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Pop-up and/or Starter Fertilizers for Corn

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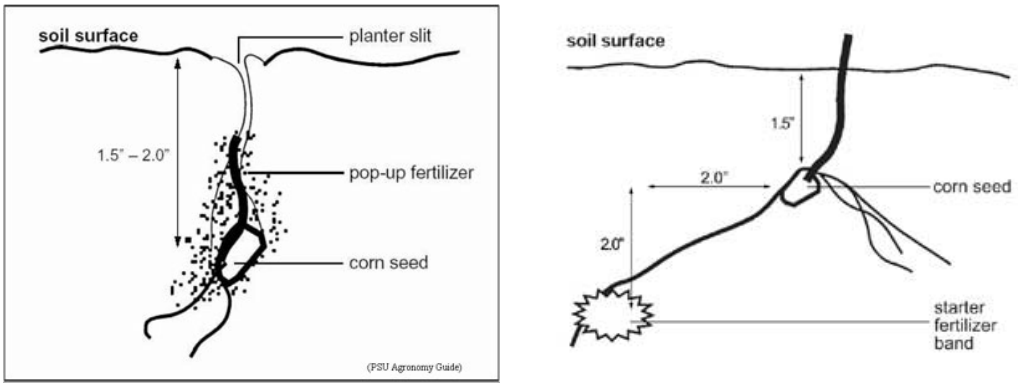
Corn growers continue to look for ways to improve yields and production efficiency. Early planting and the use of starter fertilizers are practices that many growers utilize to maximize yield potential. "Pop-up" fertilizer use is currently being discussed in the corn production community, and the purpose of this article is to clarify the definition of starter and pop-up fertilizers, and share thoughts about the use of these materials as part of a comprehensive soil fertility program for corn production.

Early season planting means that corn is being planted in cool soils and early root growth is expected to be slow. Nutrient uptake during early growth can be low due to the small root system and cold soil temperatures which limit root exploration and nutrient movement to roots. Starter and pop-up fertilizers address this issue of early season nutrient availability to plants by placing fertilizer in the soil near or with the seed.

The generally accepted definition of "pop-up" fertilizer is that the fertilizer is placed with the seed at planting while "starter" fertilizers are placed near but not with the seed. Standard placement of corn starter fertilizer is a band of fertilizer 2 inches to the side and 2 inches below the seed (Fig. 1). However, this distance from the seed is modified to fit various management systems.

Fig.1. Illustration of pop-up and starter fertilizer placement for corn.



Pop-up Fertilizer Use Considerations

The potential benefit of a pop-up fertilizer is to increase early season corn seedling growth with a small amount of fertilizer. Using a pop-up fertilizer program, less fertilizer is applied per acre through the planter compared to standard starter fertilizer programs. In addition, some growers consider using liquid insecticides at planting to control soil insects that may not be adequately controlled with seed treatments. Growers using continuous no-till systems often have cooler soils in the spring and have experienced soil insect damage to corn seedlings. Therefore, these producers have inquired about using pop-up fertilizers as carriers for liquid insecticides to reap both nutritional and insect control benefits early in the growing season.

The major concern with the use of "pop-up" fertilizer is the potential for salt injury to germinating corn seed. Salt injury occurs when the fertilizer concentration in soil solution surrounding the seedling is so high that water moves out of the seedling and into the soil. Salt injury then results in killed plants or reduced growth. Severe stand reductions and yield losses have occurred with the use of excessive rates of seed-applied fertilizers. Salt injury is associated with the total amount of nitrogen (N) and potassium (K) fertilizer applied (fertilizer rate per acre multiplied by nutrient concentration) and the sources of these elements in the fertilizers.

Recent research by Rhem and Lamb in Minnesota (2009) showed that 12 lbs of N/acre applied with the seed reduced plant populations on a loamy sand soil, while no stand reductions were observed on silty clay loam and clay loam soils. A lower rate of N (6 lbs N/acre) did not reduce stands on either the loamy sand or heavier textured soils. Gelderman and coworkers (2004) working in South Dakota also demonstrated that higher rates of N as either dry urea or urea ammonium nitrate solution (28% N) significantly reduced corn plant populations when applied with the seed. For urea containing fertilizers, ammonia is formed during the conversion of urea and can be toxic to plants. When high rates of urea are applied and this conversion happens near the seedlings, injury or death can occur. For these reasons, maximum rates of N plus K_2O applied in pop-up fertilizers should not exceed 10 lbs/acre for silt loam and clay loam soils. For sandy and sandy loam soils or soils with dry conditions at planting, the rates of N plus K_2O applied with the seed should not exceed 5 lbs/acre.

Ammonium polyphosphate (10-34-0) has been used for many years as a pop-up fertilizer and can be applied directly in the seed furrow. At rates of 100 lbs/acre (8.65 gallons/acre because10-34-0 weighs 11.65 lbs/gallon), 10 lbs of N and 34 lbs P_2O_5 would be applied. Other clear liquid fertilizers are being marketed for pop-up application and contain N, P and K. These fertilizers are generally made using liquid urea, phosphoric acid, and a source of K such as potassium carbonate, which has a lower salt index than potassium chloride (muriate of potash). While the salt index may be lower than standard fertilizers, rates of application must be carefully controlled to avoid seedling injury. Also, if a liquid insecticide is to be mixed with the fertilizer, all batches of fertilizer and the insecticides must be tested for compatibility. Compatibility of other products such as micronturients and fungicides should also be tested prior to mixing in your application equipment. Low application rates of fertilizer and/or insecticide solutions and cooler temperatures during early season planting are

favorable for precipitation of incompatible product mixtures. For all pop-up fertilizer applications, consult with the fertilizer supplier to determine the appropriate application rates (gallons/acre or lbs nutrient/acre) for each fertilizer material. Careful application equipment calibration and proper rates are essential to prevent crop injury.

