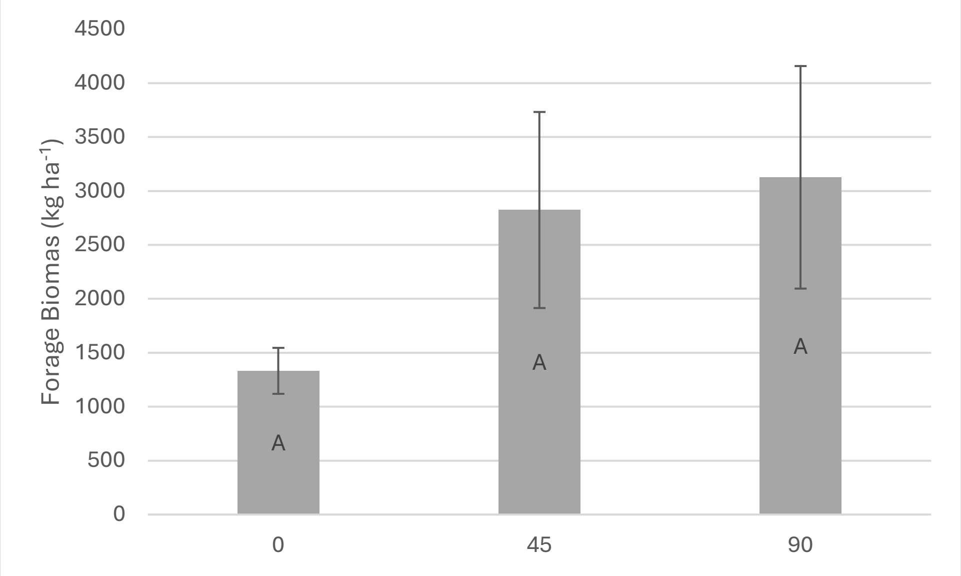


Table 1. Analysis of variance for cattle average daily gain (ADG) and normalized weight in stockpiled and sod-seeded winter grazing systems, 2024-2025.

	ADG	Normalized Weight
Year	0.0379	0.0350
System	0.0002	0.0101
Year*system	0.0008	<0.0001
N rate	0.2038	0.2580
Year*N rate	0.0725	0.1085
System*N rate	0.3755	0.8433
Year*System*N rate	0.3592	0.2927

*Normalized weight is calculated by ending weight / starting weight of the cows.

Table 2. Averaged mean cattle average daily gain (ADG) and normalized weight by year and system for stockpiled (SP) and sod-seeded (SSR) winter grazing systems, 2024-2025.

	ADG	Normalized Weight
2024 Control	0.61 A	1.05 A
2024 SP	-0.77 B	0.96 B
2024 SSR	-0.73 B	0.95 B
2025 Control	-1.29 C	0.93 C
2025 SP	-0.68 B	0.96 B
2025 SSR	-0.04 A	0.99 A

Table 3. Days of hay saved for the stockpiled (SP 0, 45, and 90 kg N ha^{-1}) and sod-seeded (SSR 0, 45, and 90 kg N ha^{-1}) winter grazing systems, 2024-2026.

Grazing System	2024-25 Days of Hay Saved	2025-26 Days of Hay Saved
Control	N/A	N/A
SP 0	28	33
SP 45	28	33
SP 90	28	35
SSR 0	49	38
SSR 45	49	47
SSR 90	49	47

Conclusion

This research demonstrates that both SP and SSR are viable, cost-effective alternatives to traditional winter supplementation for cow-calf operations in Oklahoma. Sod-seeded rye consistently provided superior forage quality, characterized by significantly higher CP and RFQ compared to SP across both years of the study. Although animal performance, measured by ADG and normalized weight, varied between the two years due to environmental factors like below-average rainfall, both alternative systems successfully maintained cattle BCS without the extensive hay and protein supplementation required by the control group.

From an economic perspective, these alternative grazing systems generally reduced total winter costs per head by minimizing the high labor and feed expenses that typically account for the majority of annual production costs. Nitrogen fertilization played a critical role in forage production, with SP showing a linear increase in biomass as N rates rose. However, the data suggest a point of diminishing returns for the SSR as the highest N rate (90 kg N ha^{-1}) significantly increased input costs without delivering a proportional improvement in animal performance or increasing days of grazing, particularly during the spring grazing period.

Ultimately, Oklahoma producers can enhance the profitability of their operations by integrating these winter grazing strategies to mitigate reliance on expensive harvested forages. While SSR offers a high-quality forage base, ranchers should carefully balance N application with moisture availability and expected animal performance to maximize net returns. These findings indicate that adopting moderate N management within these alternative systems provides a sustainable and financially sound method for overwintering beef cattle while maintaining herd health.

VARIETY SELECTION AND NITROGEN MANAGEMENT FOR DUAL-PURPOSE WINTER WHEAT PRODUCTION

Nicholas Ssebalamu and Steve Phillips

ABSTRACT

Keywords: dual-purpose wheat; wheat variety; grazing intensity; grazing tolerance; post-grazing recovery.

The dual-purpose (DP) winter wheat-cattle system is a cornerstone of the agricultural industry in Oklahoma, where 60 to 70% of harvested winter wheat (*Triticum aestivum* L.) acres are grazed annually. This system provides critical winter forage for cattle operations during a time when warm-season perennial pastures are dormant and subsequently allows for grain harvest in late spring. Despite its economic importance, grazing has shown to reduce grain yield by up to 24% when not properly managed, and current management strategies focus primarily on grazing termination timing and stocking rate with relatively little consideration for cultivar selection. Previous research has established that morphological and physiological traits including plant height and tillering capacity vary among wheat varieties and influence grazing tolerance and post-grazing recovery. However, limited studies have systematically evaluated variety-specific responses or variety × grazing intensity interactions across a range of commercially available cultivars. Similarly, top-dress nitrogen (N) recommendations for DP wheat have largely been adapted from grain-only systems and fail to accurately account for interactive effects of grazing on variety-specific N response. Grazing fundamentally alters the N use dynamics by removing aboveground biomass, triggering compensatory tillering and regrowth that may influence N uptake. Economically optimal top-dress N rates for individual DP varieties when both forage and grain value are integrated remain unresolved. This study addresses two primary objectives: (1) to evaluate the forage yield, post-grazing recovery, and grain yield of five commercial DP wheat varieties (Doublestop, Green Hammer, OK Corral, Showdown, and Uncharted) under varying grazing intensities, and (2) to determine variety-specific responses to top-dress N rates following grazing. Field trials were established using a randomized complete block design with three replications at

three locations in Oklahoma (Stillwater, Perkins, and Chickasha) during the 2025-2026 growing season, with individual plots measuring 12 ft by 5 ft wide. All plots received a uniform N application consisting of 41 lb N ac^{-1} pre-plant as urea incorporated, 50 lb ac^{-1} of DAP (18-46-0) applied in-furrow, Grazing was simulated by mechanical mowing initiated at 4 to 6-in canopy height, and maintained at a 3.5-in height to represent a moderate stocking intensity and at a 2.5-in height for heavy stocking until first hollow stem. At hollow stem, 60 lb N ac^{-1} was top dress applied as urea to all plots. A second trial evaluated the five varieties under intensive grazing with four top dress N rates (0, 30, 60, and 90 lb N ac^{-1}). Grazing initiation date, forage regrowth and total biomass production, hollow stem date, and grain yield data will be collected. Findings are expected to determine whether cultivar selection can serve as a practical management tool for reducing grain yield penalties under intensive grazing, quantify the degree of genetic variation in grazing tolerance among current commercial DP varieties, and provide producers with evidence-based cultivar and N management recommendations to improve the profitability and long-term sustainability of dual-purpose wheat–cattle systems across Oklahoma.

SOIL NITRATE STORAGE IN IRRIGATED AND DRYLAND AGRICULTURAL LANDS

Ali Ashrafi

ABSTRACT

Nitrate accumulation and transport in soil profiles are critical concerns in semi-arid agroecosystems, where irrigation and nitrogen inputs can induce subsurface leaching. We evaluated the vertical distribution and storage of soil nitrate across irrigated, non-irrigated, and uncultivated lands in southwestern Oklahoma, USA (Tillman, Harmon, Greer, Beckham, and Washita counties) in 2025. Deep soil cores were collected to a depth of 250 cm in 25 cm increments from multiple fields representing diverse management systems. Soil samples were analyzed for solution nitrate concentration (mg L^{-1}). The dataset was partitioned into root zone (0–150 cm) and deep soil (150–250 cm) layers to assess both plant-available nitrogen and potential leaching beyond the rooting depth. Statistical analyses were conducted on log-transformed nitrate concentrations to address non-normality, followed by analysis of variance (ANOVA) and Tukey's HSD tests to evaluate differences among land uses and counties. Results indicated that irrigated lands exhibited significantly higher nitrate concentrations than non-irrigated and uncultivated lands, with mean concentrations of 26.4 mg L^{-1} in the root zone and 21.5 mg L^{-1} in the deep soil, compared to 7.8 and 7.0 mg L^{-1} in non-irrigated lands and 7.5 and 7.9 mg L^{-1} in uncultivated lands, respectively, representing approximately three- to fourfold increases. In contrast, no statistically significant differences were observed among counties, indicating that land use exerts a stronger control on nitrate dynamics than regional spatial variability within the study area. Moreover, irrigated fields showed a greater vertical extent of nitrate accumulation, with concentrations exceeding 20 mg L^{-1} even at depths of 150–250 cm, while non-irrigated and uncultivated systems generally remained below 10 mg L^{-1} at these depths. Consistent with these patterns, nitrate storage was substantially higher under irrigated systems, averaging 97.3 kg ha^{-1} in the root zone and 47.6 kg ha^{-1} in deep soil, compared to 31.0 and 14.3 kg ha^{-1} in non-irrigated lands and 26.1 and 17.4 kg ha^{-1} in uncultivated lands. The combined evaluation of nitrate concentration and storage provided complementary insights into nitrogen dynamics, highlighting the role of irrigation in enhancing both magnitude and depth of nitrate occurrence. These findings emphasize the importance of deep soil monitoring for assessing long-term nitrogen sustainability and potential groundwater contamination risks in semi-arid agricultural systems.

SOIL-DRENCH APPLICATION OF FUNGICIDE "FLUTRIAFOL" AND ITS EFFECT ON ARBUSCULAR MYCORRHIZAE FUNGI (AMF) ROOT COLONIZATION IN GRAPEVINES

Aaron Essary and Dr. Lu Zhang

ABSTRACT

Arbuscular mycorrhizae fungi (AMF) are beneficial soil-dwelling fungus that bind to the roots of grapevines to enhance nutrient uptake and water uptake. "Flutriafol" is a highly systemic chemical fungicide used to suppress fungal growth by inhibiting ergosterol biosynthesis. Although Flutriafol is meant to target harmful fungi such as mildew and leaf spot, the hypothesis is that a soil-drench application of Flutriafol will inhibit root colonization of beneficial AMF in the roots of grapevines. Six grapevines were given soil-drench applications of Flutriafol while six control grapevines received no treatment. Root segments of each grapevine were then collected via soil core sampling. Roots from the core samples were then sifted from the soil, cleared using chemical baths of KOH and HCl to reveal the cortex, stained with blue pen ink, and then the root cortex was peeled and placed onto microscopy slides and analyzed under a light compound microscope. AMF colonization of each root segment was then quantified by counting individual hyphae and vesicles found within the cells of the root cortex.

