Mixing Wheat Seed with Fertilizer in the Drill: Seedling Injury and Wheat Response

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ABSTRACT

Mixing dry phosphorus fertilizer with winter wheat seed is common in Kansas to provide a starter fertilizer benefit to the crop. This study was designed to evaluate the effects of dry phosphorus (P) sources, rates and times fertilizer mixed with wheat seed, effects on early growth and overall productivity and yield of the crop. Two winter wheat studies were conducted in the 2018-2019 wheat growing season at Manhattan (Site 1) and Topeka (site 2) in Northeast Kansas. The previous crop for site 1 was soybean, and corn at site 2. The winter wheat was no-till drilled at 70 lbs acre^{-1} and mixed with either diammonium phosphate "DAP" (18-46-0) or Micro-Essentials SZ "MESZ" (12-40-0-10S-1Zn) rates of 30, 60 and 120 lbs P_2O_5 acre^{-1}. Mixing times in which wheat seed was in contact with the fertilizer were 0, 12, 28, and 40 days. The winter wheat was drilled in October and November and top-dressed with 100 lbs N acre^{-1} using UAN 28% at green up in the spring. Normalized Difference Vegetation Index (NDVI) and biomass measurements were taken at jointing in spring 2019. Significant increases in jointing NDVI were observed when overall P_2O_5 rates were increased with both sources, however, no differences were observed when time mixed with seed were compared besides a slight significant decrease at the longest MESZ mixing. Total P in jointing biomass significantly increased with P_2O_5 rates increase with both P sources although time mixed had no effect besides the longer MESZ mixing timings, which observed a significant decrease. Total P removed in grain followed the same trend as total P_2O_5 in the jointing biomass. Yield was significantly increased when rates of P_2O_5 were increased in both P sources analyzed. The time fertilizer P sources were mixed had no effects on yield except for the longer mixed MESZ treatments, which were observed a small significant decrease in yield.

INTRODUCTION

Kansas is one of the leading winter wheat-producing states in the United States. Kansas also has soil testing lower in phosphorus (P). In general, winter wheat is one of the most responsive crops to P fertilizers in Kansas making starter P fertilizer common across the state (Ruiz Diaz and Weber, 2019). Some producers lack fertilizer setups on their drills and commonly blend dry P fertilizers with wheat seed and then drill both together in the same hopper to get a starter fertilizer effect. However, little research has been done to address concerns with potential injury to wheat seed when mixed with different phosphorus fertilizer rates and timings. Thus, increases in nitrogen fertilizer rates (salt) in the seed furrow commonly cause issues with seed germination and fall stand of wheat. This could ultimately decrease fall stands of the crop, which leads to a greater need for fall/spring tillering to recover this reduction in fall stand. In addition, the question "how long can dry fertilizer sit with the wheat seed?" and "will it cause the same damage as a high starter fertilizer rate in-furrow?" This paper will provide a summary of results from an ongoing study evaluating the effect of fertilizer rates and fertilizer time exposure to wheat seed, and effects on wheat grain yield.

MATERIALS AND METHODS

The study was conducted at two locations during the 2018-2019 wheat growing season at Manhattan (site 1) and Topeka (site 2) in Northeast Kansas near Kansas State University **(Table 1)**. The previous crop for site 1 was soybean, and corn for site 2. The trials experiment were set up in a randomized complete block design with four replications. Plots were 45' by 6' for a total area of 270 ft. sq. The winter wheat variety Everest was mixed with diammonium phosphate -DAP (11-52-0) and Micro-Essentials SZ - MESZ (12-40-0-10S-1Zn) fertilizers. The blend of seed and fertilizer was stored in open plastic buckets for 0, 12, 28, and 40 days before drilling. Rates included 0, 30, 60, and 120 lbs P_2O_5 acre^{-1} with 70 lbs wheat seed acre^{-1} (complete combination of P rates and times for two P fertilizer sources). No Nitrogen (N) was applied in the fall except for N present in DAP and MESZ fertilizers. At green up 100 lbs N acre^{-1} was applied to all plots to ensure N was not a limiting factor. NDVI measurements were taken at jointing (Feekes 6) stage with a Holland RapidSCAN CS-45 active sensor ran 35-40 inches above the crop canopy. Averages of NDVI readings were then recorded for each treatment. Biomass samples were collected at jointing (Feekes 6) and were taken from 2.5 feet of row times 2 rows in the backside of the plots. Additional biomass samples were taken at soft dough (Feekes 11.2) in the same manner as the jointing biomass samples. Grain harvest was completed with a plot combine and subsamples were taken from each treatment. All biomass samples and grain were analyzed for P concentrations using the salicylic-sulfuric acid digestion method (Miller and Keeney, 1982). All statistical analysis were completed using SAS Studio (version 9.4; SAS, Institute, Inc, Cary, NC). Analysis of variance (ANOVA) using the GLIMMIX procedure was conducted.