A final consideration in the use of a pop-up fertilizer is that the rate of N supplied by the pop-up fertilizer will meet the corn seedlings need for only a short while. Therefore, if a pop-up fertilizer is the only source of N used at planting, early side-dressing will be required to prevent N stress.

Starter Fertilizers

Starter fertilizers allow higher rates of N to be applied near the seed during planting compared to pop-up fertilizers. Our work in Virginia demonstrated that 40 to 50 lbs N/acre applied in a 2 inch × 2 inch band was the optimum starter band N rate. With these N rates, we also applied P_2O_5 that was needed according to soil test calibrations. Optimum side-dress N rates varied with the site and should be based on soil and environmental conditions along with yield potential. If potassium is to be included in the starter fertilizer, then a total of 70 lbs N plus K_2O should be the highest rate applied in the 2 × 2 inch band as higher rates may cause salt injury. Sulfur and micronturients, such as zinc (Zn), can also be efficiently applied in starter bands.

Various fertilizer sources can be used to make starter fertilizers. The most common liquid materials are ammonium polyphosphate solution (10-34-0 or 11-37-0) and urea ammonium nitrate solution (30% N). Dry materials used to prepare starters include diammonium phosphate, urea, and ammonium sulfate. Growers should discuss with dealers the exact sources being used to prepare the starter fertilizers and the correct placement. In some cases, growers have decided that higher starter fertilizer rates are the most efficient way to fertilize their corn and have moved the starter band to 3 inches from the row in order to safely apply the higher rates.

Nutrient Removal: Pop-up and Starter Fertilizer Applications

While fertilizer prices have declined in recent months, P and K fertilizer prices have not declined to pre-2008 levels. The question is asked, “Can I reduce my application rates using pop-up and starter fertilizers without risking yield loss?” While placement of fertilizers in bands near the seed generally increases the efficiency of fertilizer uptake, low rates of starter and “pop-up” fertilizers cannot supply the total plant nutrient needs for a high yielding crop. A way to consider this question is to consider nutrient removals.

A 150 bu/acre corn crop takes up approximately 200 lbs N/acre, 85 lbs P_2O_5/acre, and 200 lbs K_2O/acre in the entire corn plant, but only 112 lbs N/acre, 66 lbs P_2O_5/acre, and 44 lbs K_2O/acre are removed from the field with the harvested grain (International Plant Nutrition

Institute). If the crop is harvested for silage, then the total uptake values would equal removal. Over the long-term, if nutrient removal exceeds nutrient applications from manures, fertilizers, legume cover crops, biosolids, or other sources, soil fertility levels will decline. In other words, if soil test levels of nutrients such as P and K are high because of previous fertilizer applications, no yield differences may be seen with low rates of pop-up or starter band fertilizers because the residual supplies of nutrients are adequate to grow the crop. If crop nutrient removal is greater than nutrient application, residual P and K soil levels will decline over time. However, at low soil fertility levels yields will likely suffer because of inadequate nutrient supplies with low rates of pop-up or starter band fertilizers.

Many growers in Virginia have built soil test levels for P to very high levels. A very high level is greater than 55 ppm for the VA Soil Testing laboratory (Mehlich-1 extract). No yield responses would be expected to additional P applications at this level, and certainly not at higher levels. An early season growth response would be expected from a starter or pop-up fertilizer in cool soil conditions, but most of that response will be associated with the N supplied to the seedling. However, a starter or a pop-up fertilizer may be a good method to assure early season seedling vigor while applying a small amount of P. Soil test P levels should be monitored over time as they will decline at a slow but steady rate, i.e. 5 or more years may be necessary to "drawdown" soil test levels into ranges that warrant P fertilization (Kamprath, 1999). Time needed for drawdown depends on crop removal and residual soil P levels.

Potassium soil test levels that are high to very high in Virginia are associated with heavier textured soils, i.e. silt loams and clay soils. Many sandy and sandy loam soils do not have adequate cation exchange capacity to hold enough K to reach a high soil test level. Therefore, potassium soil test levels will decline more rapidly than P. Potassium removal rates are such that not enough K can be supplied in starter or pop-up fertilizers to supply plant needs and yield reductions will be seen if no other fertilizer is applied.

As with K, the N needs of the corn crop cannot be solely supplied with starter or pop-up fertilizers. The use of a high N rate starter fertilizer (40 to 50 lbs N/acre) can be paired with a side-dress N application program to ensure that corn is never under N stress (Alley, et al.). With the pop-up fertilizer application, another source of N must be available to the corn plant because the N rate in the pop-up is not high enough to supply a significant amount N to meet corn needs. Some growers are using a starter fertilizer along with their pop-up, while other growers are opting to side-dress quickly after planting or apply significant amounts N as broadcast applications at planting. Each grower must make the appropriate decision for their soil and environmental conditions.

Summary:

Pop-up and starter fertilizers can be part of an efficient plant nutrition management program for corn. Pop-up and starter fertilizers can be used effectively to deliver small nutrient amounts precisely early in the growing season to seedlings. An understanding of the potential benefits and precautions with each fertilizer application method and source enables the

appropriate choices to be made by each grower. Overall, a comprehensive soil testing program combined with appropriate fertilizer sources, application rates, and application methods will enable growers to manage one of their greatest input costs, nutrients.

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