SPATIAL AND TEMPORAL VARIABILITY OF SOIL HEALTH SCORES AND THEIR RELATIONSHIP TO CROP YIELD

Ella Hazel Estrada, Roy Grant, and Steve Phillips

ABSTRACT

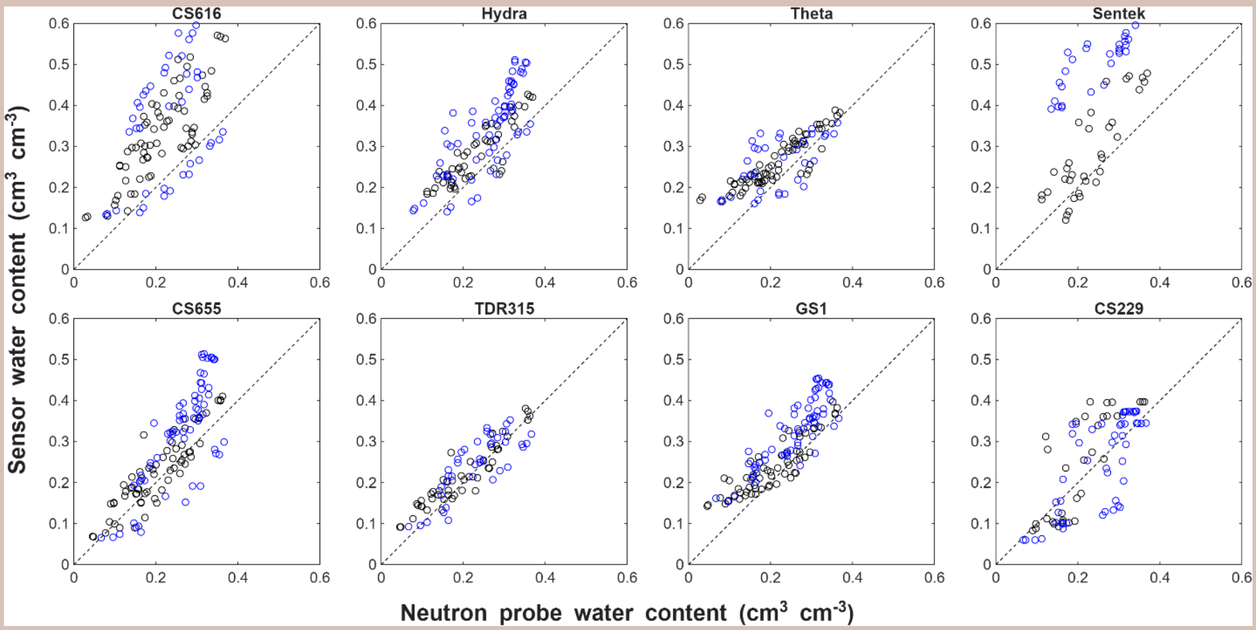
Soil health is the continued capacity of the soil to function as a vital living ecosystem that sustains plants, animals, and humans. To assess and evaluate soil health, the Comprehensive Assessment of Soil Health (CASH) was established. In CASH, different soil health indicators are used to assign a score. These indicators are soil properties that can vary spatially and temporally. In this study, soil health scores were determined across a landscape to evaluate their spatial and temporal variability and then used to evaluate the relationship between the scores and crop yield. The study evaluated physical, chemical, and biological soil properties, which were scored based on the CASH scoring system. Soil samples were collected throughout five seasons from twenty-four different blocks for various indicators. Based on the results, it showed that soil health scores varied through space and time. The effect of the block was significant on soil health scores ($p = 0.001$). This significant effect of space can be due to varying soil properties in the field, such as soil texture. Throughout the seasons, the scores were relatively different within blocks. The analysis also showed that block and season interactions were significant ($p < .001$) suggesting that differences among blocks were not consistent across all sampling seasons but instead emerged under specific seasonal conditions. Linear regression models were used to examine the relationship between soil health score and yield. Although the relationship between soil health score and wheat yield during the summer season was statistically significant ($p = 0.05$), the model explained only a small portion of the yield variability ($R^2 = 0.16$), indicating that factors other than soil health influenced yield outcomes. Multiple linear regression analysis revealed that extractable potassium and organic matter had the strongest positive standardized effects on yield, whereas soil respiration and extractable phosphorus ratings were negatively associated with yield. This indicates that nutrient availability and carbon-related properties remain critical contributors to crop productivity; however, the soil health scoring framework for these parameters did not align with observed yield responses and did not accurately reflect the soil's capacity to supply nutrients to the crop.

PERFORMANCE OF EIGHT SOIL MOISTURE SENSORS AS AFFECTED BY SOIL TEXTURE AND ELECTRICAL CONDUCTIVITY

William Brown

ABSTRACT

Accurate soil moisture information helps farmers, ranchers, and land managers make informed decisions, and this information often comes from in situ measurements. In situ sensors operate based on a variety of technologies, and there is an ongoing need to determine the accuracy of these sensors across different soils. Therefore, our objective was to evaluate the accuracy of eight in situ soil moisture sensors across soils of differing texture and bulk electrical conductivities (EC_b) at the Marena, Oklahoma, In Situ Sensor Testbed (MOISST). Sensors included the Stevens Hydra Probe, Delta-T Theta Probe, three Campbell Scientific sensors (CS229, CS616, and CS655), Acclima TDR-315, Sentek EnviroSMART, and Decagon GS1. Accuracy was quantified by comparing sensor measurements with measurements made using a calibrated neutron probe on 17 days from April to October 2020 at four sites and two depths. The CS616 exhibited the poorest accuracy (mean absolute difference, MAD = 0.182 $cm^3\ cm^{-3}$) and the TDR-315 showed the best accuracy (MAD = 0.037 $cm^3\ cm^{-3}$), although there were no data for this sensor at the site with the highest clay content and EC_b. The CS616, CS655, and Hydra Probe demonstrated decreasing accuracy with increasing clay content. Likewise, sensor accuracy decreased with increasing EC_b for some sensors, with the order of sensitivity being CS616 > Sentek > CS655 > Hydra Probe > GS1. Missing data precluded evaluation of EC_b effects on the TDR-315 and Theta Probe. The CS229 was insensitive to clay content and EC_b. Our results highlight the importance of considering soil properties when selecting soil moisture sensors.



Sensor estimated versus neutron probe volumetric water content for each sensor type for the 17 days neutron probe readings were taken. Data from the 10-cm depth are black circles, and blue circles are data from the subsurface depths, 50 cm at A, B, and D and 30 cm at site C.

Mean absolute difference (MAD) values for tested sensors at all sites and depths during the seventeen days (April through October 2020) neutron probe data were collected. Surface averages represent all 10 cm depths and subsurface averages represent all 50 cm depths plus Site C/CC 30 cm. Sensor average and site average values are marginal means from the analysis of variance, and for sensors with no missing data, marginal mean values are equal to raw values. Superscript lower-case letters indicate statistical differences of sensor average MAD ($p \leq 0.10$).

Site	Depth	CS616	Hydra	Theta	Sentek	CS229	TDR-315	GS1	CS655	Site Average
	cm	*cm^3 cm^{-3}*								
A/AA	10	0.110	0.059	0.053	0.089	0.074	0.041	0.039	0.058	**0.063**
A/AA	50	0.211	0.104	0.089	0.267	0.087	0.053	0.084	0.062	**0.122**
B/BB	10	0.207	0.055	0.035	0.049	0.062	0.017	0.021	0.024	**0.084**
B/BB	50	0.402	0.128		0.253	0.078		0.113	0.147	**0.142**
C/CC	10	0.051	0.056	0.071			0.027	0.067	0.021	**0.022**
C/CC	30	0.034	0.032	0.036		0.042	0.039	0.059	0.067	**0.080**
D/DD	10	0.119	0.053	0.049				0.037	0.042	**0.058**
D/DD	50	0.321	0.099				0.018	0.039	0.096	**0.116**
Sensor average		**0.182**^{a}	**0.073**^{bc}	**0.070**^{bc}	**0.148**^{ab}	**0.056**^{bc}	**0.037**^{c}	**0.057**^{bc}	**0.065**^{bc}	
Surface average		**0.153**	**0.044**	**0.041**	**0.119**	**0.027**	**0.008**	**0.028**	**0.036**	
Subsurface average		**0.211**	**0.102**	**0.099**	**0.177**	**0.086**	**0.066**	**0.087**	**0.094**	

