COTTON NEEDS ADEQUATE PHOSPHORUS FOR OPTIMUM YIELDS

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Abstract

Phosphorus (P) is an essential nutrient for cotton. Soil testing and plant analysis are useful for monitoring the P fertility status of a cotton crop. Soil pH is the most important soil property controlling P availability. There is no set method for applying P fertilizer, although band applications can be advantageous in soils with high P fixation potential. Starter fertilizer with P often increases growth and vigor of cotton seedlings; however, yield responses are not predictable.

Phosphorus Is An Essential Nutrient

Adequate P is critical in the early stages of cotton growth. Phosphorus can stimulate cotton root growth and promote early fruiting. Phosphorus is essential for the storage and transfer of energy within the plant. In addition, P is a component of several plant biochemicals that control cotton growth and development.

How Much Phosphorus Is Needed?

A soil test should be used to determine whether available P in the soil is adequate. Plant analysis should be used to determine whether the growing crop is getting enough P from the soil. Sufficiency ranges for P in cotton leaf tissue have been established (Table 1). In a mature plant, P is concentrated in the seed. Expressed in fertilizer terms, the amount of phosphate (P_2O_5) required to make the crop, and the amount removed from the field at harvest, depend on yield (Table 2). To convert elemental P to a P_2O_5 basis, multiply the elemental P value by 2.27.

Soil and Fertilizer Phosphorus

Soil Phosphorus

Phosphorus availability is governed by soil pH. In acid soils, P binds with iron (Fe), aluminum (Al), and manganese (Mn) oxides to form insoluble compounds. In alkaline soils, P precipitates with calcium (Ca) to form calcium phosphates, so that it becomes less available to plant roots. Phosphorus availability is greatest at soil pH 6.0-7.0. Soils with high clay content (especially kaolinitic clays) fix more P. Soil compaction, water content, and aeration affect P availability and uptake by cotton roots. Although the amount varies, about 20% of the total P in soil is in the organic matter fraction. This percentage is determined largely by the soil test P and organic matter content.

Fertilizer Phosphorus

There is no set method of applying phosphate fertilizer for cotton production. Band applications of P are sometimes advantageous. In soils with high P fixation potential (low or high pH extremes, very low inherent fertility, and/or a high 1:1 clay content), higher cotton yields may result when P fertilizer is banded. Band application allows more P to be positionally available to cotton roots. Phosphorus banded with ammonium-nitrogen increases P uptake relative to when P is banded alone. Broadcast applications are desirable when high rates of P fertilizer are used. Fall applications of P are effective, if soil test P levels are medium or higher, and soil pH is favorable.

Starter Fertilizer

In some cases, starter or "pop-up" P fertilizer may increase P uptake, seedling size, root growth (Table 3), and lint yield. Starter fertilizer often increases the growth and vigor of cotton seedlings, but the response may not be evident at the time of harvest. Consequently, yield responses to starter P in soils that test high are unpredictable – positive responses, as well as a lack of response, have been observed in Mississippi, Louisiana (Tables 4 and 5), Georgia, Alabama, and North Carolina.

Table 1. Phosphorus content (ppm) of a fully-mature cotton leaf on a vegetative branch at full bloom.

Low	Sufficient	High
<0.25	0.25 - 0.45	>0.43

Table 2. Phosphate (P_2O_5) requirements and removals to produce the given cotton lint yields. In all cases, units are lb./A.

Lint Yield	Required	Removed
750	45	18
1500	63	36

Table 3. Effect of 11-37-0 starter fertilizer rate and placement on cotton root growth at 33 and 56 days after planting on Commerce silt loam soil in Louisiana. Values are means of 4 replications. Samples were collected with a hand probe from within the row of each treatment.

	Root Length Density, cm/cm^3		
	Seedling	Early Bloom	
Treatment	0-4 inches*	0-4 inches*	4-8 inches*
Check	1.00 b	0.95 a	1.71 a
Surface Band, 12 gal./A	1.34 ab	0.97 a	1.72 a
In-furrow,1.5 gal./A	1.46 a	1.25 a	1.25 ab
In-furrow,2.5 gal./A	1.48 a	1.18 a	0.82 b

*Means followed by the same letter are not significantly different at the 5% level.

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Table 4. Effect of an in-furrow application of 1.5 gal. 11-37-0/A at planting on cotton yields at 8 locations in Louisiana.

		Cotton Lint Yield, lb/A		
Year	Soil	Check	Starter	Difference + or (-)
1990	Commerce sil	1255	1400	145*
1991	Commerce sil	1184	1191	7
1991	Necessity sil	1503	1586	83*
1992	Loring sil	878	889	11
1992	Caspiana sil	922	911	(11)
1992	Commerce sil	999	1040	41
1992	Sharkey c	515	697	182*
1992	Norwood sil	734	837	103**
Mean		999	1069	70

*Difference significant at the 0.05 level.

**Difference significant at the 0.01 level.

Table 5. Effect of a 3-inch surface band application of 12 gal. 11-37-0/A at planting on cotton yields at 7 locations in Louisiana.

		Cotton Lint Yield, lb./A		
Year	Soil	Check	Starter	Difference + or (-)
1990	Commerce sil	1255	1443	188**
1990	Norwood sil	823	895	72
1990	Loring sil	1045	1032	(13)
1991	Commerce sil	1184	1331	147*
1991	Loring sil	949	1073	124**
1992	Commerce sil	999	1144	145
1992	Loring sil	878	957	79*
Mean		1019	1125	106

*Difference significant at the 0.05 level.

**Difference significant at the 0.01 level.