

Starter Fertilizer for Corn in Vermont

By Bill Jokela,
Extension Soils Specialist,
University of Vermont Extension

The Basics of Starter Fertilizer

What is starter fertilizer?

“Starter fertilizer” refers to the placement of plant nutrients in a concentrated zone near the seed with the planter—so named because it is done to give plants a good early season “start.” It is also known as “banded,” or “row,” fertilizer and refers to an application method or placement of nutrients, rather than to a specific type of fertilizer. Typical placement is 2 inches below and 2 inches to the side of the seed, although actual distance from the seed can vary.

What are the benefits?

Use of starter, or row, fertilizer for corn can result in increased early season growth, increased yields, and sometimes earlier maturing of the crop compared to the same amount of nutrients applied as broadcast fertilizer before planting. This “starter effect” can occur even if overall soil fertility levels are quite high. This growth and yield response to starter is most likely to occur under conditions of low soil-test phosphorus (P) or potassium (K), early planting, limited soil drainage, and/or high-residue conservation tillage.

Why is starter fertilizer effective?

The advantages of a banded starter fertilizer can be attributed to two phenomena—proximity of nutrients to the germinating seed and increased efficiency of band-placed fertilizer. First, placement of fertilizer near the seed provides nutrients within the rooting zone during germination and early seedling growth. This is a time when root growth, plant uptake, and release of nitrogen (N) and P from soil organic matter are often limited by cool soil temperatures, resulting in a temporary nutrient deficiency. Placement of soluble nutrients near the seed supports seedling growth until the root system is large enough to access nutrients from a greater soil volume. This is especially important for P and K, which are essentially immobile in the soil. Secondly,

with band placement, less fixation (tie-up) of P, and sometimes K, occurs because there is less soil-fertilizer contact. This means more applied nutrients are available for plant uptake, resulting in greater efficiency of nutrient use.

When is starter fertilizer most important?

Crop response to starter fertilizer is most likely under conditions that cause cool soil temperatures or low availability of nutrients in the soil at planting. When soil test P or K are below optimum, band placement of soluble nutrients near the seed is more critical and the probability of a yield increase is high (see Figure 1. a). When soil test P and K are high, yield increases may not always occur (see Figure 1. b).

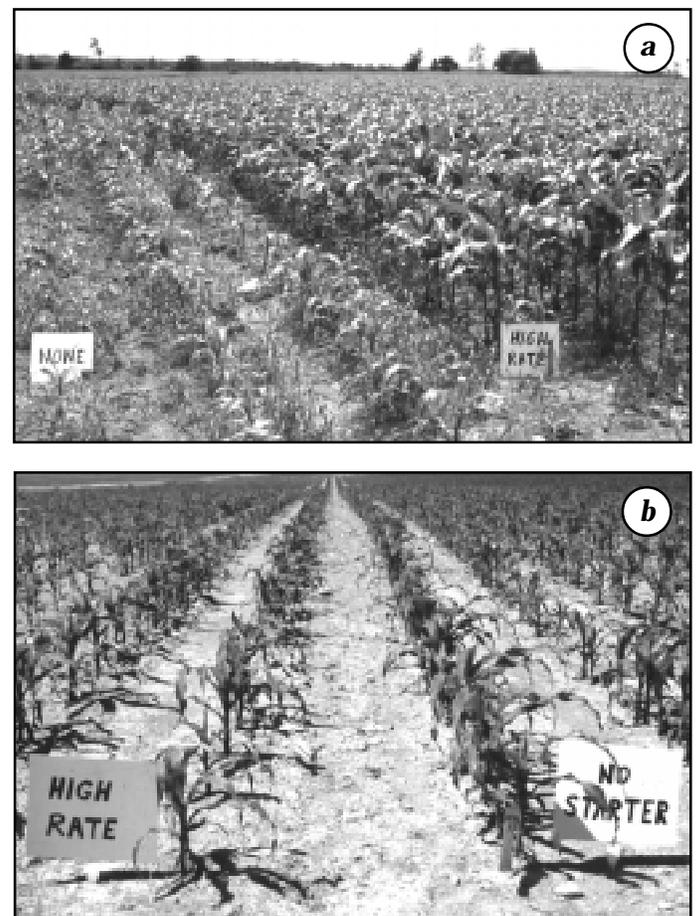


Figure 1. a) Early growth increase from starter fertilizer (right) compared to no starter (left). b) Lack of growth response from application of starter fertilizer (left) vs. none.