CLAY DIFFERENTIALLY INFLUENCE PHOSPHATASE ACTIVITIES IN SOIL

Grace Williams and Shiping Deng

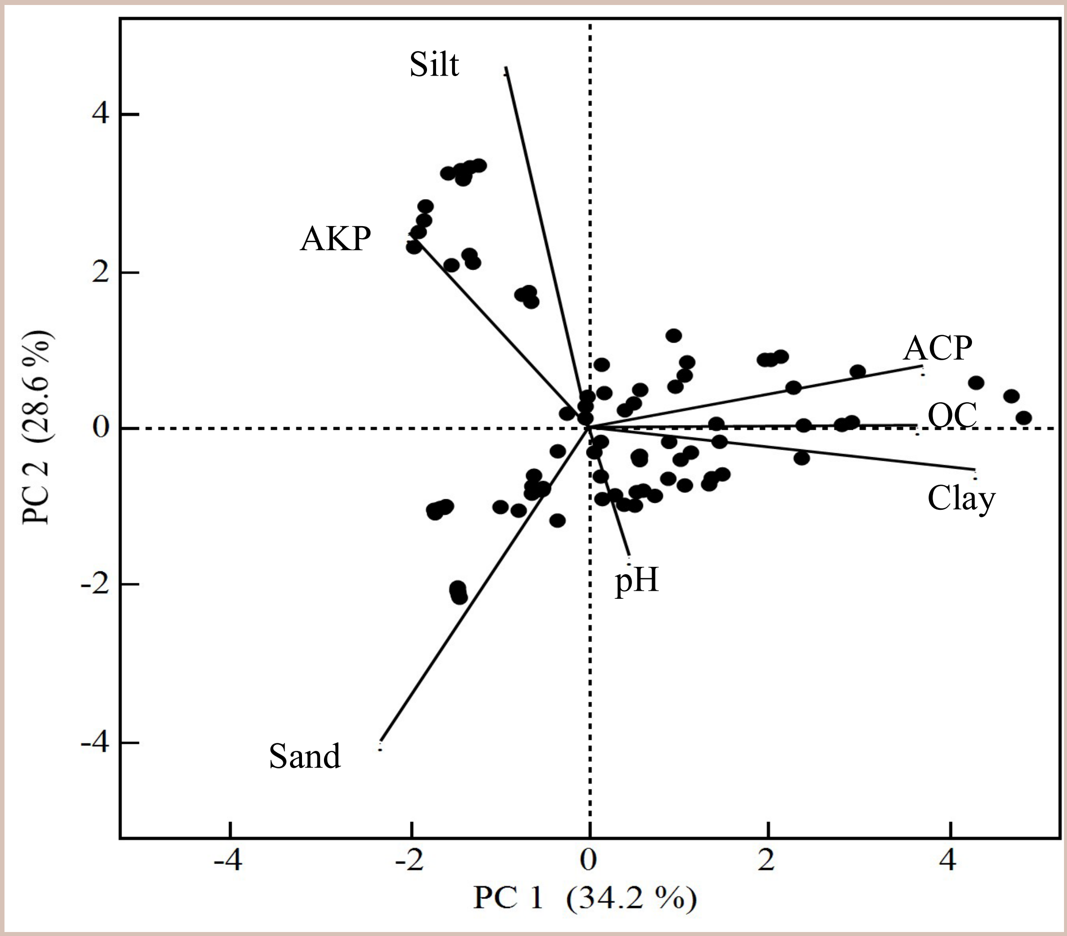
ABSTRACT

Phosphatase enzymes play a critical role in soil phosphorus cycling, yet acid phosphatase (ACP) and alkaline phosphatase (AKP) differ markedly in their biochemical properties and interactions with soil constituents. This study synthesizes data from 46 studies encompassing 388 globally distributed soils to evaluate the relationships between ACP and AKP activities and soil properties, including texture, organic carbon (OC), and pH. The activities of ACP exhibited variability across soils and was strongly correlated with clay (r = 0.66***–0.88***, $P < 0.001$), reflecting stabilization through weak physicochemical interactions. In contrast, AKP activity showed significantly lower activities than ACP and had no significant correlation with clay, aligning instead with silt content. These contrasting behaviors suggest enzyme-specific interactions with clay surfaces, leading to enhanced ACP stability and activity but not for AKP. Principal component analysis showed difference between stable biochemical pools in the soil (ACP) and microbial processes (AKP), offering a broader view on how phosphorus behaves in the soil. These findings highlight the different ecological roles ACP and AKP play in soil, and the importance of mineral-organic interactions in regulating soil's long-term biochemical function and its capacity to cycle phosphorus.

Table. Principal components (PC1 and PC2) loadings for figure

Parameter	PC1	PC2
Eigenvalues	2.4	2.0
Total variance (%)	34.2	28.6
Cumulative variance (%)	34.2	62.8
Acid phosphatase (ACP)	**0.77**	0.16
Alkaline phosphatase (AKP)	-0.41	**0.51**
Clay	**0.89**	-0.11
Sand	-0.48	**-0.82**
Silt	-0.19	**0.95**
Organic Carbon (OC)	**0.76**	0.01
pH	0.09	-0.34

Figure. Principal component biplot of acid phosphatase (ACP), alkaline phosphatase (AKP), and fundamental soil properties of 110 soils across 11 studies.



Conclusion

Acid phosphatase is a more reliable indicator of long-term phosphorus storage in soil, while alkaline phosphatase may reflect active microbial processes. Although clay is known to regulate soil enzymes, this study shows its effect are enzyme-specific, an important consideration in soil management and conservation strategies.

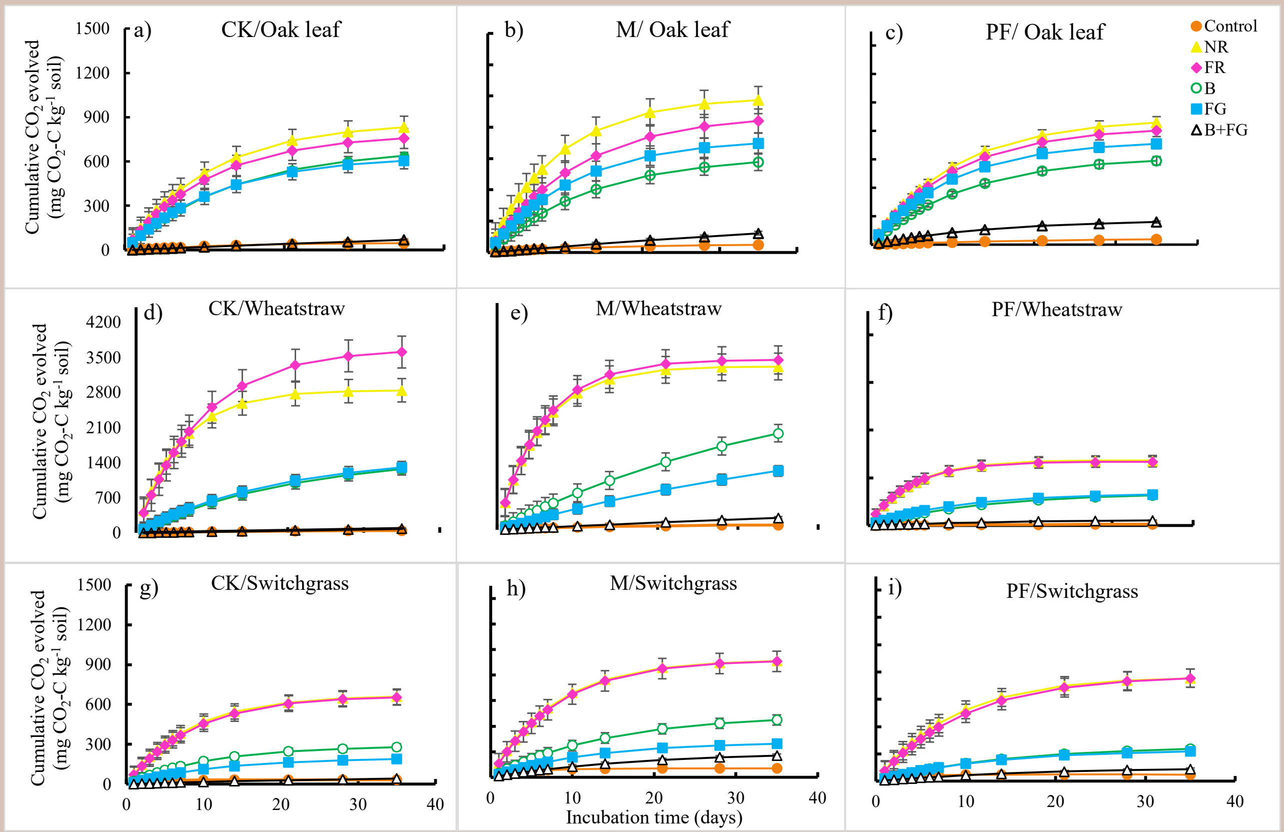
BACTERIA VS. FUNGI: WHO LEADS THE BREAKDOWN TREE LEAF AND GRASS RESIDUES IN SOIL?

Grace Williams and Shiping Deng

ABSTRACT

Disentangling the web of factors governing decomposition requires a holistic approach that recognizes soil as an integrated system rather than independent processes. Understanding how oak leaves, wheat straw, and switchgrass decomposition kinetics and how they affect microbial communities could inform management strategies that enhance ecosystem health, function, and sustainability. A laboratory incubation study examined the effects of different plant residues on soil microbial activity and diversity, as well as the relative contributions of bacteria and fungi to carbon residue decomposition. Soils were amended with sterilized and non-sterilized oak leaf, wheat straw, and switchgrass residue, with or without bactericide, fungicide, or both. Carbon dioxide (CO_2) evolution was monitored over time during incubation. Oak-leaf amended soils were further analyzed via DNA sequencing. The chemical makeup of the reside, particularly nitrogen content, drove decomposition potential and rate, with wheat straw (C:N= 34.1) exhibiting highest percentage of residue carbon mineralized (28%). While fungi surpassed bacteria in decomposing the complex carbon compounds in oak leaf residues, both bacteria and fungi contributed to rapid decomposition of more labile carbon in wheat straw and switchgrass residues. Despite their different roles, bacteria and fungi metabolic functions were strongly dependent on each other during decomposition. In the short term, plant residues shifted microbial community structure while maintaining overall diversity. These findings offer quantitative insights into the biological processes essential for developing holistic soil management strategies that optimize decomposition efficiency while preserving soil health and productivity.

Figure. Cumulative CO_2 evolved in three tested soils that were amended with oak leaf (a,b,c), wheatstraw (d,e,f), and switchgrass (g,h,i) residues. Values represent means ± standard error.



Conclusion

While fungi led the breakdown of complex carbon compounds and both fungi and bacteria broke down simpler carbon compounds, the two groups remained metabolically dependent on each other throughout decomposition. Overall, decomposition rate was driven by residue chemistry, with wheat straw breaking down the fastest, followed by oak leaves, and switchgrass being the slowest given its high carbon to nitrogen ratio (C:N = 147:1).

