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G361
(Revised October 2012)

Using Starter Fertilizers for Corn, Grain Sorghum, and Soybeans

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Starter fertilizer may increase early growth of corn and grain sorghum, especially for reduced tillage. Increased early growth often does not translate to increased grain yield. Increased yield is most likely on soils with low phosphorus, on sandy soils with low organic matter, or some high pH soils.

Proper use of starter fertilizer is part of the management for achieving high yields on some soils, but starter fertilizer may benefit production most under reduced tillage, on irrigated sandy soil, and on high pH soils.

What Is a Starter Fertilizer?

Starter fertilizer is defined as "the placement of small quantities of nutrients in a concentrated zone in close proximity to the point of seed placement at the time of planting." This placement can be in a band over the row, in the furrow, below the seed, to the side of the seed, or to the side and below the seed. A disadvantage of placing starter fertilizer over the row is that the immobile nutrients are not positionally available to early root growth.

Starter fertilizer should not be confused with fertilizer placed in a band near the row to correct a soil nutrient deficiency. Band application of fertilizer is an effective way to correct nutrient deficiencies and can result in early growth response as well. Band application of phosphorus fertilizer on low phosphorus soils is suggested for corn and grain sorghum to maximize fertilizer use efficiency.

Placement of starter fertilizer in the seed furrow, commonly called "pop-up", requires care to prevent germination injury from fertilizer salts. Metering equipment must function properly to deliver uniform low rates of fertilizer in the seed furrow. Ammoniated zinc application in the seed furrow should be less than one quart per acre, or one pint per acre on dry sandy soil, as released ammonia can damage the seed. The amount that can be applied safely is limited (usually less than 5-7 lb per acre of N plus K_2O in-furrow), and depends on the fertilizer used and soil properties. Ammonium thiosulfate (12-0-0-26S) should never be placed in the furrow with the seed.

A starter fertilizer usually is composed of two or more nutrients. Under Nebraska conditions, a combination of nitrogen and phosphorus often constitutes an effective starter material. Liquid 10-34-0 is a popular starter fertilizer material. Liquid 7-21-7 is also commonly used; however, potassium is not an essential starter nutrient on most Nebraska soils.

The addition of zinc and/or sulfur may be desirable for some soil conditions. Zinc should be included when the zinc level in the soil is marginally adequate. Sulfur should be added for sandy soils low in organic matter.

Nitrogen alone may give an early growth response where soil nitrogen is low at the time of planting or with cooler soil temperatures under heavy crop residue but where phosphorus, zinc, and sulfur are adequate. This is most likely to occur after excessive spring rains, particularly on low organic matter and/or sandy soils. Such rains will leach nitrogen and can result in cooler soil conditions.

Benefits from Starter Fertilizer

The primary benefit of starter fertilizer may be an increase in early growth and crop uniformity. Corn and grain sorghum commonly respond to starter fertilizers with increased early growth. This early growth response results in larger plants of more uniform size, which may permit earlier lay-by cultivation and ditching for gravity irrigation. Increased early growth in corn or grain sorghum can occur when starter fertilizer containing phosphorus is applied to soils that test as high as 45 ppm phosphorus (Bray-P1). Growth response often occurs on sandy soils when proper rates of nitrogen and sulfur are used, even if the soils have high phosphorus levels.

Early growth response to starter fertilizer may result in slightly earlier flowering and/or crop maturity. A few days earlier flowering or maturity can result in improved yield in years of early frost in the fall. This effect of starter

fertilizer is most often observed on grain sorghum in areas where nights are cooler. Also, earlier maturity may result in slightly drier grain at harvest.

Increased growth and earlier flowering, however, often do not translate to higher yield. Grain yield increase from starter fertilizer containing phosphorus is most likely on soils low in phosphorus (Bray-P1 of 15 ppm or less). Grain yield increase on sandy soil is commonly due to nitrogen and/or sulfur in the starter fertilizer.

Soybeans seldom respond to nitrogen in starter fertilizer in Nebraska, although response of short season varieties often occurs further north and west, e.g., Brookings, S.D., and Ogallala, Neb. For soybeans, fertilizer containing phosphorus is suggested when the soil test level (Bray-P1) is 10 ppm phosphorus or less. The fertilizer can be banded beside the row but not closer than 1 inch to the seed.

Starter Fertilizer for No-till

Soil temperature is commonly lower with no-till than with tilled soils due to more ground (residue) cover. Cooler soil temperatures slow plant root development and the release of plant nutrients from soil organic matter. A greater response to starter fertilizer is expected under reduced tillage, compared with tilled conditions.

In research conducted in Nebraska, when Bray-P1 was less than 15 ppm, starter fertilizer commonly resulted in increased grain yield, with an average increase of 13.5 bu/ac for no-till irrigated corn on medium texture soils. Starter fertilizer application did not result in increased no-till dryland corn in eight trials conducted in eastern Nebraska, but soil test P was above 15 ppm for seven of these trials. Placing the starter fertilizer over the row, in the furrow, and to the side and below the seed was equally effective.