Low soil temperatures are most common with early planting (early May in Vermont), poorly drained soils that slow spring warm-up, and conservation tillage practices that insulate the soil surface with crop residues. Soils with low soil pH (acid soils) or high reactive aluminum tie up more of the applied P, so the advantage of band-placement increases under these conditions. The amount of fixation of K is

Guidelines for Starter Fertilizer Use on Corn

If soil test P and K levels are high, or if adequate nutrients are supplied from manure or broadcast fertilizer, only low rates (10 to 20 lb/acre of N, P_2O_5 , and/or K_2O) are needed. For most fertilizers this means a rate of about 100 lb/acre.

Probability of corn yield increase from starter fertilizer is highest with low to medium soil test P or K, especially with any of the following conditions:

- Poor or limited soil drainage.
- Early planting or cool, wet spring conditions.
- Reduced tillage/no-till with crop residue remaining.

There is a moderate probability of a starter response with optimum or high soil test P and K, especially when one or more of the above conditions exist.

Probability of a starter response is low if soil test P and K are excessive and none of the above conditions exist. Consider eliminating starter fertilizer.

Precautions:

- Limit N + K_2O rate to 80 lb/acre in 2" by 2" band. Note limits on urea and DAP.
- Limit N + K_2O to 10 lb/acre for seed-placed pop-up. Avoid urea and DAP.

Starter fertilizer in the total nutrient program:

- For many corn fields on dairy and livestock farms, a low rate of starter may be the only fertilizer needed—in combination with nutrients supplied by manure and/or plow-down legume or grass forages. A Pre-side-dress Nitrate Soil Test (PSNT) should always be used to assure that adequate N is available.

more a function of the type and amount of clay in the soil.

The “starter effect” can occur even when overall soil fertility levels, as indicated by soil tests, are optimum or higher. Only low rates are required, enough to supply 10 to 20 lb/acre of N, P_2O_5 , and/or K_2O . When nutrient levels are below optimum, starter fertilizer applied at higher rates can be an efficient method to meet the fertility needs of the crop (but see precautions, page 3). (Optimum soil test categories are 4.1-7 ppm available P and 101-130 ppm K. See UVM Extension Brieflet 1390, *Nutrient Recommendations for Field Crops in Vermont*, for further information.)

Starter Fertilizer and Water Quality

Band placement of fertilizer nutrients, especially P, can be considered an environmental “best management practice.” Phosphorus that is placed in a band below the soil surface at low rates is much less susceptible to loss via surface runoff than surface-applied P and, therefore, less likely to reach streams and lakes where it could degrade water quality. Consequently, the Phosphorus Index, an indicator of potential for P runoff from a field, assigns a lower rating to P applied as a starter fertilizer than to the same amount broadcast on the surface. (See *A Phosphorus Index for Vermont*, a UVM Extension factsheet expected to be available later in 2001.) Even with band placement, however, applying higher rates of P than needed will enrich soil P and contribute to increased P concentrations in runoff.

Using Starter Fertilizer for Corn

Fertilizer Materials

A wide range of fertilizer grades are well suited for use as a starter for corn. Phosphorus is generally considered the key element for boosting corn growth on cool early spring soils, especially if P soil test levels are below optimum, but some N should also be included especially under conservation tillage. Some of the N should be in the ammonium form as it enhances P uptake by the plant. Potassium should not be overlooked if K soil test is less than optimum. Examples of starter fertilizer include 10-20-20, 10-20-10, 15-20-20, 10-40-10, and 15-15-15. If K is not a concern, then straight monoammonium phosphate, or MAP (11-55-0), or fluid fertilizers such as ammonium polyphosphate (10-34-0 or 11-37-0) can be good choices. Straight diammonium phosphate, or DAP (18-46-0), can also be used but note the precautions mentioned on page 3. Dry and

fluid fertilizers are equally effective in terms of plant response if the rate and ratio of nutrients are comparable. The choice between forms should be based on considerations such as cost, convenience, and equipment availability.