CONTRIBUTIONS OF BACTERIA AND FUNGI TO CARBON USE EFFICIENCY AND DYNAMICS IN SOIL

Grace Williams and Shiping Deng

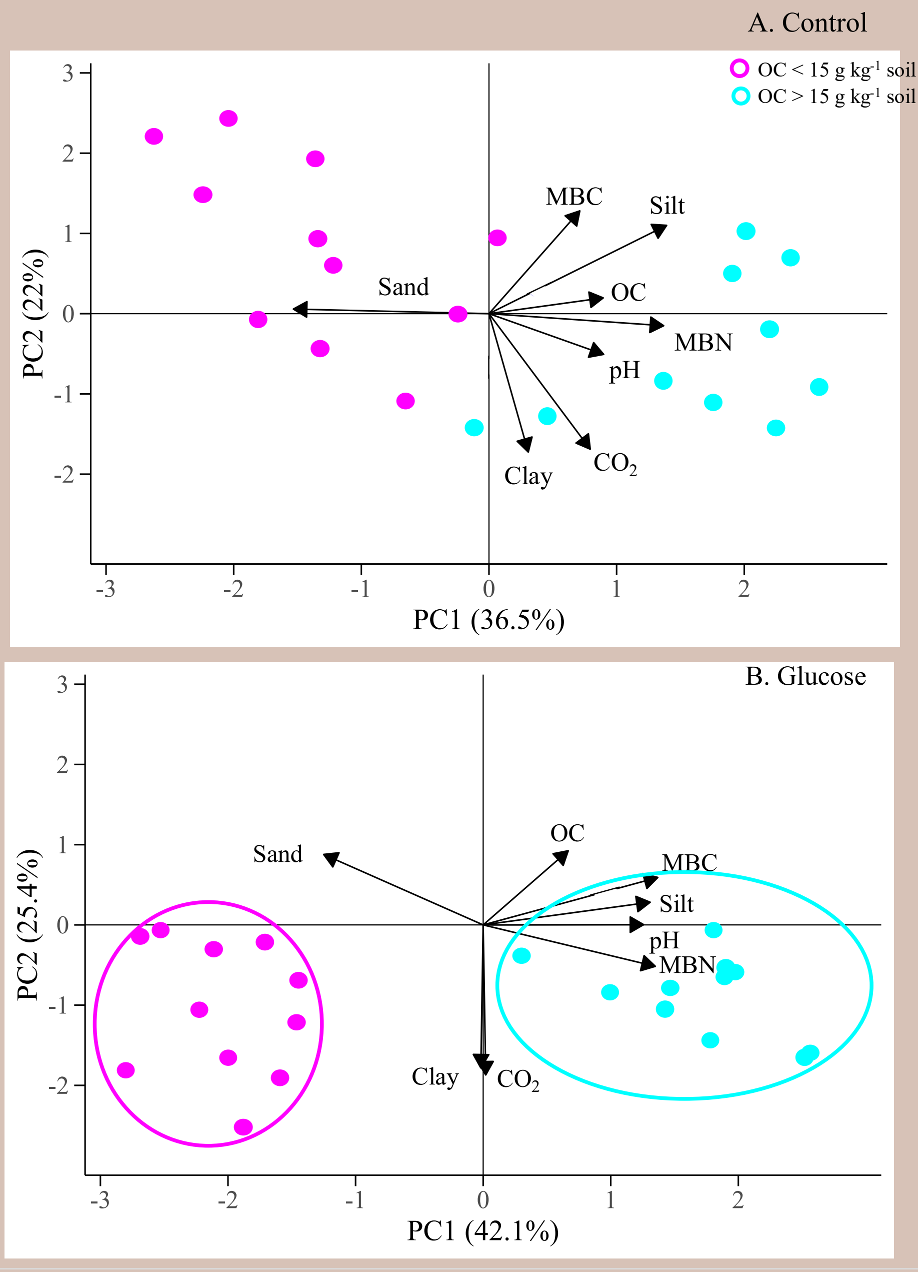
ABSTRACT

Soil microbial communities are central drivers of carbon cycling, yet their diversity and the heterogeneous nature of the soil environment complicates predictions of carbon dynamics. This study investigates how efficiently soil bacteria and fungi use carbon, microbial community composition, and influence of soil properties and land use on microbial carbon dynamics under glucose amendment alone or in combination with selective biocides. Twenty-two soils from Oklahoma prairie and croplands were amended with glucose and treated with bactericide and/or fungicide. Carbon dioxide (CO_2) evolution was measured every 10 days over the 30 day incubation period, while microbial biomass carbon and nitrogen were measured and microbial community composition was assessed through DNA sequencing at the end of the incubation. Bacteria and fungi competed for glucose, with fungi being the more efficient competitor, achieving a carbon use efficiency (CUE) of 40%. Under glucose addition, fast-growing bacterial and fungal taxa dominated, while rare taxa served as sensitive indicators of glucose addition. Native soil organic carbon governed microbial growth and CUE, while soil texture further shaped these dynamics. Specifically, higher silt content favored carbon allocation toward microbial biomass, whereas higher clay content was associated with greater carbon losses through microbial respiration. At the system level, prairie soils assimilated carbon more efficiently than cropland soils. Enhanced understanding of how microbial members use carbon and soil properties that govern their use may help predict soil carbon storage and CO_2 emissions, guiding management practices that promote carbon retention in soils.

Table. Principal components (PC1 and PC2) loadings for Figure.

Parameter	Control		Glucose	
	PC1	PC2	PC1	PC2
Eigenvalues	3.1	1.9	3.6	2.2
Total variance (%)	35.8	23.0	43.4	24.2
Cumulative variance (%)	35.8	58.8	43.4	67.6
CO_2 evolution (CO_2)	0.28	-0.57	-0.01	-0.63
Microbial biomass carbon (MBC)	0.43	0.51	0.58	0.20
Microbial biomass nitrogen (MBN)	0.46	-0.11	0.52	-0.19
Soil organic carbon (OC)	0.31	0.06	0.43	0.31
pH	0.29	-0.22	0.41	0.01
Clay	0.10	-0.59	-0.02	-0.61
Silt	0.47	0.47	0.54	0.09
Sand	-0.48	0.03	-0.43	0.29

Figure. Principal component biplots showing relationships among soil properties, microbial biomass carbon (MBC), microbial biomass nitrogen (MBN), and cumulative CO_2 evolution over the first 10 days (CO_2). (A) control soils; (B) glucose-amended soils.



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Conclusion

When glucose was added, bacteria and fungi competed for easily available carbon, with fungi as the more efficient competitor. Fast-growing bacterial and fungal taxa came to dominate the microbial community under glucose addition, while rare taxa were sensitive indicators of carbon pulses in the soil. Carbon use efficiency was largely governed by soil organic carbon content and soil texture. Prairie soils assimilated labile carbon more efficiently than cropland soils.

UNDERSTANDING SOIL MICROBIAL AND ENZYMATIC ACTIVITY DYNAMICS TO ILLUMINATE BACTERIAL AND FUNGAL CONTRIBUTIONS

Grace Williams and Shiping Deng

ABSTRACT

Microorganisms are considered major contributors of soil enzymes, yet enzyme activity does not always strongly correlate with microbial activity. This discrepancy stems from measured enzyme activity contributions varying in origin, biochemical state, and location in soil. This study investigated relationships between acid phosphatase (ACP) or alkaline phosphatase (AKP) activities and microbial activity, biomass, community composition, basic soil properties, and quantified relative contributions of bacteria and fungi to glucose-induced ACP and AKP activities. Twenty-two soils with diverse properties were amended with glucose and selective biocides (bactericide and/or fungicide), and enzyme activities, CO_2 evolution, microbial biomass carbon and nitrogen were measured over 30-day incubation. Microbial community composition was assessed through PLFA profiling. In the presence of glucose, phosphatases were positively correlated with microbial biomass and respiration. In the absence of added glucose, ACP was not significantly correlated with microbial biomass and activity, while AKP remained strongly related, suggesting ACP is largely stabilized within the soil matrix whereas AKP remains cell-associated. Glucose-induced ACP was produced by bacteria and fungi, while bacteria dominated glucose-induced AKP production. Activities of ACP better reflect biochemical potential of the soil, while AKP activity is a better reflection of relative activity and mass of microbial populations in soil.

Figure 1. Average values and percent treatment-induced change relative to control for acid phosphatase (A and B) and alkaline phosphatase (C and D) activities at day 10.

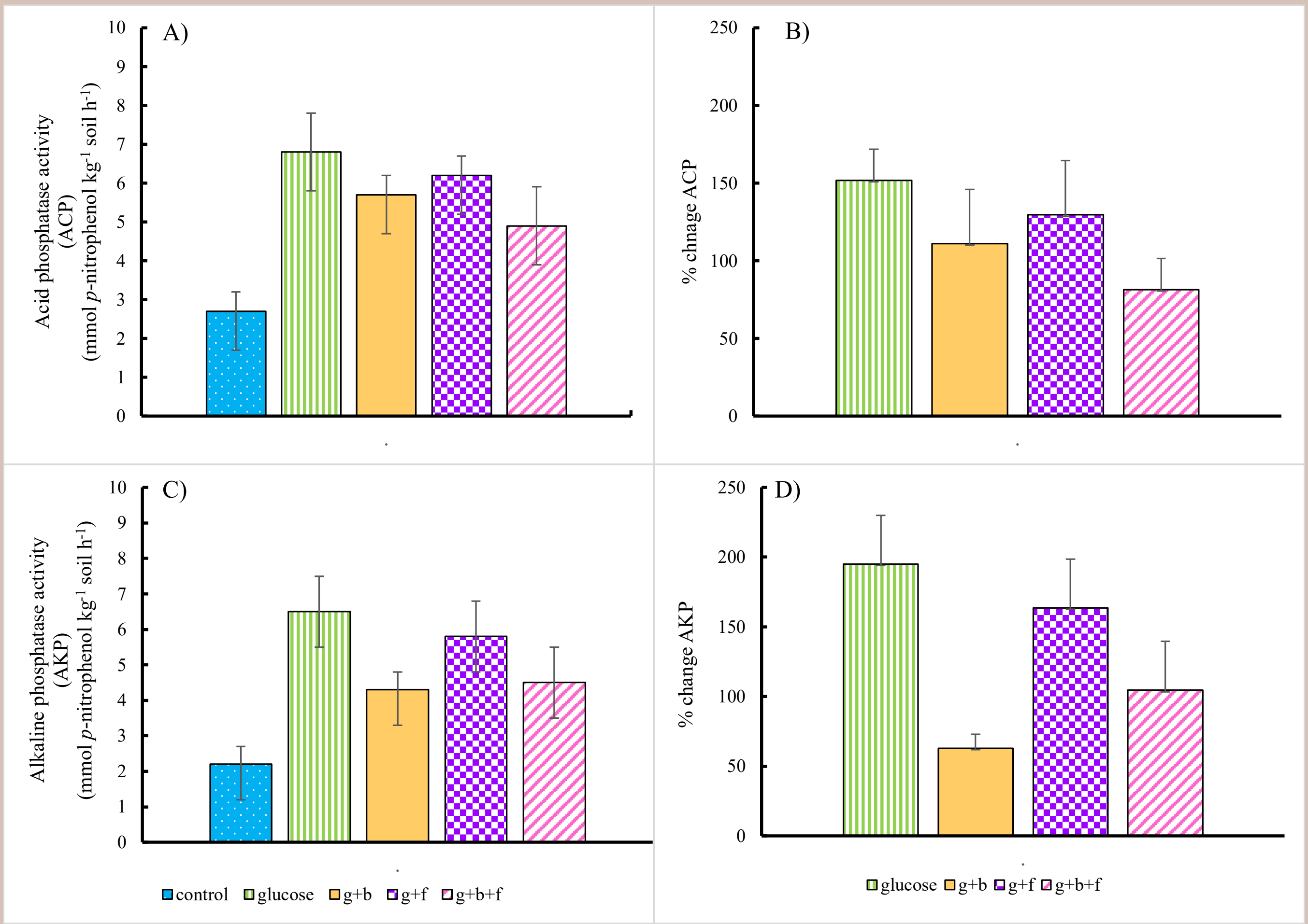
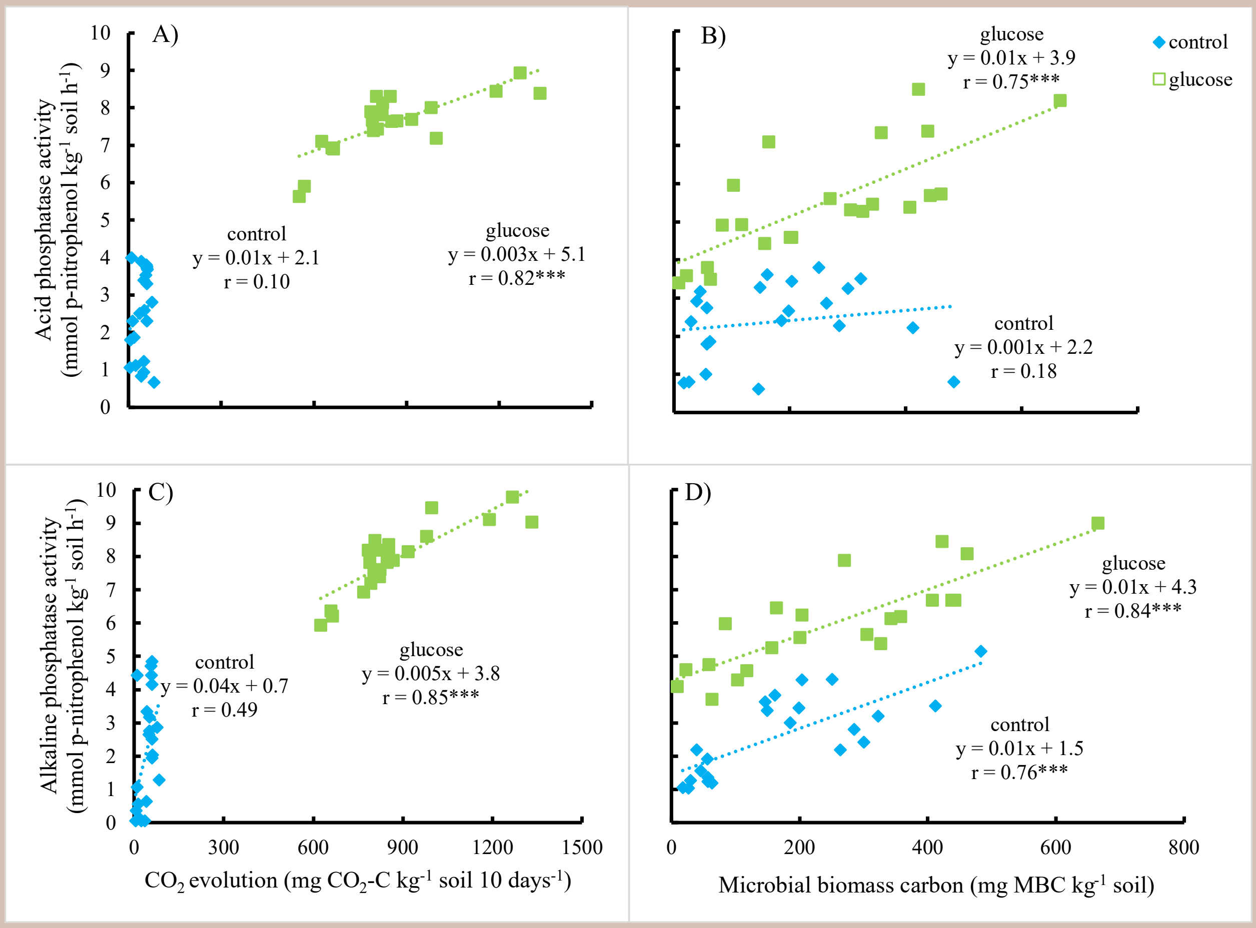


