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INJECTING PHOSPHORIC ACID WITH SUBSURFACE DRIP IRRIGATION SYSTEMS

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Abstract

Presently, one of the problems farmers are facing in West Texas after continuously raising cotton for 10 years on previously installed SDI systems is the depletion of nutrients. Since SDI systems wet a portion of the soil forming a wetting bulb, most of the nutrients are absorbed from this portion where the water infiltrates. This process has depleted nutrients that otherwise would have been plentiful for uptake given that the soils are rich on them, mainly nutrients such as phosphorus (P) and potassium (K). In comparison with furrow systems a bigger area is wetted and roots spread taking the nutrients from this bigger area. Some SDI farmers have observed big increases on cotton lint yields just by the addition of small amounts of phosphorus. Several questions arise regarding these applications, such as what are the most appropriate rates, or whether to split the rates between the phenological stages. Another question is, what is the most efficient method to apply phosphorus and potassium. These nutrients can be either knifed into the soil, or injected through the irrigation system. This paper presents the results of two field experiments. The first experiment consisted of 4 treatments and 4 replications. The treatments were: 1) No phosphorus applications, 2) Knifing the phosphorus into the soil, 3) To apply 4 gallons of phosphoric acid in one application, 4) To apply 4 gallons of phosphoric acid in two applications. The second experiment consisted of 4 treatments and 4 replications. The treatments were: 1) No phosphorus applications 2) Injection of 4 gallons of phosphoric acid in two applications of 2 gallons each, 3) Injection of 8 gallons of phosphoric acid in two applications of 4 gallons each, 4) Injection of a phosphorus solution commonly known as Miller Solugro in two applications of 4.25 lbs/acre per application. In the first experiment, although not statistically different, the knifed phosphorus resulted in numerically higher seed cotton weights than the yield obtained with the injection of phosphorus through the subsurface drip irrigation system. In the second experiment, the treatments results were statistically different. Seed cotton weights resulted in higher yields for the treatments with the application of phosphorus.

Introduction

The Subsurface Drip Irrigation (SDI) cotton acreage in Texas has increased dramatically in the last 10 years. In 1994, Henggeler listed the SDI cotton acreage to be about 3300 acres (10% of the irrigated acreage of St. Lawrence area). This year according to Bryan Frerich there are about 220,000 cotton acres with SDI in the state of Texas (Frerich, 2004). The biggest area with cotton acreage irrigated with SDI remains in the St. Lawrence area of Texas (Upton, Reagan and Glasscock Counties), and the Lubbock area. The water supplies and small irrigation system capacities has pushed this trend up, and also perhaps the fact that irrigation efficiencies above 55 lbs/ac-in can be obtained with SDI systems, (Enciso et al., 2002 and 2003). Irrigation efficiency is defined as the lint yield divided by the irrigation amount applied. In comparison, irrigation efficiencies of 35 lbs/ac-in are generally obtained with furrow systems. One of the problems farmers are facing after continuously raising cotton for 10 years on the previously installed SDI system, is the depletion of nutrients. Since SDI systems wet a portion of the soil, forming a wetting bulb, most of the nutrients are absorbed from this portion where the water infiltrates. This process has depleted nutrients that otherwise would have been plentiful for uptake given that the soils are rich on them, mainly nutrients such as phosphorus (P) and potassium (K). In comparison with furrow systems a bigger area is wetted and roots spread taking the nutrients from this bigger area. Some SDI farmers have observed big increases on cotton lint yields just by the addition of small amounts of phosphorus. Several questions arise regarding these applications, such as what are the most appropriate rates, or whether to split the rates between the phenological stages. Another question is, what is the most efficient method to apply phosphorus and potassium. These nutrients can be either knifed into the soil, or injected through the irrigation system. One of the challenges of phosphoric acid injection into the irrigation system in desert environments is that water generally is hard (high in calcium and magnesium), and it should be acidified before phosphoric acid is injected, to avoid the formation of phosphates that could precipitate in the drip line and clog its emitters. Another method of injecting phosphoric acid to avoid the formation of phosphates is to inject the phosphoric acid at a faster rate to lower the pH below 4, and avoid any precipitation that eventually may clog the emitters. The objectives of this study were to evaluate the yield response to different amounts and timing of Phosphorus applications.