Band Placement

The key to an effective starter fertilizer is the placement of the fertilizer band—close enough to provide available nutrients to the new seedling but far enough to avoid salt or ammonia injury to the seedling. The most common placement is 2 inches below and 2 inches to the side of the seed row (see Figure 2), although actual distances may vary from 1 to 3 inches.

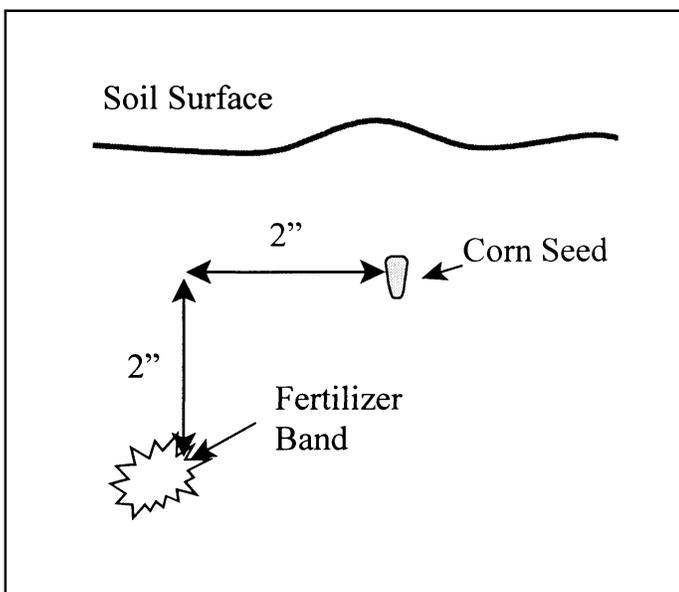


Figure 2. Typical placement of starter fertilizer band is 2 inches to the side and below the seed, although distances can vary from 1 to 3 inches.

Low rates of fertilizer can be applied directly with the corn seed, a method known as “pop-up.” Pop-up application is best suited to high-testing soils where only very low rates are needed. Advantages of this method are that it doesn’t require a separate fertilizer opener on the planter and that it enables the farmer to use lower rates. However, caution must be taken to avoid seedling injury, especially under dry soil conditions. Limit N + K₂O rate to 10 lb/acre and avoid fertilizers containing DAP or urea, which can release toxic levels of ammonia.

Application Rates

The optimum starter fertilizer rate depends on the specific field situation and on the material used.

Only low rates (10 to 20 lb/acre of N, P₂O₅, and/or K₂O) are needed to provide a true starter effect—that is, the yield benefit gained from placement of fertilizer nutrients in a band near the seed. For most dry fertilizers this means a rate of about 100 lb/acre, which is as low a rate as can be applied by many planters. For example, 120 lbs of a 15-15-15 fertilizer would supply 18 lbs each of N, P₂O₅, and K₂O (1.20 x 15 = 18). If soil test P and K levels are high, or if adequate nutrients are supplied from manure or broadcast fertilizer, then this low rate is usually all that is needed. Keeping application rates low reduces cost and minimizes the time spent filling fertilizer hoppers during planting. However, applying a 100 lb/acre rate of a high P-analysis fertilizer, such as 11-55-0 or 10-40-10, provides much more P and may not be cost-effective unless the soil is P-deficient. Increasing the starter fertilizer N rate to 30 to 50 lb/acre would be appropriate if no manure has been applied and additional N will not be applied until sidedress time. This would usually require a higher N-analysis fertilizer with a higher N:P ratio—e.g., 1:1 or even 2:1—to avoid a high fertilizer rate that would supply excess P.

