EFFECTS OF PHOSPHORUS AND POTASSIUM APPLICATION TIMING ON A WHEAT DOUBLE CROP SOYBEAN SYSTEM

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ABSTRACT

The wheat-double crop soybean system is a popular choice for Oklahoma producers, as it allows for two crops in one year, and therefore, more revenue in less time. With favorable conditions and proper management, double crop soybeans are yielding as well as full season soybeans. Weather pattern shifts over the last few years have raised the question for growers if they should invest more into the summer double crop, as there is growing potential for profit. While attempting to increase yield and profit of the summer crop, it is also important to not limit the potential of the winter wheat crop. This study is designed to evaluate the effects of phosphorus (P) and potassium (K) fertility management for a wheat – double crop soybean cropping system, over three timings, and different rates, to better understand how these effect the wheat and soybean yield. The study also determines if OSU fertilization rates based on soil tests are effective. This study consists of 13 treatments replicated 4 times that were established at planting of winter wheat. A total of 6 site years spread out across eastern and north central Oklahoma over two years made up this research. Oklahoma State University's winter wheat P and K recommendations based on the sufficiency approach maximized yields when P and K where the only limiting factors. As in previous work, locations with acidic soil pH responded to the addition of P fertilizer above sufficiency recommendations. At one location with low P and pH, in season application of additional P at top dress maximized yield in wheat. Pre plant application on soybeans has been found to significantly impact yield in one location, although further investigation of soybean data is needed.

INTRODUCTION

Double cropping soybeans in Oklahoma is becoming a popular option for farmers looking to improve their profits in uncertain economic times. Double cropping can be defined as harvesting two crops from the same field in one year (Borchers, et al., 2014). This system offers several advantages such as improving soil quality, reducing erosion, a more efficient use of land and equipment, and provides more food and feed for an expanding world population (Holshouser, 2015). As double crop soybean (*Glycine max*) production increases, additional questions are being raised as to what is the optimal fertilizer program for a wheat (*Triticum aestivum*) and soybean system. Currently, published literature is lacking as to the optimum nutrient management practice for a winter wheat and double crop soybean system. Currently if producers add nutrients for the double crop it is applied as a single pre-plant application prior to the wheat crop. The proper timing of nutrient application for the double crop has not been documented, much less if additional nutrients are needed above that of the primary cash crop, winter wheat. Therefore, this study will observe the impact of different phosphorus (P) and

potassium (K) fertilization timings on a wheat-soybean double crop system focusing on soybeans.

MATERIALS AND METHODS

This trial was established at two locations, Haskell and Ponca City, for the 2019-2020 growing season. For the 2020-2021 growing season 4 sites were established in 2 areas of Oklahoma. Two locations are in Lamont, one location is at Lake Carl Blackwell, and a location at Haskell once again. These locations represent different soil types and rainfall patterns.

The trial is organized as a randomized complete block design (RCBD) consisting of 13 treatments and 4 replications. The treatments were split into 3 separate timings across the combined winter wheat and then double crop soybean growing season. The fertilizer applications were made either pre-plant or top-dress in the wheat season or at planting of the double crop soybeans. Treatments consisted of combinations or single applications of N, P, and K. Multiple P and K treatments were determined using OSU recommendations based on preplant soil tests. Treatments with a "+" next to the letter represent the application of the OSU recommendation for both the wheat and soybean crop.

Treatment	Pre – Wheat	Top – Dress	Pre – DC Soybeans
1	N	N	-
2	NP	N	-
3	NK	N	-
4	NPK	N	-
5	NP+K	N	-
6	NPK+	N	-
7	NP+K+	N	-
8	NPK	NP	-
9	NPK	NK	-
10	NPK	NPK	-
11	NPK	N	P
12	NPK	N	K
13	NPK	N	PK

Figure 1. Treatment structure of the wheat – double crop soybean trial.

Pre-plant wheat soil samples were taken at a 0-15 cm depth with 2.54 cm diameter soil probes in each plot at both locations. The samples were dried and ground to pass through a 2 mm sieve or less. The samples were then analyzed for pH and buffer index using a 1:1 soil: water suspension and glass electrode (Sims, 1996; Sikora, 2006). They were also analyzed for phosphorous and potassium concentration using Mehlich-3 extractant solution (Mehlich, 1984) and analyzed using an ICP spectrometer (Soltanpour, et al., 1996).

Fertilizer was applied almost exclusively by hand in granular form as top-dress. UAN was applied with a John Deere Gator. A constant rate of 67.25 kg ha^{-1} of nitrogen as

ammonium-nitrate or UAN was applied on all plots at all trial locations at pre-plant wheat timing. Phosphorus was applied as triple super phosphate (0-46-0) and potassium was applied as muriate of potash (0-0-60
At maturity, 7 of the wheat and double-crop soybean crops were harvested by a Kincaid 8-XP plot combine (Kincaid Equipment Manufacturing; Haven, KS). Yield data was collected by a Harvest Master Yield onboard monitoring computer (Juniper Systems; Logan, UT), and grain samples were collected from each plot. The middle 2 rows of each plot (wheat and double-crop soybeans) were harvested at all locations. The remaining 4 crops were hand harvested due to time constraints and bad field conditions at time of maturity. The 2019-2020 wheat crop at Haskell failed due to freeze and flood damage. Subsequently, the wheat at this location was baled off.

RESULTS AND DISCUSSION

Oklahoma State University's winter wheat P and K recommendations based on the sufficiency approach maximized yields when P and K where the only limiting factors. As in previous work completed in the past, locations with acidic soil pH responded to the addition of P fertilizer above sufficiency recommendations. At one location with low P and pH, in season application of additional P at top dress maximized yield in wheat. Pre plant application on soybeans has been found to significantly impact yield in one location, although further investigation of soybean data is needed.