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Evaluating the Interaction Between Chelated Iron Source and Placement on Phosphorus Availability in Soybean

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Abstract

In agriculture, chelating agents are used to supplement micronutrients, such as iron (Fe). However, little research has been conducted at the field-scale level to evaluate chelating agent effects on phosphorus (P). The objectives of this study were to evaluate three commercially available chelated Fe sources on early soybean growth and nutrient uptake. The study was conducted at six locations in 2014 and 2015. The experimental design was a randomized, complete block with a factorial treatment arrangement. The two factors included fertilizer source and fertilizer placement. The fertilizer sources were P only, EDTA-Fe, HEDTA-Fe, and one glucoheptonate product, Cee*Quest N5Fe758 (CQ-758), with two fertilizer placements, in-furrow with seed contact and surface band at planting. Results show soybean yield was affected by chelate source and placement. Greater yields occurred with application in-furrow at Scandia in 2014 and 2015, but in-furrow was superior at Rossville in 2015. Increased yields also occurred with applications of EDTA and HEDTA. However, further analysis of tissue and grain may show chelate effects on nutrients.

Keywords

phosphorus, soybean, chelating agents, fertilizer, placement

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Summary

In agriculture, chelating agents are used to supplement micronutrients, such as iron (Fe). However, little research has been conducted at the field-scale level to evaluate chelating agent effects on phosphorus (P). The objectives of this study were to evaluate three commercially available chelated Fe sources on early soybean growth and nutrient uptake. The study was conducted at six locations in 2014 and 2015. The experimental design was a randomized, complete block with a factorial treatment arrangement. The two factors included fertilizer source and fertilizer placement. The fertilizer sources were P only, EDTA-Fe, HEDTA-Fe, and one glucoheptonate product, Cee*Quest N5Fe758 (CQ-758), with two fertilizer placements, in-furrow with seed contact and surface band at planting. Results show soybean yield was affected by chelate source and placement. Greater yields occurred with application in-furrow at Scandia in 2014 and 2015, but in-furrow was superior at Rossville in 2015. Increased yields also occurred with applications of EDTA and HEDTA. However, further analysis of tissue and grain may show chelate effects on nutrients.

Introduction

Increasing yield with the application of chelated micronutrients has been studied extensively since the 1920s. Chelating agents are used extensively in the Great Plains and North Central regions due to widespread Fe deficiencies in soybean (Good and Johnson, 2000). The chances of increasing soybean yields with the application of micronutrients is highest with Fe (Liesch et al., 2011) and magnese (Mn) (Loecker et al., 2010), when compared to other nutrients. Soil application of chelated Fe has shown to decrease Mn uptake (Ghasemi-Fasaei et al., 2003) as soybeans are affected more by Fe/Mn antagonism (Ghasemi-Fasaei et al., 2003).

In addition to the effects of chelated Fe on other metals, there is potential for an effect on plant available phosphorus (P). A soil incubation study observing the effects of chelates on plant available P resulted in increased P with the application of EDTA and HEDTA (Edwards et al., 2013). Increasing chelating agent application rate was also found to increase soil test P for EDTA and HEDTA ($r2$=0.86 and 0.95) in a soil with high P adsorption capacity. This increase in P was attributed to EDTA binding Fe within soil colloids and decreasing the P adsorption capacity of the soil (van der Zee and van Riemsdijk, 1988).

Farmers often question the most effective application method of chelated micronutrient and their effects on other nutrients. Little research has been conducted at the field-scale level to evaluate the effect of chelates on phosphorus and other nutrients. The objectives of this study were to evaluate four commercially available chelated Fe sources on early soybean growth and nitrogen (N), P, and potassium (K) uptake, comparing two common application methods.

Procedures

The study was conducted at six locations; Rossville, Scandia, and Hutchinson in 2014, and Rossville, Scandia, and Colby in 2015. The experimental design was a complete, randomized block design with four replications. Plots were 10 ft wide by 30 ft long (4 rows of soybeans) at all locations. In 2015, the plots at Colby were 10 ft wide by 20 ft long. A total of 11 treatments were included at each location and are described in Table 1. The treatment structure includes an absolute control with a factorial arrangement of placement and fertilizer source. In-furrow and surface band fertilizer placements were compared in combination with 3 fertilizer chelate products and one phosphorus only product for each placement. Phosphorus fertilizer was applied at 20 lb P_2O_5 per acre and chelates were applied in-furrow and surface banded at 3 and 6 gal per acre, respectively. The chelating agents used were commercially available products. Both EDTA and HEDTA were solutions of 4.5% Fe. The CQ-758 contains 5% Fe chelated as a glucoheptonate.

