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# Session 2C: Soils and Agriculture

Kentucky Water Resources Research Institute, University of Kentucky

# SESSION 2C: SOILS AND AGRICULTURE

## SOIL PHOSPHOROUS IN URBAN KENTUCKY: LAWN AND GARDENING OUR WAY TO HELL IN A VEGETABLE BASKET

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An excess of phosphorus (P) in the environment can lead to eutrophication and degradation of surface waters. Research at the University of Kentucky has demonstrated that at soil test P levels greater than 60 mg $kg^{-1}$, P becomes water soluble and has a greater potential to reach surface and ground water than at concentrations below 60 mg $kg^{-1}$. Often the public blames water quality impairments on agricultural practices that lead to sediment and nutrient runoff without reflection on personal practices at home that may also impair local water bodies. An investigation of the temporal and spatial distribution of all soil P tests collected over 25 years (1990 – 2014) from row cropped fields and pastures (agriculture: 810,978 tests) compared to residential home lawns and gardens (urban: 179,184 tests) was conducted. Amongst all of the soil tests collected, 79% of all urban soil tests were greater than 60 mg $kg^{-1}$ while only 34% of all agriculture soil tests where greater than 60 mg $kg^{-1}$. In 119 out of 120 counties, the average soil test is 93 mg $kg^{-1}$ higher in urban soils relative to agricultural soils. Amongst physiographic regions, the Bluegrass has a significantly higher average soil test P levels (ag: 156 mg $kg^{-1}$, urban 261 mg $kg^{-1}$) than any other region. The lowest average soil test P levels were found in the western Coalfield (agriculture: 76 mg $kg^{-1}$, urban: 137 mg $kg^{-1}$) and western Pennyrile (agriculture: 68 mg $kg^{-1}$, urban: 142 mg $kg^{-1}$). Temporally, the state average amongst all agricultural soils was 62 mg $kg^{-1}$ in 1990 and has decreased steadily to 51 mg $kg^{-1}$ in 2014, demonstrating that the agricultural community has been effective at reducing P levels in their row-crop fields and pastures. Alternatively, the state average soil test P amongst all urban soils was 94 mg $kg^{-1}$ in 1990 and has increased to 113 mg $kg^{-1}$ in 2014. These results indicate that there is an impactful educational opportunity in the urban sector to improve nutrient management and the reduction of P released to the environment.

# OPTIMIZING YIELD AND WATER USE EFFICIENCY OF SOYBEAN PRODUCTION IN KENTUCKY- EXPERIMENTAL AND MODELING APPROACH

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Water limitation is one of the main causes for the gap between potential and actual yields in many soybean production areas of the US. In Kentucky, the estimated yield gap ranges from 12 to 32%, and was partially associated to the ability of different soils to hold water (Egli and Hatfield, 2014). Currently only 5% of soybean production in the state is irrigated (USDA-NASS, 2017). Continuous water availability under both rainfed and irrigated conditions thus pose a threat for stable high row crop productivity in the state. It is critical to quantify yield productivity and water use efficiency (WUE) across a range of management options to develop sustainable recommendation practices. We hypothesize that management recommendations of planting date and maturity group (MG) selection that maximize yield and WUE will differ from irrigated to rainfed conditions.

Field experiments took place in Lexington and Princeton, KY during 2017. The experimental design was a split-split-plot with four replication. The main factor was planting date (May16$^{th}$ and June 21$^{st}$ in Lexington, May 23$^{rd}$ in Princeton), the second factor was irrigation (rainfed vs irrigated) and the third factor was soybean maturity (MG 2, 3, 4 and 5). A total of 16 cultivars were used, with four cultivars nested within each MG. Phenology stages were monitored, and during-season destructive samples were taken to estimate crop and seed growth rate. Drip irrigation was applied to the irrigated treatments when the soil-water deficit reached 30 mm. Soil-water deficit values were estimated based on weather data and a daily soil-water balance. Daily crop evapotranspiration (ET) for the irrigated treatments were estimated using the standardized dual-crop coefficient Penman-Monteith approach (FAO-56) (Allen, 2006) and used to calculate preliminary WUE data for the irrigated treatments presented in Table 1. Actual ET values for each treatment under both irrigated and rainfed conditions will be estimated using a mechanistic crop-soil-water model (DSSAT-CROPGRO; Hoogenboom et al., 2017). The suitability of the model to predict ET will be assessed based on the model ability to predict yield and plant growth differences across the different treatments in the study.

Irrigation increased yield by 13 to 30% in Lexington depending on maturity group and planting date (Table 1).For planting dates in May, irrigation increased yields by 16 to 30%, while for late planting dates in June, irrigation increased yields to a lesser extent (6 to 13 %). In Princeton, irrigation did not produce a significant yield increase in most cases, and yields were reduced by 11% in MG 3 cultivars. (Table 1). The MG cultivar choices that would maximize yield within a location and planting date were different for the rainfed compared to the irrigated treatments (Table 1). For example, for planting dates in May at Lexington, MG 3 to 5 cultivars would maximize yields under rainfed conditions, while earlier soybean maturities (MG 2 to 4 cultivars) would maximize yields under irrigation. The study was successful identifying management options that can increase WUE under irrigated conditions while maintaining yield productivity. Short-season MGs showed a higher WUE compared to later MGs (Table 1).