Early grain sorghum growth and time to flowering under no-till conditions was regularly enhanced with starter fertilizer *(Table I)*. However, yield was increased in only one of 18 trials conducted on medium and fine texture no-till soils, even with early planting. The average increase in sorghum grain yield over the 18 trials was 2 bu/ac for N+P starter fertilizer, with no additional increase with sulfur included in the starter fertilizer. As with corn, placing the starter fertilizer over the row, in the furrow, and to the side and below the seed was equally effective. Row cleaning, before or at planting, to remove crop residues from the crop row also resulted in early enhanced growth but did not increase no-till grain sorghum yield. Starter fertilizer and row cleaning generally did not result in lower grain moisture at harvest time.

Table I. Starter fertilizer and row cleaning decreased the time to flowering, compared with no starter, but had little effect on grain yield of no-till grain sorghum in eastern Nebraska.

	Time to flower, days	*Grain yield, bu/Ac*[1]
Starter fertilizer, N+P (18 trials)	-3	+2
Starter fertilizer, N+P+S (18 trials)	-3	+2
Row cleaning (6 trials)	-3	-1
Row cleaning plus starter fertilizer, N+P (6 trials)	-4	+2

[1]Yield differences were not statistically significant.

Salt Effects

Starter fertilizer placed near the seed has a salt effect that can damage germination and early plant development. The starter fertilizer rate that can be applied safely depends on the fertilizer's salt content or *salt index* value, the distance between the fertilizer and the seed, and the soil texture. Measured salt index values for several products used as starter fertilizer are presented in *Table II* as salt effect per gallon of liquid product and relative to 10-34-0. Salt index is often estimated as the sum of N + K + 0.5 x S. This underestimates the salt index for some formulations, especially for ammonium thiosulfate. Rather than attempting to calculate salt index, it is better to use the values based on measured effects *(Table II)*.

Table II. Salt index comparisons for commonly used starter fertilizer products expressed as pounds of salt effect per gallon and relative to 10-34-0.

Product	*Salt index, lb/gal*	*Value relative to 10-34-0*
Ammonium polyphosphate 10-34-0	2.28	1.00
7-21-7	3.04	1.33
Urea ammonium nitrate 28-0-0	6.75	2.96
Urea ammonium nitrate 32-0-0	7.78	3.41
Ammonium thiosulfate 12-0-0-26	30.90	13.55

From J.J. Mortvedt. *http://www.spectrumanalytic.com/support/library/ff/salt_index_calculation.htm*. Accessed August 2, 2012.

The limits for rates of starter fertilizer application to avoid salt damage are listed for 10-34-0 in *Table III*. Rates for other fertilizers are determined relative to the rates for 10-34-0. These application rates are determined to provide safe conditions for all years with very rare exceptions.

Table III. The amount of 10-34-0 that can be safely applied per acre for corn and grain sorghum in 30-inch rows as influenced by distance from the seed and soil texture. Determine safe application rates for other fertilizers by dividing the value relative to 10-34-0 given in *Table II* into the amounts listed below.**

Placement	*Sandy soils*	*Non-sandy soils*
	*10-34-0 (gal/acre)**	
With the seed (pop-up)	5	5
1/4 to 1/2 inch from the seed	10	10
1 inch from the seed	20	40
2 inches or more from seed	20+	40+

*The safe application rate for soybeans is one-half of these values.
**For narrower row-widths, the application rate may be increased. For 22-inch rows, multiply values by 1.36 and for 15-inch rows multiply by 2.

When soil moisture at planting is adequate and rainfall occurs soon after planting, problems associated with salt damage will be minimal or will not occur. Problems from salt damage, such as reduced germination and emergence, can be anticipated when soil moisture becomes limited because no rainfall occurs for two or three weeks after planting, and the fertilizer was placed too close to the seed.

Drying of the soil after planting increases salt concentration (increased ionic strength), which interferes with new root growth. The risk of salt damage is reduced when starter is applied in-furrow if spliters are used and the starter fertilizer is applied to the sides of the seed furrow and away from the seed.

In general, application of too much nitrogen, potassium, and sulfur close to the seed will delay corn, grain sorghum, and soybean emergence, and reduce stand.

Nutrient Need and Ratios

Starter fertilizers commonly have a N:P_2O_5 ratio of about 1:3. This is a good ratio for fine-textured soils not high in phosphorus. The starter fertilizer formulation, however, should be determined based on nutrient need rather than on nutrient ratios. Application of starter fertilizer with a higher ratio of N:P_2O_5 (1:1 or 2:1) may supply too little phosphorus to stimulate early growth on soil low in phosphorus (<15 ppm P). For soils with soil test P above 20 ppm Bray-P1, the starter fertilizer should be mostly N with little or no P. If Bray-P1 is between 15 to 20 ppm, include some P in the starter fertilizer due to spatial variability in soil P availability.

Summary

Starter fertilizer use typically results in increased early growth of corn and sorghum, especially under no-till conditions and on sandy or high pH soils. The increase in early growth often does not result in increased yield, especially for grain sorghum and for corn when Bray-P1 is above 15 ppm. However, no-till irrigated corn yield response, when Bray-P1 is less than 15 ppm, is substantial when N and P are applied over-the-row, 2x2, or in-furrow.

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