Material and Methods

Two experiments were conducted with subsurface drip irrigation systems to evaluate the yield response to phosphorus applications. The first experiment was intended to answer the following question: What is best -- to knife the phosphorus into the soil as farmers do traditionally or to inject it through the irrigation system? The second experiment was oriented toward obtaining the best phosphorus injection rates. The first experiment was conducted on the Floyd Schwartz farm located in St. Lawrence Texas during 2004. It consisted of a complete randomized experiment with 4 treatments and four replications, with a total of 16 plots. Each plot consisted of 4 cotton rows, 950 ft long. Each treatment represented an area of 1.23 acres. The cotton rows were spaced every 40 in. The treatments were: 1) No phosphorus applications 2) Knifing the phosphorus into the soil, 3) 4 gallons of phosphoric acid in one application, 4) 4 gallons of phosphoric acid in two applications. The variety Deltapine 458 BR was planted on May 20. Liquid nitrogen (N32) was injected through the irrigation system at a rate of 32 gals/acre and split in two applications on July 19 and August 3. Urea ammonium nitrate (UNA) was the N source. The drip system had emitters installed every 24 in and each emitter had a discharge of 0.24 GPH. The drip-line was spaced every 40 in and installed at 12 in depth. The system could apply an irrigation depth of 0.06 inches per hour. The soil was a clay loam soil with good drainage (29% sand, 42% silt, and 29% clay). Harvest data were gathered from within each plot mechanically by harvesting four rows. Seed cotton was weighed for each replication, and a portion (about 0.60 kg) was ginned at the Texas A&M Agricultural Research and Extension Center in Lubbock, TX. The seedcotton weight was analyzed with a general linear model (GLM) with mean separation by the least square difference (SAS Institute, 1991).

The second experiment was also conducted in St. Lawrence Texas during 2004 on the Kenneth Braden farm. The experiment consisted of a complete randomized experiment with 4 treatments and four replications, with a total of 16 plots. Plot length was 185 ft. and there were 12 rows per treatment. The cotton rows were spaced every 40 in. The treatments were: 1) No phosphorus applications 2) Injection of 4 gallons of phosphoric acid in two applications of 2 gallons each, 3) Injection of 8 gallons of phosphoric acid in two applications of 4 gallons each, 4) Injection of a phosphorus solution commonly known as Miller Solugro in two applications of 4.25 lbs/acre per application. The variety Deltapine 458 BR was planted on May 21 in 40 in rows. Liquid nitrogen (N32) was injected in three applications with a rate of 30 gals/acre (July 7, July 20 & August 3). The drip system had emitters installed every 24 in and each emitter had a discharge of 1 GPH. The drip-line was spaced every 40 in and it was buried at a depth of 14 inches. The system could apply an irrigation depth of 0.06 inches per hour. Watermark blocks were installed to obtain soil water data. Rainfall and weather data was recorded daily. The soil at the field site was a Reagan silty clay loam (fine-silty, mixed, thermic Ustolic Calciorthids) with moderate permeability on a 1% slope. Harvest data were gathered from within each plot by hand picking two 10 ft. sections of row.

Results and Conclusions

The results of the two experiments are presented separately.

First Experiment

The rainfall received during the season was 8.4 in. (Table 1). A pre-irrigation depth of 6.03 in. was applied from March 23rd to May 6th and an in-season irrigation depth of 10.4 in. from May 21 to August 21. The total in-season water applied was 16.4 inches, and the total water applied was 24.8 in.

Table 1. Rainfall received during 2004.

Month	Inches
Jan	0.48
Feb	0.44
Mar	1.38
April	1.98

	May	0.05
	June	4.29
	July	1.27
	Aug	2.81
	Sep	2.86
	Oct	0.06
Pre-plant		4.28
in- season		8.37

There was no statistical difference for seed cotton weight among the treatments (Fig. 1). Although not statistically different, the knifed phosphorus resulted in numerically higher seed cotton weights than the yield obtained with the injection of phosphorus through the subsurface drip irrigation system. The average yield for the knifed phosphorus was 85 lbs/ac higher than the injected phosphorus through the drip system and 224 lbs/ac higher than the no phosphorus application treatment. The difference in yields could be attributed to the fact that the knifed phosphorus was injected about 4 inches deep and the injected phosphorus was injected at 12 in. Roots may have more opportunity to uptake the knifed phosphorus. However, it is important to obtain the lint yields, quality characteristics, and economics to draw further conclusions. There was no difference between splitting the phosphorus in two applications or in applying it in only one application; the yields were similar for these treatments.