RESULTS

Early Growth

Increases were observed in NDVI when increasing rates of P_2O_5 were mixed with the seed with both DAP and MESZ fertilizer sources **(Figure 1A)**. However, no significant differences were observed when DAP was mixed with increasing time intervals. Although, when MESZ was mixed, the NDVI values at jointing was lower for the longer time interval of 40 days **(Figure 1B.)**. Also, significant increases were observed in total P uptake at jointing when increasing rates of both P fertilizer sources **(Figure 1B.)**. However, there was no significant effects of time mixed and total P uptake at jointing with either P fertilizer sources **(Figure 1D.)**.

Grain yield and P removal

Preliminary results of this study showed that as rates of both P fertilizer sources were increased, significant increases were observed in the total amount of P removed in wheat grain **(Figure 2A.)**. However, when looking at duration of source mixed with seed, no significant results were found for DAP but a slight decrease was observed in P removal for the longest MESZ mixing time of 40 days **(Figure 2B.)**. In addition, yield was significantly increased as rate of both P fertilizer sources increased **(Figure 3B.)**. Also, the time DAP was mixed with seed had no significant effect on grain yield while the longest mixing time using MESZ resulted in a small decrease in wheat grain yield **(Figure 4B.)**.

DISCUSSION

Based on these preliminary results, P rates in-furrow were the primary driver for increasing NDVI at jointing, P uptake at jointing, grain yield and P removal with the grain. This response was significant up to the highest P rate for both fertilizer sources and likely due to the combination of low soil test and late planting date for the wheat (due to unfavorable weather conditions). The time DAP was mixed with wheat seed had no effect on any of the measurements taken which indicates producers have flexibility regarding the time elapsed between mixing the seed and fertilizer, and planting. In this study the storage conditions were in a dry environment to prevent fertilizer from absorbing water, it is possible that conditions of high relative humidity might affect the physical characteristics of the seed-fertilizer blend. When MESZ was mixed with wheat seed for an extended time (approximately 40 days), NDVI, P removal, and yield showed a small decrease. However, the overall trends observed in these prelimiraly resuls sugest that either P fertilizer source can be stored for a prolonged period of time with no negative impact, and producers can avoid the economic expenses of replacing the seed-fertilizer blend.

REFERENCES

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Table 1. Sites and soils type information for wheat experimental studies from 2019

					0-6" samples		
Location	County	Soil Type	Soil Texture	Planting Date	pH	P	OM
						ppm	%
1	Riley	Smolan	Silt Loam	11/19/2019	5.75	17	3.2
2	Shawnee	Eudora	Silt Loam	10/19/2019	6.99	18	1.6