Figure 2. Pearson correlation between the activities of acid phosphatase or alkaline phosphatase at day 10 with CO_2 evolution (A, C), and day 30 phosphatase activities with microbial biomass carbon (B,D) measured across 22 soils under control or glucose-amended treatments.



Conclusion

Soil ACP and AKP activities were significantly correlated to microbial activity when soil was amended with readily available carbon. Without labile carbon addition, ACP activity was weakly related to microbial biomass and activity while AKP activity was still strongly correlated. ACP was produced by both bacteria and fungi, while AKP was produced largely by bacteria. ACP activity may better reflect the soil's accumulated capacity for phosphorus transformation, while AKP serves as an indicator of microbial metabolism.

EVALUATING THE INFLUENCE OF SUBSOIL CONSTRAINTS ON SURFACE SOIL HEALTH

Ishneet Kaur, Ella Hazel Estrada, and Steve Phillips

ABSTRACT

Soil health indicators are widely used to assess the ability of soil to function in an ecosystem. However, the effect of soil health on crop productivity may be influenced by inherent characteristics of subsoils. It is important to understand the relationship between subsoil characteristics and surface soil health indicators to accurately interpret soil health in spatially variable landscapes. This study will evaluate the influence of depth of subsoil root constraints on surface soil health indicators at the Lake Carl Blackwell Agronomy Research Station, Stillwater, Oklahoma during 2025-2026 cropping years from an experimental area of 6.5 acres. The study field is divided into 24 main plots measuring 21 x 36 m. To capture the spatial variability in soil properties, four soil cores (1-m depth) were collected from each main plot, totaling 96 samples. Composite surface soil samples of 10 to 15 1.9-cm cores were collected at a depth of 15 cm from the same subplots. Morphological characterization of core samples was done to identify subsoil constraints and their depth was determined. Surface soil samples were analyzed for health indicators like available water capacity (AWC), wet aggregate stability (WAS), pH, electrical conductivity, organic matter (OM), total N, P, K, Ca, and Mg. Statistical analyses will be conducted by fitting linear regression models to evaluate the relationship between depth of subsoil constraints and the measured soil health indicators. The strength and direction of the relationships will be evaluated using Pearson correlation coefficient. Soil health indicators are expected to show significant associations with the depth of subsoil constraints. The findings of this study will highlight the importance of considering subsoil properties for accurate soil health assessments.

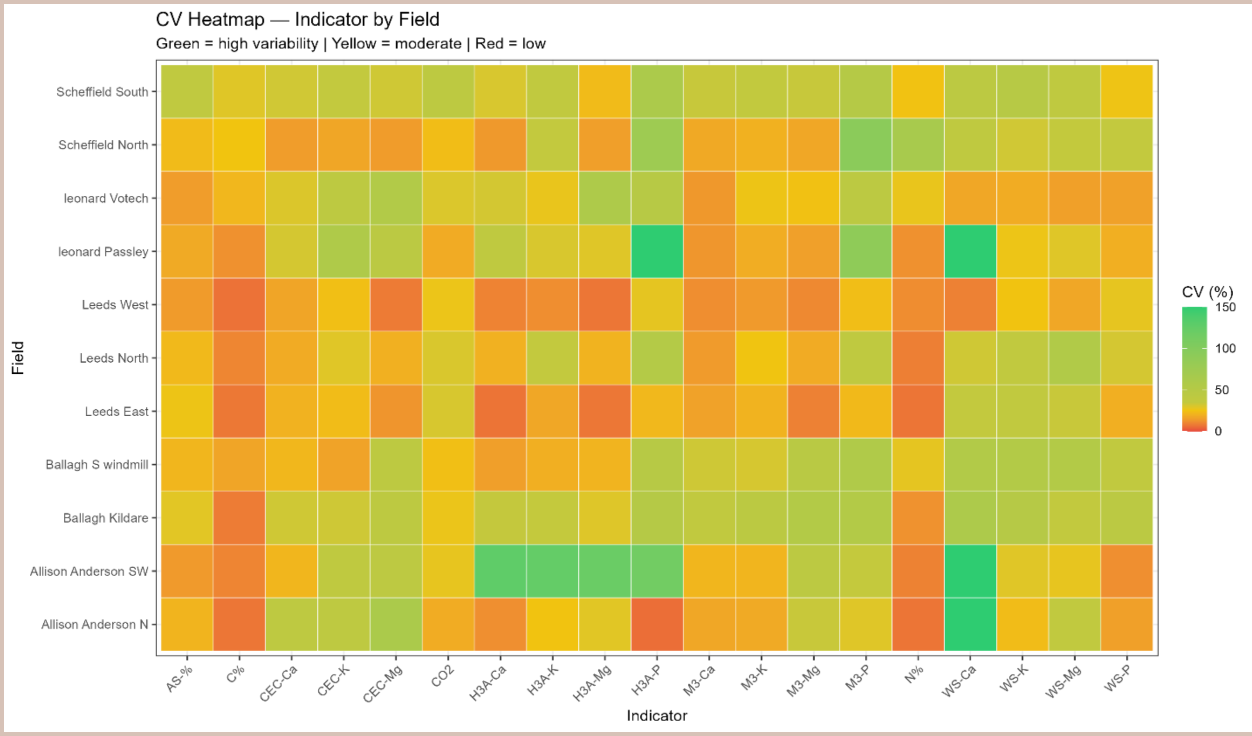
CHARACTERIZING SPATIAL VARIABILITY OF SOIL HEALTH MEASURES AND COMPARING THEM TO STANDARD NUTRIENT MANAGEMENT TESTS