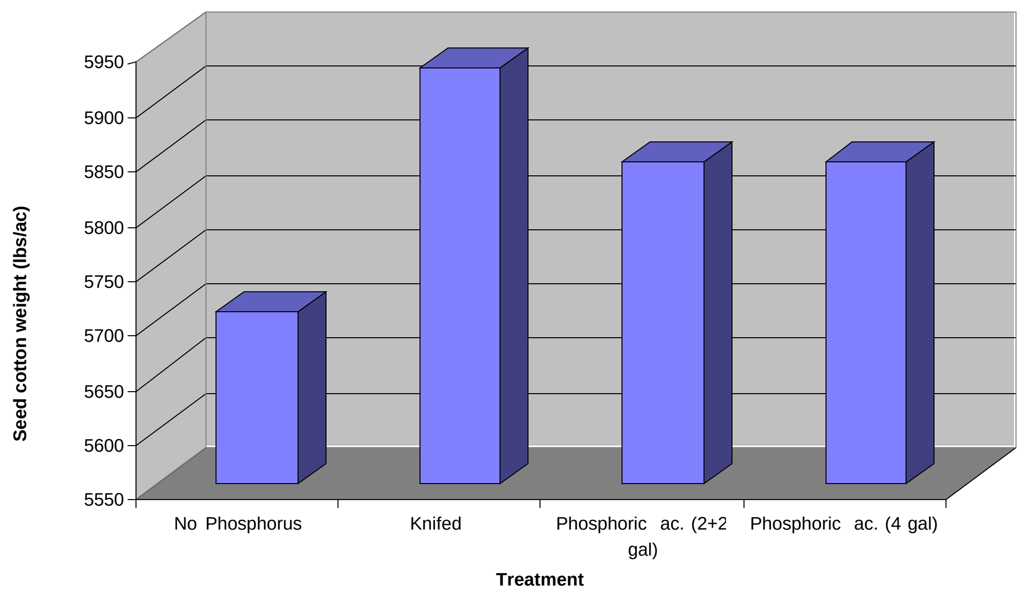

Fig. 1. Effect of different phosphorus applications on seed cotton weight.

Second Experiment

A pre-irrigation depth of 7.1 in. was applied from April 26 to May 18 and an in-season irrigation depth of 10 in. from June 17 to August 20. The total water applied (irrigation plus rainfall) was 25.5 inches. The total water applied was below the cotton water requirements of about 32 in. The average seed cotton weight for the treatments of Experiment 2 are presented in Fig. 2. Seed cotton weights resulted in significantly higher yields for the treatments with the application of phosphorus.

The injection of 8 gallons of phosphoric acid resulted in higher yields than the 4-gallon injection of phosphoric acid, the injection of the miller solution and the no application of phosphorus by 224, 320, and 1520 lbs./ac respectively.

It will be important to obtain the lint yields, quality characteristics, and economics to draw solid conclusions about the experiment. However, for this experiment, cottonseed yields were increased by the injection of phosphorus.

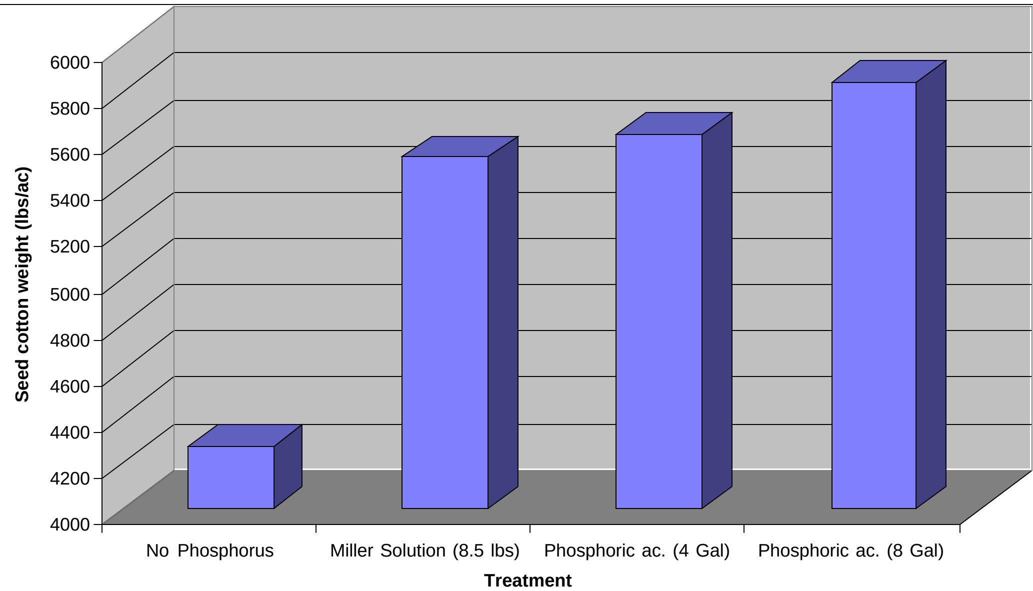

Fig. 2. Effect of different phosphorus applications on seed cotton weight.

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