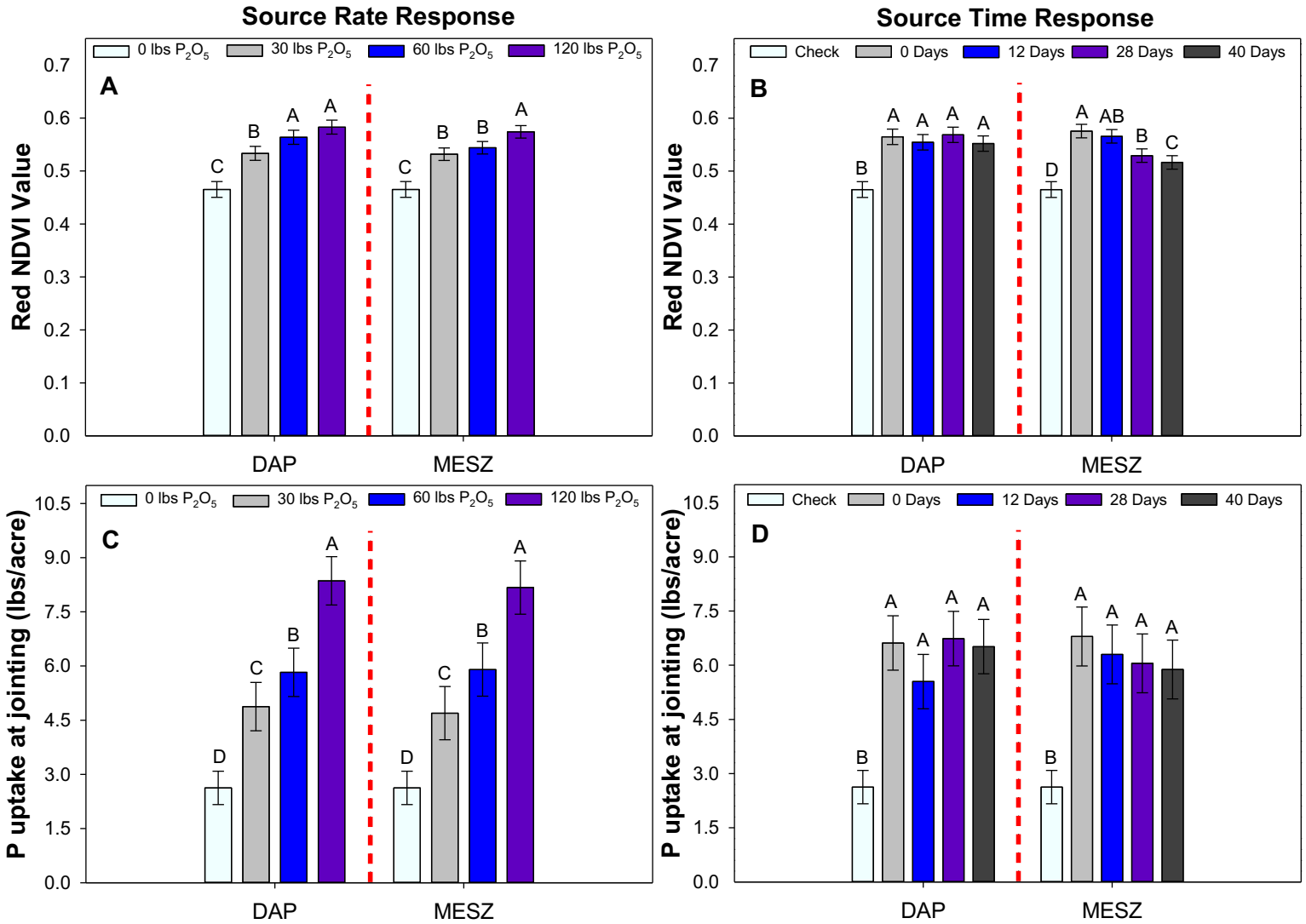

Figure 1. NDVI measurements taken at the jointing (Feekes 6) stage with comparison made between fertilizer source rates mixed with seed (A) and comparison made between fertilizer mixing duration with seed (B). P uptake at jointing lbs acre^{-1} at the jointing (Feekes 6) stage with comparison made between fertilizer source rates mixed with seed (C) and comparison made between fertilizers mixing duration with seed (D).