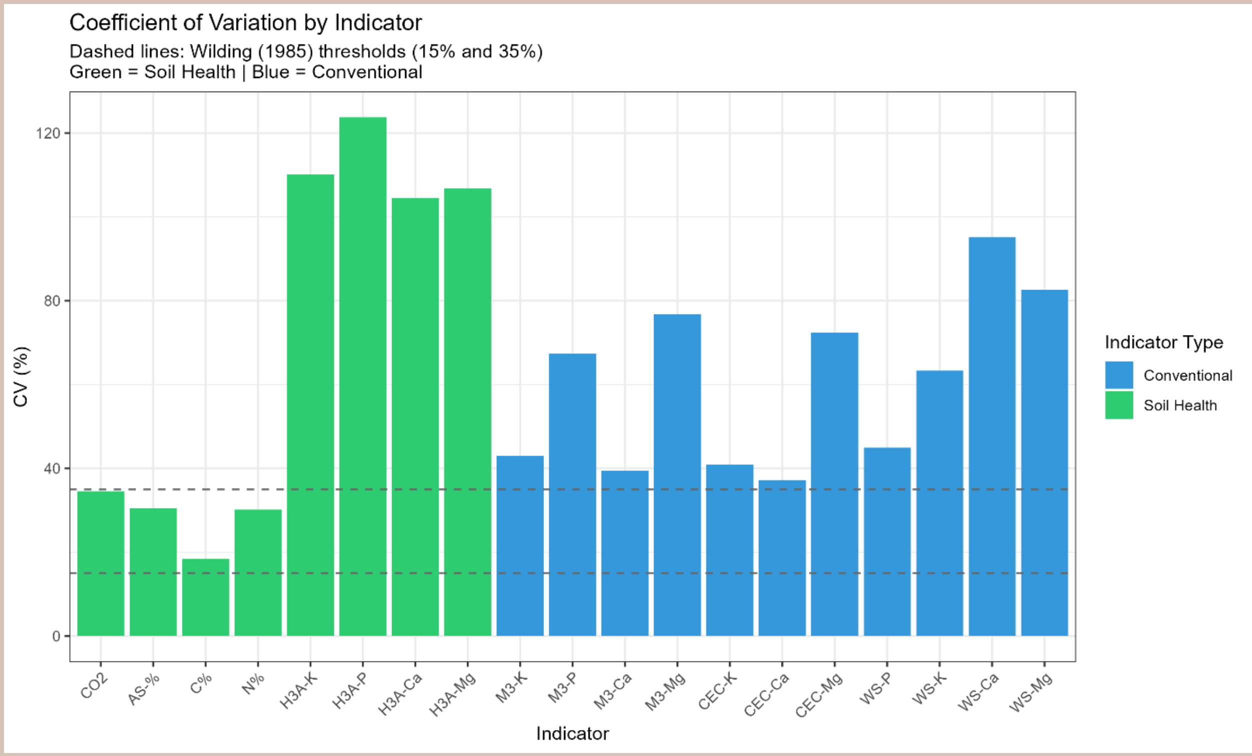
Allan Wylie

ABSTRACT

Soil health assessments incorporating biological indicators such as CO_2 burst and H3A-4 extractable nutrients are increasingly applied at the field scale to guide management decisions, yet the spatial resolution at which these tests remain stable and interpretable is poorly characterized. Evaluation of the spatial variability of soil health metrics was done across 11 agricultural fields in Oklahoma using composite samples collected at 15.24-meter intervals. Tests included CO_2 burst, aggregate stability, total carbon and nitrogen by dry combustion, and H3A-4 extracted K, P, Ca, and Mg, alongside conventional Mehlich-3, ammonium acetate, and water-extractable nutrient fractions. The fields characterized within-field spatial structure using coefficients of variation, runs tests, and lag-1 autocorrelation, and evaluated between-field differences with the Kruskal-Wallis test and Benjamin-Hochberg correction. Bulk biological tests exhibited moderate spatial coefficients of variation (18-35%), while H3A-4 extractable nutrients showed high variability (105-124%), were higher than all conventional extractants that ranged between roughly 37% to 95%. Despite this difference in magnitude, lag-1 autocorrelation at 12.24-meter resolution was broadly similar across test types, with CO_2 burst showing the weakest spatial structure of any test in the dataset. These findings indicate that spatial behavior is not uniform across soil health indicators and that composite scores derived from differing spatial variations may reflect fundamentally different spatial realities for different component tests, a consideration with direct implications for how soil health assessments are sampled, interpreted, and applied at the field scale.

Figure 1-1, Figure 1-2





EVALUATION OF SENSOR -BASED NITROGEN RECOMMENDATIONS FOR GRAIN SORGHUM IN OKLAHOMA

Deepa Pokharel

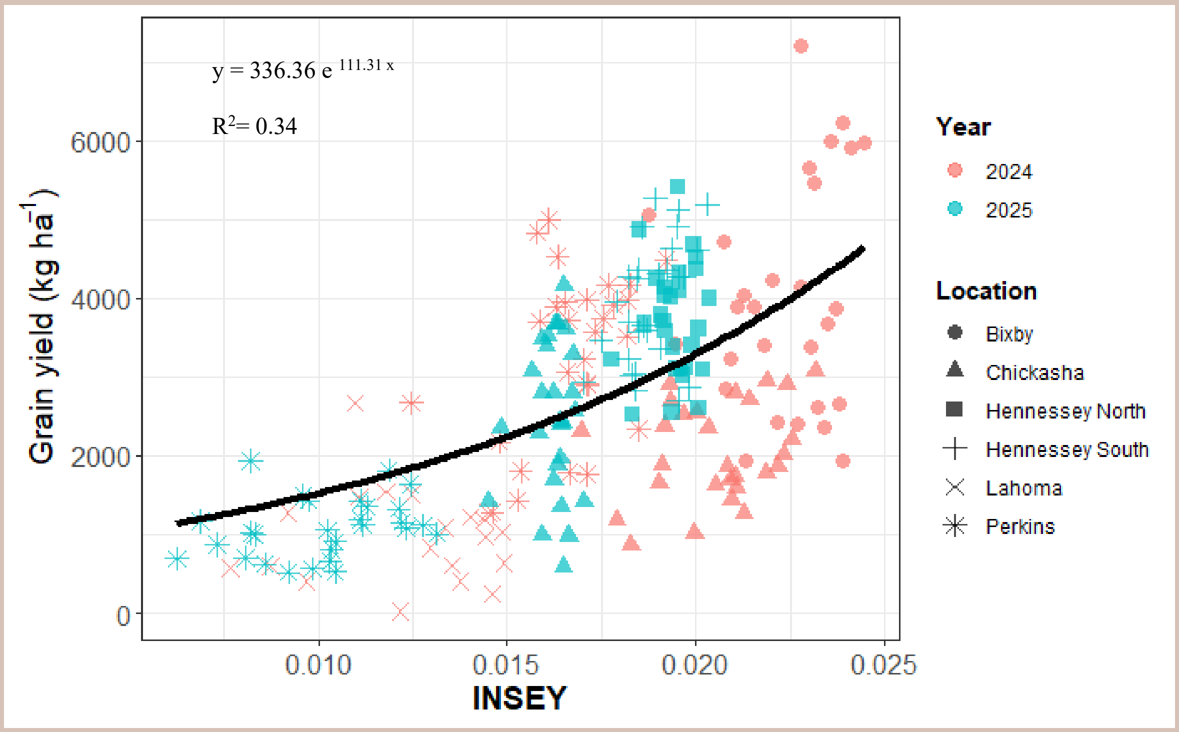
ABSTRACT

Grain sorghum is an important cereal crop for Oklahoma's semi-arid environment; however, management of N, which is based on yield goal approach, is difficult for growers due to high environmental influence on yield. Current yield prediction model for sensor-based in-season N recommendation for grain sorghum was developed using the data from single location in north-central Oklahoma and Kansas data in 2008. This may not accurately predict yield in Oklahoma's specific soil, climatic conditions and management practices in today's context. Thus, this study aims to evaluate the existing yield prediction model and validate for correct N rate recommendations within the Sensor-Based Nitrogen Rate Calculator (SBNRC) specifically for Oklahoma grain sorghum. Field experiments were conducted across ten Oklahoma locations during 2024 and 2025. To establish varying yield potentials needed to evaluate the SBNRC algorithm, trials consisted of seven pre-plants N rates (0 to 202 kg ha^{-1}) in RCBD design replicated four times. Side dress N rates (0 to 168 kg ha^{-1}) were established separately in 2025 for the validation of accurate N rate recommendations. Normalized Difference Vegetation Index (NDVI) data were collected at mid-vegetative stage using a handheld GreenSeeker sensor. In-season estimation of yield (INSEY) was then regressed exponentially with observed yield to develop region specific yield prediction model. Results showed that existing model remained accurate for irrigated condition (Stillwater), while a new rainfed-specific model was developed ($YP_0 = 336.36\ e^{111.31 * INSEY}$) for grain sorghum in Oklahoma. Validation showed that RI_{NDVI} correctly identified the non-responsive sites. Both current and updated algorithms in SBNRC gave zero N rate recommendations. The updated model improved yield prediction while comparing with observed yield at check plot as it increased the correlation coefficient (R) from 0.79 to 0.85 and reduced RMSE from 5059 to 1111 kg ha^{-1}. Integrating this updated model into SBNRC will increase the accuracy of predicted yield and provide accurate N rate recommendation for rainfed grain sorghum in Oklahoma.

Comparison of current and updated SBNRC yield prediction models using R, R^2, and RMSE

Metrics	Current		Updated	
	YP0	YPN	YP0	YPN
R	0.78	0.65	0.85	0.696
R^2	0.62	0.42	0.72	0.485
RMSE (kg/ha)	5059.2	5084.5	1111.2	1099.9

Exponential equation showing the relationship between in-season estimation of yield (INSEY) and grain sorghum yield (kg ha^{-1}) for combined locations and years excluding Stillwater



Conclusion

Using optical sensors to estimate in-season N needs in grain sorghum is a good approach. Yield prediction algorithm is the main component in SBNRC. This study demonstrated that existing yield prediction algorithm in SBNRC for grain sorghum is still valid for irrigated condition (Stillwater) while it overestimated the yield potential in rainfed conditions at Oklahoma. A different relationship between the in-season estimation of yield (INSEY) and final grain yield was observed between irrigated and rainfed locations. These differences were primarily driven by differences in water availability and its impact on crop N response. A new sensor -based yield prediction model specifically for rainfed grain sorghum was developed.

Validation showed that in-season RI_{NDVI} correctly identified the non-responsive sites. Both current and updated algorithms in SBNRC gave zero N rate recommendations; while the updated model generally improved yield prediction under rainfed conditions in Oklahoma. These findings indicate that updated algorithm within the SBNRC can provide accurate yield predictions and N rate recommendations for rainfed grain sorghum production in Oklahoma.

NITROGEN NUTRITION INDEX THRESHOLDS AND YIELD RESPONSES ACROSS WINTER WHEAT GENOTYPES VARYING IN GRAIN PROTEIN CONCENTRATION

Samson Olaniyi Abiola, Ignacio A. Ciampitti, Josefina Lacasa, Brian D. Arnall, and Amanda de Oliveira Silva

ABSTRACT

Understanding how winter wheat genotypes differing in grain protein concentration (GPC) respond to nitrogen (N) availability is critical for optimizing N management strategies. This study evaluated four winter wheat genotypes, Iba (low GPC), Gallagher (medium GPC), Doublestop CL+ (high GPC), and Green Hammer (high GPC), under two fertilizer N rates (0 and 120 kg N ha^{-1}) across eight site years in Oklahoma from 2020 to 2023. Aboveground biomass and tissue N concentration were measured at key growth stages. The Nitrogen Nutrition Index (NNI), derived from published critical N dilution curves, was used to quantify crop N status and its relationships with relative grain yield, yield components, and GPC. Adequate N status (NNI ≥ 1.0) was observed in 77% of cases under fertilized conditions compared to only 24% under zero N application. High GPC genotypes maintained adequate N status more consistently, with Green Hammer and Doublestop CL+ exceeding the critical N curve in 43% and 38% of observations, respectively. The low GPC genotype Iba attained maximum yield at the lowest NNI threshold (0.70), while Doublestop CL+ required a higher threshold (0.77), reflecting differences in N use efficiency and yield potential among genotypes. Yield components responded differentially to N supply, with spike weight saturating at lower NNI values (0.63 to 0.77) compared to spike number (0.79 to 0.89) and shoot biomass (0.74 to 0.94). These results demonstrate that genotypes with contrasting GPC exhibit distinct NNI thresholds for optimizing yield components and grain yield, underscoring the need to revisit existing critical N dilution curves for dryland winter wheat production in the central Great Plains.