Initial soil samples were collected in the spring of 2014 and 2015 by collecting one composite sample at 6 inches deep per plot. Samples were analyzed for pH, Mehlich-3 P, ammonium acetate K, and organic matter (Table 2). The center two rows of soybeans were machine harvested for the total length of the plot (30 ft). Grain weights were recorded at the end of the growing season and adjusted for 13.0 % moisture. Soybean seed grain moisture and test weight were monitored at harvest.

Data were analyzed by location and across locations, using location as a random variable for analysis. Soybean parameters were analyzed using PROC GLIMMIX SAS 9.1 (SAS, 2010) to determine if there was a significant ($P = 0.10$) response to fertilizer source, fertilizer placement, and the interaction between fertilizer and placement using soil test P (STP) as a continuous variable. Main effects of fertilizer and placement and the interaction on least square means of soybean parameters were tested.

Results

All locations, except Colby, can be categorized as below the "critical level" on STP (Table 1) (Liekam et al., 2003), therefore, having a response to P fertilization. Chelate placement was found to significantly affect soybean yield in Scandia and Rossville (Table 2). Increased yields with in-furrow placement in Scandia in 2014 and 2015 could be attributed to finer texture soils. However, in Rossville, greater yield with surface band applications could potentially be due to sandy soil texture. Fertilizer application in-furrow with seed contact in soils with low CEC and organic matter could have detrimental effects on germination. Further analysis of application on population count could further explain these results. Chelate source was also found to affect soybean yield (Table 2). Highest yields were observed after applications of EDTA-Fe and HEDTA-

Fe. Further analysis of tissue samples taken at V-4 and R-3 and grain samples following harvest may prove chelate and placement effects on nutrient uptake.

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Table 1. Initial soil test results taken in early spring 2014 and 2015

Location	Year	pH	Phosphorus	Potassium	Organic matter
			------------ mg/kg	------------	%
Hutchinson	2014	6.87	19	183	2.3
Rossville	2014	7.07	17	218	2.1
Scandia	2014	6.21	6	508	2.8
Colby	2015	7.4	27	832	2.0
Rossville	2015	7.2	20	256	2.0
Scandia	2015	6.6	13	507	2.9

Table 2. Soybean yields (bu/a) by site year as affected by fertilizer source and placement in 2014 and 2015

		2014†			2015		
Placement‡	Fertilizer§	Hutchinson	Rossville	Scandia	Colby	Rossville	Scandia
In-furrow	P Only	42.8 ab	51.9 cd	32.8 a	56.8 bc	66.7 b	75.0 a
In-furrow	CQ-758	38.3 bcd	46.2 e	32.0 ab	54.5 c	68.0 ab	70.7 abc
In-furrow	EDTA-Fe	41.7 ab	54.6 abc	31.7 ab	62.6 a	67.1 b	74.5 ab
In-furrow	HEDTA-Fe	36.4 cd	59.0 a	31.9 ab	53.8 c	68.7 ab	74.4 abc
In-furrow placement		39.5	52.8	31.7 a	56.9	66.4 b	73.1 a
Band	P Only	41.2 abc	58.2 ab	31.6 ab	60.1 ab	70.2 ab	74.2 abc
Band	CQ-758	35.1 d	51.2 cde	30.2 bc	56.5 bc	72.8 a	70.5 abc
Band	EDTA-Fe	37.9 bcd	53.1 bc	30.5 bc	59.0 abc	69.9 ab	69.6 bc
Band	HEDTA-Fe	41.1 abc	49.9 cde	29.2 c	62.9 a	68.7 ab	69.2 c
Surface band placement		39.8	51.8	30.3 b	59.6	69.6 a	70.5 b

† Different letters in each column by parameter signify treatment differences at alpha=0.1 level.
‡ Fertilizer placement as in-furrow was in contact with the seed at planting; band, surface band using a backpack sprayer on the row.
§ CQ-758, Cee*Quest N5Fe758.