Under scenarios of similar yields across two MG options, shorter-season cultivars offered the advantage of increasing WUE. As an example, for May planting dates in Lexington, MG 2 to 4 cultivars would produce similar yields but MG 2 would increase WUE by 23% compared to MG 4 cultivars (Table 1).

**Preliminary results from this study indicate that state MG recommendations might need to be re-adapted depending on water management and availability, and that informed decisions on MG selection could have a significant impact on WUE without a yield penalty.** Data from 2018 and estimations of ET and WUE under rainfed conditions based on crop model simulations will be used to provide management recommendations that increase water productivity for soybean production in KY.

Table 1. Average yield (kg $ha^{-1}$) for rainfed and irrigated treatments, yield increase due to irrigation (%), water use efficiency (WUE, kg $mm^{-1}$) and total evapotranspiration (ET, mm) by location, planting date, and soybean maturity group (MG). Data from 2017 at Lexington and Princeton, KY.

| | | | | | | **Irrigated treatments** | |
|---|---|---|---|---|---|---|---|
| **Maturity group** | **Location** | **Planting date** | **Yield (kg $ha^{-1}$) Rainfed** | **Yield (kg $ha^{-1}$) Irrigated** | **Yield increase due to irrigation (%)** | **WUE (kg $mm^{-1}$)** | **Total ET (mm)** |
| 2 | Lexington | May | 4301 **b** | 5599 **a** | 30* | 12.3 **a** | 454 |
| 3 | Lexington | May | 4822 **a** | 5758 **a** | 19* | 11.2 **ab** | 515 |
| 4 | Lexington | May | 4671 **a** | 5398 **a** | 16* | 10.0 **b** | 542 |
| 5 | Lexington | May | 4960 **a** | 4587 **b** | -8 | 7.5 **c** | 610 |
| | | | | | | | |
| 2 | Princeton | May | 4231 **b** | 4344 **b** | 3 | 10.3 **a** | 422 |
| 3 | Princeton | May | 4957 **a** | 4425 **b** | -11* | 9.6 **a** | 487 |
| 4 | Princeton | May | 5015 **a** | 5460 **a** | 9 | 10.5 **a** | 519 |
| 5 | Princeton | May | 4254 **b** | 4307 **b** | 1 | 6.8 **b** | 631 |
| | | | | | | | |
| 2 | Lexington | June | 3833 **b** | 4212 **b** | 10* | 12.0 **a** | 350 |
| 3 | Lexington | June | 4188 **b** | 4727 **a** | 13* | 12.2 **a** | 388 |
| 4 | Lexington | June | 4550 **a** | 4799 **a** | 5 | 11.1 **b** | 433 |
| 5 | Lexington | June | 3454 **c** | 3695 **c** | 7 | 7.8 **c** | 476 |

†Different letters indicate significant differences ($p<0.05$) across MGs within a location and planting date. *An asterisk represents a significant effect of irrigation within a location, planting date, and soybean MG treatment ($p<0.05$).

<u>References:</u>

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# VARIATIONS IN SOIL SATURATED HYDRAULIC CONDUCTIVITY ACROSS MULTIPLE LAND USES IN FAYETTE COUNTY, KENTUCKY

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Nonpoint source pollution, flooding and other phenomena depend heavily on the seemingly simple, yet notoriously inconsistent, relationship between rainfall and runoff. Methods are available to account for some of the major sources of variation in the rainfall-runoff relationship. Even so, it is prudent to validate the benefits of these methods under a variety of circumstances and, in view of the importance of the issue, to continue to seek improvements in rainfall-runoff modeling.

The objective of this study was to examine relationships between soil hydraulic conductivity, a soil characteristic that is key in the rainfall-runoff relationship, and more easily-obtainable soil parameters (e.g., bulk density and texture). Soil cores (5.7 cm diam. x 6.0 cm length) were collected from 24 sites in Fayette County, Kentucky, which varied according to land use (residential, pasture, industrial and parks), hydrologic soil group as mapped by USDA Natural Resources Conservation Service staff (hydrologic soil groups B and C) and, in the case of residential land use, the age of the residence (new, medium and old). Saturated hydraulic conductivity of the samples was determined using a constant head permeameter, and the data were analyzed for significant relationships with other soil parameters. The findings indicate that, under conditions of this study, saturated hydraulic conductivity is more closely related to dry bulk density than any other soil parameter investigated. The implications on runoff estimation, and on all processes that are dependent on runoff, are potentially significant.