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K-MEANS CLASSIFICATION OF OKLAHOMA WINTER WHEAT PRODUCTION ENVIRONMENTS BASED ON NITROGEN RESPONSE AND IMPLICATIONS FOR YIELD AND GRAIN PROTEIN QUALITY

Samson Olaniyi Abiola and Brian D. Arnall

ABSTRACT

Developing effective nitrogen (N) management recommendations for winter wheat requires accounting for the structured variability in yield potential and N responsiveness across diverse production environments. This study classified 52 Oklahoma winter wheat site years spanning 14 growing seasons (2009 to 2023) across seven locations into distinct environment types and evaluated the effect of N application method on grain yield and grain protein quality within each type. K-means clustering applied to control yield, yield response to N (ΔYield), and economically optimal N rate (EONR) identified three environment types: Low Yielding (n = 27; maximum yield = 2.34 Mg ha^{-1}), N Efficient (n = 10; EONR = 51 kg N ha^{-1}), and High Yielding (n = 15; ΔYield = 2.11 Mg ha^{-1}). Cumulative growing degree days did not differ significantly among environment types, while rainfall emerged as the primary differentiating variable, with High Yielding environments receiving 60 mm more post topdress precipitation than Low Yielding environments. Split N application improved grain yield over pre-plant application exclusively in High Yielding environments (360 kg ha^{-1}; $p < 0.05$), with no yield advantage detected in Low Yielding or N Efficient environments. Grain protein deviation (GPD) analysis revealed that split application improved protein quality beyond what yield level alone would predict in both Low Yielding (GPD: +0.17% versus 0.19%; $p < 0.01$) and N Efficient environments (GPD: +0.40% versus 0.43%; $p < 0.01$), while no significant GPD difference was observed in High Yielding environments. These findings demonstrate that environment type classification provides a meaningful and practical framework for anticipating both yield and protein quality outcomes of N management decisions in Oklahoma winter wheat production.

TISSUE NUTRIENT DYNAMICS AND STOICHIOMETRIC RESPONSES OF COTTON TO BIOLOGICAL PRODUCTS AND NITROGEN FERTILIZATION RATES ACROSS DIVERSE PRODUCTION ENVIRONMENTS

Samson Olaniyi Abiola and Brian D. Arnall

ABSTRACT

Optimizing cotton (*Gossypium hirsutum* L.) lint yield without excessive nitrogen (N) inputs requires a mechanistic understanding of whether commercial biological products alter tissue nutrient status or whether N fertilization remains the primary driver of nutritional responses. Building on null agronomic effects documented in a companion study, this investigation evaluated the influence of biological products on cotton tissue nutrient concentrations and stoichiometric ratios across diverse U.S. Cotton Belt environments. A multi-environment field experiment was conducted across eleven locations over two growing seasons, evaluating six commercial biological products marketed for nutrient mobilization, fixation, or micronutrient enhancement at a fixed N rate of 45 kg N ha^{-1}, compared against five N rates (0, 45, 90, 135, and 180 kg N ha^{-1}) without biological product application. Leaf tissue samples collected at early bloom were analyzed for nitrogen (N), carbon (C), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), aluminum (Al), and boron (B). Relative nutrient concentrations were calculated against the 45 kg N ha^{-1} baseline, and stoichiometric ratios (N:P, N:K, Ca:Mg, and Fe:Mn) were computed to assess nutrient balance.

Biological products exerted no significant effect on tissue nutrient concentrations or stoichiometric ratios relative to the 45 kg N ha^{-1} baseline ($p > 0.05$). In contrast, N rate was the sole driver of tissue nutrient status, with dose dependent increases in tissue N, Ca, Mg, and Zn mirroring lint yield responses documented in the companion study. Tissue N concentration increased by 15.7% above baseline at 135 kg N ha^{-1}, while the allometric relationship between tissue N concentration and lint yield remained consistent across all

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biological product treatments. These null effects at the tissue level provide a mechanistic basis for the agronomic failures reported in the companion study, where biological products failed to improve lint yield or fiber quality despite manufacturer claims. Collectively, these findings affirm that N fertilization remains the primary determinant of cotton nutritional status and lint yield across diverse production environments, and that commercial biological products do not meaningfully alter cotton nutrient uptake. This evidence supports the development of robust, evidence based N fertilizer recommendations for commercial cotton production systems.

HERBICIDE TARGETS IN OKLAHOMA WHEAT

Caroline Xu

ABSTRACT

Herbicides are widely used for weed control in wheat fields in Oklahoma. However, the same biochemical pathways targeted by herbicides in weeds also exist in wheat. This significantly reduces wheat production when we use herbicide to kill weeds.

Herbicides in Group 15 of the Herbicide Resistance Action Committee (HRAC) classification act as seedling shoot growth inhibitors. They inhibit the synthesis of very long-chain fatty acids through binding to the enzymes in the pathway to prevent proper membrane formation and ultimately stop seedling shoot growth. The genes (EVLCFA-3) that are involved in the synthesis of very long-chain fatty acids, found on chromosomes 4 and 5 in wheat, can be edited to prevent the interaction of the enzyme and herbicide.

In this research, CRISPR Cas9 was applied to edit the EVLCFA-3 genes in the cultivars OK20708, Strad CL+, Gallagher, and Baker's Ann, local to Oklahoma. The constructs for editing were transformed using particle bombardment.

Until now, several transgenic lines T0 have been obtained, and the T1 generation is under screening. These positive plants carry the editing constructs and have the potential to edit EVLCFA-3 genes.

In parallel, ethyl methanesulfonate (EMS) mutants with modifications in the EVLCFA-3 genes are under testing. The herbicide Zidua SC, which possesses 41.46% active content of pyroxasulfone, will be used for chemical spraying for phenotyping.

The results from these experiments will allow us to confirm the association between the EVLCFA-3 genes and the herbicide tolerance from the edited lines, which could be used for the development of new wheat varieties. Furthermore, a deeper understanding of the mechanisms of herbicides targeting the very long-chain fatty acid biochemical pathway could improve wheat production.

GRAIN YIELD RESPONSE TO P AND K FERTILIZER IN WHEAT DOUBLE CROPPING SYSTEMS

Chisom Ejezie and Steve Phillips

ABSTRACT

Phosphorus (P) and potassium (K) fertilizer recommendations have not been developed specifically for wheat-based double cropping systems in Oklahoma. This leaves producers reliant on full-season crop guidelines that may not adequately address the compressed growing seasons and nutrient demands of these systems. This study, therefore, evaluated the effects of P and K application timing (fall, winter, spring, summer) and fertilizer rate treatment (six treatments varying P and K application between wheat and double-crop phases) on wheat and double-crop grain yield. Three rotations evaluated were wheat-soybean, wheat-corn, and wheat-sorghum, at Lake Carl Blackwell Agricultural Research Station, Stillwater, Oklahoma during the 2024/2025 growing season using a split-split plot design with four replications.

Fertilizer rate treatments significantly affected yield in wheat-soybean and wheat-corn rotations, while application timing had no significant effect across all three rotations. In the wheat-soybean system, wheat P and K plus double-crop P application to the wheat-soybean rotation increased soybean yield by 7.3-7.6% compared to wheat P and K alone, while wheat P and K plus double-crop K provided little to no practical benefit (+1.0%). In the wheat-corn system, applying double-crop P and K only reduced wheat yield by 7.5-10.4%, while corn showed no response to treatments. In the wheat-sorghum system, neither crop responded significantly to timing or fertilizer rate treatments. These results demonstrate that P and K fertilizer response is rotation-specific, with soybean showing the strongest and most consistent response to P application in double-crop systems.

EFFECT OF P AND K MANAGEMENT ON NUTRIENT UPTAKE AND USE EFFECIENCY IN WHEAT-BASED DOUBLE CROPPING SYSTEMS

Chisom Ejezie and Steve Phillips

ABSTRACT

In wheat-based double cropping systems, two crops draw sequentially from the same soil nutrient pool within a single calendar year, creating a nutrient cycling challenge that remains poorly resolved. How phosphorus (P) and potassium (K) applied to the wheat phase carry over to the double crop is not well understood, and how much of that carryover is actually recovered by the subsequent crop remains largely unquantified. This knowledge gap has direct practical consequences: fertilizer rate decisions for the double crop are typically made under time pressure at wheat harvest, yet producers have no empirical guidance on how prior-phase nutrient applications influence double-crop nutrient availability, uptake, or use efficiency.

This study addresses these gaps by evaluating the effects of P and K application timing (fall, winter, spring, summer) and six fertilizer rate treatments varying P and K distribution between wheat and double-crop phases on nutrient uptake and use efficiency. The three rotations evaluated were wheat-soybean, wheat-corn, and wheat-sorghum at Lake Carl Blackwell Agricultural Research Station, Stillwater, Oklahoma, over three growing seasons using a split-split plot design with four replications. Whole plant samples collected at physiological maturity quantify total P and K uptake for each crop phase, and nutrient use efficiency is assessed through agronomic efficiency, apparent recovery efficiency, and partial factor productivity. Pre-plant and post-trial soil test trends are used to assess changes in soil nutrient status across treatments and years, with findings intended to inform practical P and K management guidance for Oklahoma rainfed double-crop producers.

EFFECT OF SOIL MOISTURE VARIABILIY ON CROP RESPONSE TO P AND K FERTILIZER MANAGEMENT IN RAINFED DOUBLE CROPPING SYSTEMS

Chisom Ejezie and Steve Phillips

ABSTRACT

In rainfed wheat double-cropping systems, soil moisture availability at wheat harvest is the primary constraint on double-crop establishment and the most consequential uncertainty producers face at planting. Beyond driving the decision of whether to plant, soil moisture variability also moderates how crops respond to phosphorus (P) and potassium (K) fertilizer applications, influencing nutrient availability, diffusion to root surfaces, and ultimately yield. This moderating role of soil water availability on fertilizer timing and rate response remains poorly quantified in double-crop systems, leaving producers without guidance on whether P and K management recommendations hold consistently across variable moisture environments or depend on soil water conditions at and following planting.

This chapter addresses these gaps by evaluating how in-season soil moisture variability moderates crop yield, nutrient uptake, and nutrient use efficiency responses to P and K application timing and six fertilizer rate treatments varying P and K distribution between wheat and double-crop phases. Wheat-soybean, wheat-corn, and wheat-sorghum rotations were evaluated at Lake Carl Blackwell Agricultural Research Station, Stillwater, Oklahoma, over three growing seasons using a split-split plot design with four replications. Continuous volumetric water content data from capacitance probes are incorporated as an environmental covariate to isolate treatment effects from background moisture-driven variability. Interaction terms between soil moisture and treatment factors assess whether certain timing windows or fertilizer rate treatments maintain yield and uptake advantages under sub-optimal soil water conditions, with findings intended to inform moisture-sensitive P and K management guidance for Oklahoma rainfed producers.