If soil test levels are in the low to optimum range, then a higher rate of starter fertilizer can be used to supply most or all of the P and significant portions of the N and K. A high amount of P in the starter band is not a concern, but too much N and/or K can cause seedling injury. (See precautions, below.) For soils testing low in P or K, a combination of starter and broadcast fertilizer or manure is recommended. (See UVM Extension Brieflet 1390, *Nutrient Recommendations for Field Crops in Vermont*, for specific nutrient recommendations.)

Precautions with Starter Fertilizer

There are some limitations on starter fertilizer use to avoid seedling injury and possible yield loss. Fertilizer salts—primarily N and K compounds—can cause poor germination and seedling injury if excessive rates are applied near the seed. To prevent these problems, limit the combined N + K₂O banded with corn planter (2 inches to the side and 2 inches below the seed) to 80 lb/acre. For example, 300 lbs of 15-20-20 would supply 45 lbs of N and 60 lbs of K₂O for a total 105 lbs, an amount in excess of the 80 lb limit. Another concern is the release of toxic levels of ammonia and/or nitrite from some N-containing fertilizers that can cause severe seedling injury. No more than 30 lb/acre of N as urea, 30 lb/acre of P₂O₅ as DAP, or 30 lb/acre from a combination of the two should be applied in a starter band (Cornell Cooperative Extension, 2000). Damage is more likely if soil conditions are dry at or in the few

weeks following planting. Application rate of P per se is not a limitation except as part of N-containing materials (e.g., DAP). For seed-placed, or pop-up, fertilizer, limit N + K₂O rate to 10 lb/acre and avoid fertilizers containing DAP or urea (or N solutions which contain urea).

Results of Field Trials with Starter Fertilizer for Corn

On-farm Trials with Corn Silage in Vermont

A field study was carried out in 1986-1989 as part of the St. Albans Bay Rural Clean Water Program to evaluate the effect of different rates of starter fertilizer on early plant growth and yield of silage corn (Jokela, 1992). Participating farmers applied starter fertilizer on replicated plots on a total of 12 field sites at the following rates: High (50-60 lb P₂O₅/acre + N and K, usually their normal rate), Low (25-30 lb P₂O₅/acre + N and K), and None (no starter applied). The field sites had soil test levels ranging from medium to high in P and K and soil drainage from poor to excessive (though most were somewhat poorly to poorly drained). All but two sites received dairy manure for the current season. Planting dates were between May 16 and June 4, with most in mid-May. Corn silage yields were 20 ton/acre or greater—at 30% dry matter (DM)—with starter.

The yield response to starter fertilizer varied with soil test P and K level (see Figure 3). Three of the six sites with either P or K testing medium (below optimum) showed a significant yield increase from starter (one had an unexplained decrease), whereas only one of the six sites testing optimum in both P and K responded to starter fertilizer. (That site received no manure and had the highest Al test level.) The low fertilizer rate was adequate on three of the four responsive fields; only Site 1 showed a significant (though small) yield increase from the high rate, a result of potassium (based on soil and plant analysis). On the four responding sites, the average yield increase from the low rate of starter fertilizer was over 5 ton/acre (at 30% DM).

Starter response was also related to soil drainage. Two of the three poorly drained sites showed a yield increase from use of starter, compared to only two of six (or one-third) of the somewhat poorly drained sites and none of the three well-drained sites. Early plant growth was also measured on ten of the sites and showed a similar pattern of response as yield. In this study, the earliest planting dates were in mid-May and none had high-residue conservation tillage. In fields planted in early May or with conservation tillage (both of which tend to lower soil temperature),

the probability of a starter response would probability be greater.

Another demonstration field trial was carried out on a farm in Guildhall in northeastern Vermont in 2000. Starter fertilizer (120 lb/acre of 10-20-10) was applied at planting in mid-May only to alternating pairs of corn rows on a well drained fine sandy loam soil testing high in P and medium in K. Measured silage yields were about 20 ton/acre and showed no significant effect of starter fertilizer.