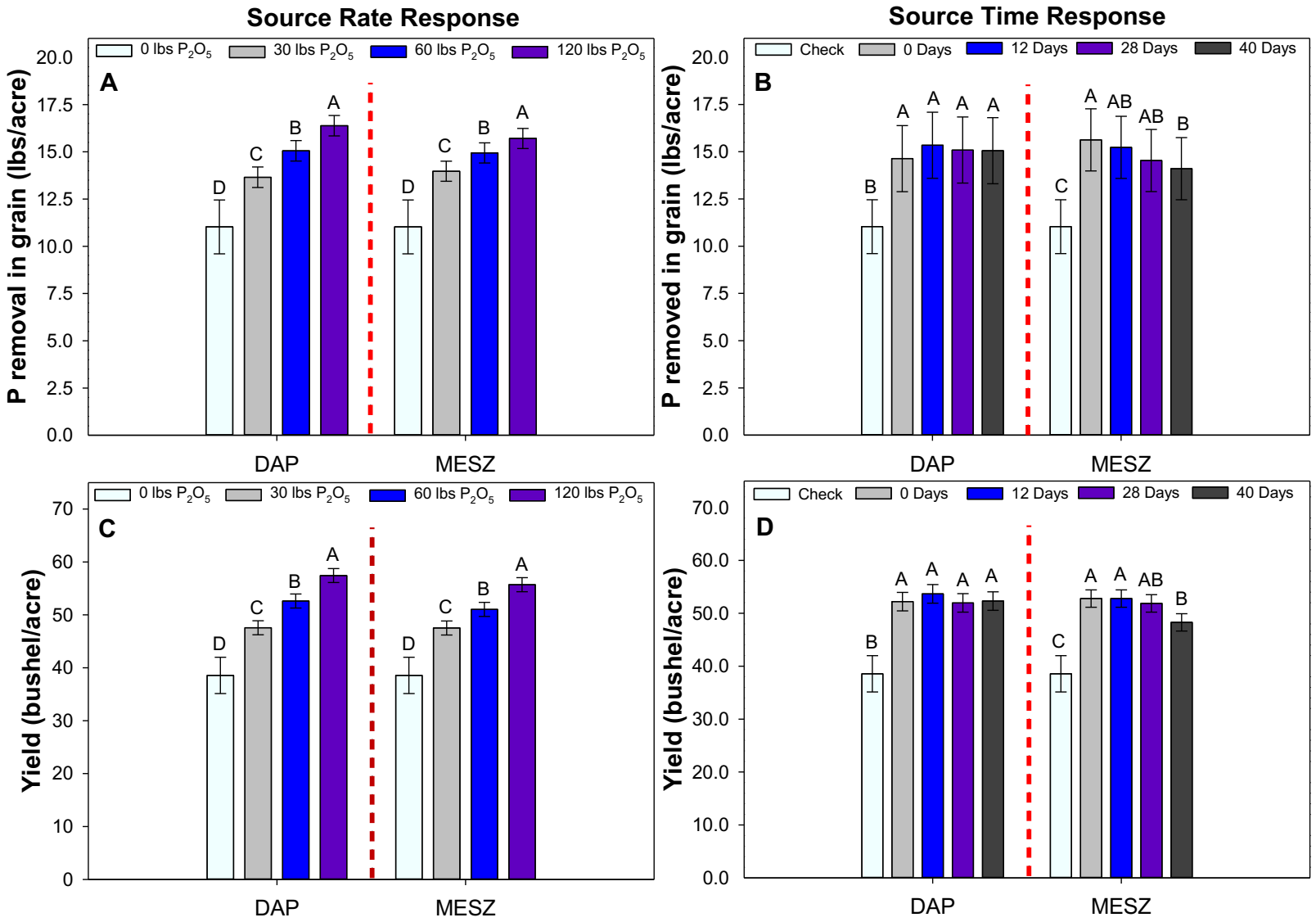

Figure 2. P removed in grain lbs acre^{-1} at grain harvest with comparison made between fertilizer source rates mixed with seed (A) and comparison made between fertilizer mixing duration with seed (B). Grain yield in bushel acre^{-1} with comparison made between fertilizer source rates mixed with seed (C) and comparison made between fertilizers mixing duration with seed (D).