IDENTIFYING SOCIAL MEDIA STAKEHOLDER ENGAGEMENT METHODS FOR INCREASING REACH OF WEED SCIENCE EXTENSION CONTENT

Nia Grigsby, Brody Houser, and Liberty Galvin

ABSTRACT

Extension professionals are at a crossroads with engaging stakeholders and are seeking new and innovative ways to reach producers, students, collaborators, donors, etc. The objective of was to determine and create educational content that serves a broad audience and meets extension objectives of "reach", or the unique number of users who see the content. We assed performance of paid and unpaid pictures, and short form videos (under 20 seconds) using the Meta business suite. Consistent posting, i.e., the same type of content posted weekly on the same day, generated more views and interactions, compared to inconsistent posting of random content. Paid photos got around 2,438 views, but the photo with the highest engagement was unpaid and had 2,168 views. Consistently posted short form videos generated 280 views, while our highest engagement for short form content was 6,221 views on single topic. Consistency encourages people to visit our pages, but the highest engagement comes from unpaid, non-traditional extension content. In conclusion, as extension professionals we need to identify our goals with content, whether that be purely engagement or education to a broader audience, and how that intersects with what format audiences engage with most.

ASSESSING CULTURAL WEED CONTROL OPTIONS FOR SEASON-LONG INTEGRATED WEED MANAGEMENT IN WINTER WHEAT SYSTEMS

Claire Roche, Connor Cox, Amanda de Oliveira Silva, and Liberty Galvin

ABSTRACT

Cultural weed control practices introduce integrated weed management (IWM) opportunities for multi-generational wheat producers navigating herbicide resistance in weedy grasses. Oklahoma State University has released 37 varieties of wheat since 2000; however, variety selection is not well studied within an IWM system. The basis of this project is to provide a comparison of IWM systems to one another by evaluating the interaction of variety selection, combinations of fall and spring chemical weed control, and planting timing. Three Oklahoma State University wheat varieties Orange Blossom (a ClearField+ technology/ tolerant to Beyond® herbicide, tall stature, typical maturity) Smith's Gold (tall stature, early maturing), and Butler's Gold (moderate stature, late maturing) were planted at Field and Research Service Units in Chickasha (hot, dry), Perkins (intermediate, sandy soils), and Lahoma (cooler, wetter vs. other sites). Wheat was planted at a conventional timing (mid-October) and delayed timing (mid-November) at all three locations. Fall weed control included tillage alone, or tillage + AnthemFlex® pre-plant. Beyond® was used in the spring on applicable varieties, however, no other herbicides were used. Field experiments were organized as a split-plot design with variety being the main plot and seven systems encompassing, variety and tillage/chemical weed control, randomized within. Major weeds observed included Jointed goatgrass (*Aegilops cylindrica*) and downy brome (Bromus tectorum) in Lahoma; Italian Ryegrass (*Lolium perenne multiflorum*) in Perkins and Chickasha, Johnsongrass (*Sorghum halepense*) and Truecheat or Rye brome (*Bromus secalinus*) in Chickasha; henbit (*Lamium amplexicaule*) emerged and died within the wheat growing season in all locations. Delayed planting had considerably greater weed control ($p < 0.0001$) over all species observed compared with conventional planting timing regardless of all varieties and

sites. Due to low rainfall, plots that were weed-free post-treatment in the fall remained weed free through most of the growing season. This study is ongoing and will be harvested to determine yield and dockage from treatments.

COMPETITIVE ENHANCEMENT OF WINTER WHEAT USING SEED TREATMENT UNDER ANNUAL ITALIAN RYEGRASS INFESTATION

Sushmita Dey and Liberty Galvin

ABSTRACT

Italian ryegrass (*Lolium perenne ssp. multiflorum*) is a major factor limiting winter wheat production, especially with limited herbicide availability due to prevalent herbicide resistance. Seed treatments may initiate competitive crop growth during establishment. The research evaluated how winter wheat seed treated with CruiserMaxx® Vibrance® Elite® competed against untreated wheat in different infestation scenarios of Italian ryegrass. In a greenhouse experiment, an additive design was used with a constant wheat density of ≈ 20 seeds/sq ft and the Italian ryegrass density varying to represent 0, 25%, 50%, and 100% infestation levels (0, 5, 10, and 20 Italian Ryegrass plants, respectively). Four replications were done with the whole experiment repeated in time. The emergence of wheat and Italian ryegrass was recorded daily for 28 days after planting. The height of the plants was measured weekly. Harvesting was completed at 28 days after planting and included separating roots and shoots from a representative sample of Italian Ryegrass and wheat within each replication. Plants were dried to measure dry biomass. At the 25% infestation level, Italian ryegrass emergence was significantly less when planted with treated wheat than untreated wheat ($p = 0.0037$). Using R statistical software and the stats package, we found no difference in wheat emergence whether treated or not. Wheat was taller than Italian ryegrass at all densities regardless of the seed treatment, but there was no significant different in height between treated and untreated wheat seedlings. Seed treatment may be a tool to improve early-season wheat competitiveness and subsequently assist in the suppressing of Italian ryegrass during the early period of crop establishment.

EARLY POST EMERGENT HERBICIDES UNDER VARIOUS PH AND RAINFALL ACTIVATION TIMING SCENARIOS AND THEIR EFFECTS ON SOIL MICROBIAL ACTIVITY

Connor Cox, Oliver Li, and Liberty Galvin

ABSTRACT

Herbicide performance in Oklahoma winter wheat is frequently hampered by variable rainfall and diverse soil pH. This study investigates the complex interactions between herbicide efficacy, microbial respiration, and the soil adsorption of herbicides to soil particles. Furthermore, the study evaluates how soil pH and moisture modulate herbicide binding; specifically, how low and high pH environments may increase the adsorption of weak-acid herbicides, potentially sequestering them from both weeds and microbial degraders. The objective is to determine how soil pH and moisture levels dictate herbicide availability, microbial degradation, and nutrient cycling. A greenhouse efficacy trial and laboratory soil incubation were conducted using three herbicides that are formulated as a combination of residual and contact chemistry: pyroxasulfone + saflufenacil, pyroxasulfone + carfentrazone-ethyl, and chlorsulfuron + metsulfuron-methyl. The experimental design included a 1" simulated rainfall at 2, 7, and 14 days after herbicide application to activate the residual components but not wash away contact herbicides. To assess biological and chemical interactions, CO2 flux and nitrogen enzyme activity were monitored for 28 days. The greenhouse study results showed pyroxasulfone + saflufenacil, pyroxasulfone + carfentrazone-ethyl maintained consistent control, Conversely, chlorsulfuron + metsulfuron-methyl efficacy was highly sensitive to soil pH and moisture. A Pearson correlation coefficient (r) will be used to link CO2 flux with nitrogen enzyme levels in the laboratory soil incubation study. These results will clarify if herbicides are locked to soil particles inhibiting microbial degradation, nutrient cycling, and the binding potential of soil pH are various herbicides.

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PLANT AND SOIL SCIENCES

EFFECTS OF PRECISION SOIL DISTURBANCE ON WEED SEEDBANK DYNAMICS AND SOIL HEALTH

Connor Cox, Daniel Adamson, and Liberty Galvin

ABSTRACT

Reduced- and no-till systems in Oklahoma rely heavily on herbicide-based weed control. However, widespread confirmation of herbicide-resistant weed populations and limited herbicide options have increased management complexity. As a result, producers often revert to tillage as a lower-cost control strategy, despite potential negative impacts on soil conservation. This creates a critical need for integrated weed management approaches which maintain soil health while reducing reliance on herbicides. Strategically timed soil disturbance events may provide a compromise by targeting herbicide-resistant weed populations without fully returning to conventional tillage systems. However, their effects on weed seedbank dynamics in long-term no-till systems (≥5 years) remain poorly understood. This study evaluates how a single series of targeted tillage operations, using different equipment types and depths, influences seedbank processes, including withdrawals (germination, emergence, decay) and deposits (seed rain and burial), as well as soil health indicators such as soil carbon stocks, bulk density, aggregate stability, and infiltration. Preliminary results indicate that seeds buried below approximately 2 inches experience increased decay, while seeds buried deeper than 2 inches remain viable in the soil profile. Shallow disking provided approximately 40% weed control, compared to up to 95% control with moldboard plowing followed by disking. This research will improve understanding of how strategic soil disturbance affects weed seedbank ecology and soil health in conservation systems. Outcomes will support the development of integrated weed management strategies that improve control of herbicide-resistant weeds while preserving the long-term soil conservation benefits of reduced- and no-till production systems.

EFFECTS OF RAINFALL ACTIVATION TIMING AND SOIL PH ON EARLY POST-EMERGENT HERBICIDE APPLICATION EFFICACY

Connor Cox and Liberty Galvin

ABSTRACT

Early-season weed control is critical for Oklahoma winter wheat production, yet herbicide performance remains inconsistent due to unpredictable rainfall patterns and diverse soil pH levels across the region. This study evaluated how the timing of a 1" simulated rainfall applied at 2, 7, and 14 days after herbicide application (DAHA), influenced herbicide efficacy across varying soil pH scales. Field trials were conducted at three locations: Efaw (pH 4.92, no-till), Lahoma (pH 6.8, conventional till), and Chickasha (pH 6.2, conventional till). The three herbicide treatments used were chlorsulfuron + metsulfuron-methyl, pyroxasulfone + carfentrazone-ethyl, and saflufenacil + pyroxasulfone, applied at wheat emergence using a split-plot design with 4 replications. Results indicated that soil pH and existing moisture significantly impacted the "activation window." At Efaw (low-pH, no-till), pyroxasulfone + carfentrazone-ethyl provided consistent weed control, while chlorsulfuron + metsulfuron-methyl provided the most effective burndown of existing weeds. Irrigation timing had a minimal effect in Lahoma, with all treatments achieving similar residual weed control by 28 days after simulated rainfall. Conversely, hot and dry environmental conditions at Chickasha that persisted into late November prevented weed emergence. These findings suggest that while a wider activation window may exist depending on herbicide chemistry, efficacy remains highly contingent upon soil properties and environmental interactions such as existing soil moisture compared with rainfall. Further replication is required to quantify the specific influence of initial soil moisture on these activation windows.

EVALUATION OF METRIBUZIN TOLERANCE IN WINTER WHEAT

Thomas Parkey, Ty Shreve, Amna Dar, Connor Cox, Brett Carver, and Liberty Galvin

ABSTRACT

Oklahoma State Weed Science has recently detected statewide herbicide resistance to many commonly used post-emergence herbicides. Therefore, new product discovery has become necessary to successfully control grassy weeds in wheat production. The objective of this study was to determine wheat variety tolerance to metribuzin, as previous OSU wheat research suggests tolerance exists in some varieties while others are more susceptible to injury. We utilized 39 wheat varieties from Oklahoma, Texas, and Kansas. 10 seeds of each variety were grown in small pots in a greenhouse environment until they reached the 3-4-leaf stage, at which time they were transferred to an enclosed spray chamber and treated with 1.5 oz/ acre of metribuzin at 20 GPA with a single 8002 nozzle. Plants were returned to the greenhouse, and injury assessed at 3, 7, 14, 21, and 28 days after treatment. This study is ongoing with the objective of selecting varieties for field testing in the coming 2026-2027 wheat field season. This research will assist with herbicide mode of action rotation and diversification and is imperative to the development of new trait packages for wheat across the United States.