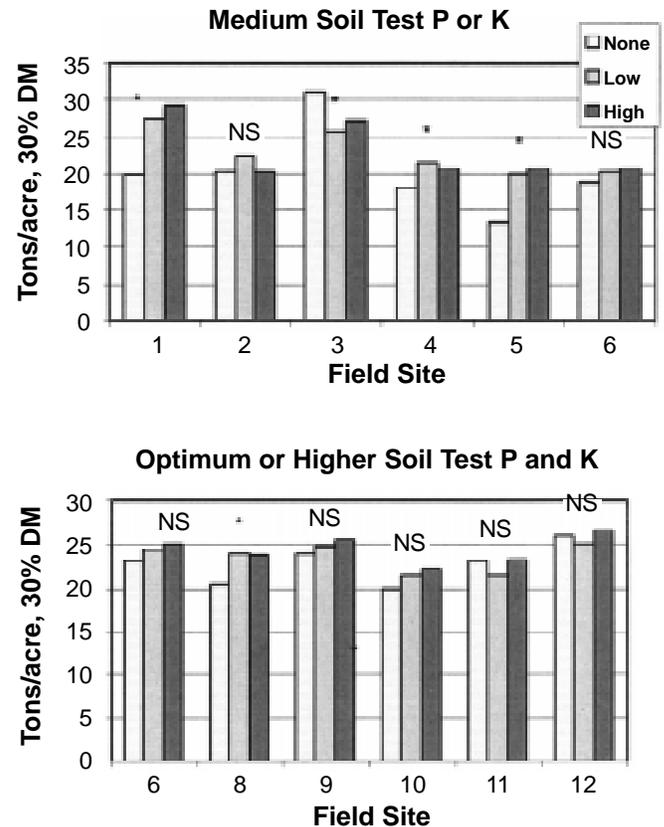


Figure 3. Corn silage yields with low or high rates or no starter fertilizer on sites with medium soil test P or K (above) or optimum or higher soil test P and K (below). Franklin County, VT, 1986-1989. * = significant; NS = no significant effect.

Field Trials with Corn for Grain in the North Central States

The effect of starter fertilizer on corn grown for grain on soils testing high or excessive in P and K was evaluated in 100 replicated on-farm trials in Wisconsin from 1995 to 1997 (Bundy, 1999). Use of a starter rate of 10-20-20 gave an average yield increase of about 4 bushels per acre compared to no starter. An economical response to starter occurred about 30 to 40% of the time. The probability of a yield response was greater where soil test K was

less than 150 ppm (still in the high range) or when long-season hybrids were planted late. This last result suggests that starter fertilizer had a beneficial effect by hastening crop maturity. In another series of twenty on-farm trials in Wisconsin, the recommended starter rate of 10-20-20 was compared to the rate used by the farmer, commonly two to three times higher. The results showed there was no yield benefit from the higher fertilizer rate—the same conclusion as in the Vermont research discussed above.

The effect of tillage system on starter response was shown in field trials with grain corn (crop residue remaining) in Minnesota and Indiana. The Minnesota trial showed twice the yield increase from starter fertilizer (10 bu/acre vs 5 bu/acre) with no-till or chisel plowing compared to moldboard plowing (Randall and Swan, 1991). In Indiana, yield increase from starter was 8 bu/acre under no-till, but only 1 bu/acre under conventional tillage (Brouder, 1996).

Field Trial Conclusions

Yield response to starter fertilizer is most likely under the following conditions:

- Medium or lower soil test P or K.
- Soils with poor or limited drainage.
- No-till or reduced tillage with crop residue remaining.

If soil tests are optimum or higher, or adequate nutrients are supplied:

- Crop response to starter rates higher than about 10-20-20 are unlikely.
- Yield response is more likely for long-season hybrids planted late.

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Abbreviations:

N = nitrogen	MAP = monoammonium phosphate
P = phosphorus	DAP = diammonium phosphate
K = potassium	DM = dry matter



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