Evaluation of Phosphorus Source and Chelate Application as Starter Fertilizer in Corn

C.L. Edwards and D.A. Ruiz Diaz

Summary

The differences between common phosphorus (P) fertilizers as a starter in corn production have been studied for many years. However, little research has been conducted showing which P fertilizer sources are most effective with varying compositions of ortho- and poly-phosphate. The objectives of this study were to evaluate three commercially available P fertilizers, 0-16-19, 10-34-0, and 0-18-18 ($N-P_2O_5-K_2O$) as starter band with and without the addition Cee*Quest-70 (CQ-70), a glucoheptonate chelate. The study was conducted at two locations, Scandia and Rossville, in 2014 and 2015. Experimental design was a randomized, complete block with four replications and a factorial treatment arrangement. Whole plant corn tissue samples were taken at V-6 and weighted for biomass. Tissue samples were analyzed for P. Yield, V-6 biomass, and V-6 P uptake were analyzed for treatment differences. Results show that there were no yield differences between P fertilizers with or without the addition of CQ-70. Phosphorus fertilizer was found to have a significant effect on P V-6 tissue concentration at the Rossville location. However, there was no effect on P uptake. Fertilizer source was found to have a significant effect on V-6 biomass and P uptake.

Introduction

Starter fertilizers usually consist of P and potassium (K) since seedling uptake of P and K are greatest in early growth. Starter fertilizers placed in proximity of the root zone enhance nutrient availability (Jokela, 1992), especially P and K (Barber and Kovar, 1985). The most common fertilizers used as starters consist mainly of P and K; however, some research has shown the addition of N placed with P results in greater uptake of P (Olson and Drier, 1956; Kamprath, 1987). The effects of starter fertilizer have shown an increase in early nutrient uptake (Randall and Hoeft, 1988; Rehm and Lamb, 2009). However, yield effects are inconsistent, even with an increase in early season growth (Vetsch and Randall, 2002).

Procedures

The study was conducted at two locations in 2014 and 2015, Rossville and Scandia, Kansas. The experimental design was a complete, randomized block design with four replications. Plots were 10 ft wide by 30 ft long (4 rows of corn). A total of 9 treatments were included at each location and are described in Table 1. The treatment structure includes a control with a factorial arrangement of fertilizer source by CQ-70. Three phos-

phorus fertilizer products, 0-16-19, 10-34-0, and 0-18-18, were applied at 30 lb P_2O_5 per acre with and without the addition of CQ-70 at 3 gallons per acre. Liquid products 0-16-19, 10-34-0, and 0-18-18 were applied using a backpack sprayer immediately after planting in a surface band. The addition of CQ-70 was mixed with liquid sources prior to banded application.

Initial soil samples were collected in spring 2014 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). Plant tissue samples were collected at specific growth stages for corn, and seed grain were analyzed after harvest. The center two rows of corn were used for sampling and harvest. Ten whole plant samples were collected at growth stage V-6 (Pedersen, 2009). All plant tissue samples were dried in a forced air oven at 60°C for a minimum of 4 days. After drying, plant samples were ground with a Wiley Mill grinder to pass a 2 mm screen and digested using a sulfuric acid and hydrogen peroxide digest (Thomas et al., 1967). Phosphorus concentrations were then determined by inductively coupled plasma atomic emission spectroscopy (ICP-AES). The center two rows of corn were machine harvested. Grain weights were recorded at the end of the growing season and adjusted for 15.5% moisture. Corn 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. Corn parameters were analyzed using *SAS® PROC GLIMMIX (S*AS Institute, Cary, NC, 2010) to determine if there was a significant ($P = 0.10$) response to fertilizer source, addition of CQ-70, and the interaction between fertilizer and CQ-70. Main effects of fertilizer and CQ-70 and the interaction on least square means of corn parameters were tested.

Results

The Rossville and Scandia locations in both 2014 and 2015 can be considered high yielding and are categorized above the "critical level" for soil test P (Table 2) (Liekam et al., 2003). Therefore, both locations should not be expected to show response to P fertilization. The chelate addition CQ-70 had no effect on early corn growth, nutrient uptake, or yield. Corn yield was found to be significantly affected by fertilizer source at Scandia and Rossville in 2015 and averaged across locations (Table 3). Highest yields were observed with applications of 0-16-19 with the addition of Cee*Quest 70 product. Greater accumulation at growth stage V-6 was observed with 0-16-19 applications in Rossville in 2015. There were no differences averaged across site years. Phosphorus uptake at V-6 tissue was greatest with 0-16-19 with CQ-70 and 10-34-0 and 0-18-18 without the addition. Neither fertilizer source nor CQ-70 affected yield or other parameters due to the high levels of P already in the soil and the fact that application rates were as starter.

References

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Table 1. Description of treatments

CQ-70	Fertilizer†
Without	0-16-19 (Ortho 80/Poly 20)
	10-34-0 (Ortho 60/Poly 40)
	0-18-18 (Ortho 100)
With	0-16-19 (Ortho 80/Poly 20)
	10-34-0 (Ortho 60/Poly 40)
	0-18-18 (Ortho 100)

† Fertilizer application rate was 30 lb P_2O_5 per acre for all treatments.

Table 2. Initial soil test results taken in early spring in 2014 and 2015 in Rossville and Scandia

Location	Year	pH	Phosphorus	Potassium	Organic matter
			---------- mg/kg ----------		%
Rossville	2014	6.68	23	342	2.0
Scandia	2014	6.20	26	598	3.1
Rossville	2015	7.4	24	225	1.7
Scandia	2015	5.8	32	513	2.1

Table 3. Average corn yields as affected by phosphorus fertilizer source with and without additions of Cee*Quest 70 (CQ-70) in 2014 and 2015, and across locations

		Rossville†		Scandia		
CQ-70	Fertilizer	2014	2015	2014	2015	Average‡
Yield (bu/a)						
Without	0-16-19	253	154 ab	238	220 b	216 ab
	10-34-0	266	146 abc	230	250 a	223 ab
	0-18-18	269	141 abc	226	231 ab	217 ab
With	0-16-19	248	169 a	230	255 a	225 a
	10-34-0	255	116 bc	238	236 ab	211 b
	0-18-18	266	131 bc	232	246 a	219 ab
V-6 Biomass (g/plant)						
Without	0-16-19	60.5	11.5 bc	179	16.7	67.0
	10-34-0	60.8	12.3 ab	174	16.4	65.9
	0-18-18	62.7	12.3 ab	184	17.1	69.0
With	0-16-19	71.6	13.4 a	182	16.4	70.8
	10-34-0	65.0	10.9 bc	186	18.0	70.0
	0-18-18	67.3	10.6 c	174	17.7	67.3
V-6 phosphorus uptake (mg/plant)						
Without	0-16-19	219	32.6 b	587	70.4	227
	10-34-0	217	34.8 ab	612	72.2	234
	0-18-18	227	38.4 a	644	77.2	247
With	0-16-19	267	39.6 a	587	72.3	241
	10-34-0	232	31.7 b	599	70.8	233
	0-18-18	253	30.7 b	566	70.3	230

† Different letters in each column by parameter signify treatment differences at alpha=0.1 level.
‡ Average over years and locations.