

# Micronutrient Response Enhanced By Fluid Starters

Mixed solutions create intimate contact between nutrient compounds in the various carriers combined.

*Summary: Numerous studies have documented crop responses to N, P, K, and S in starters. But micronutrients have received less attention as components of starter applications. The purpose of this article is to provide some examples of how starters can be used to enhance the effectiveness of micronutrient fertilizers.*

Opportunities exist to improve crop response to micronutrients by combining them with starter fertilizer applications. Starters can improve early growth and root development, hasten maturity, and improve yields under a variety of conditions. Crops planted early in cool soils particularly seem to benefit from starters. Studies have demonstrated improved micronutrient response in starters for a variety of reasons. Under soil conditions that potentially reduce nutrient availability from broadcast fertilizers, starter applications may:

1. Produce superior micronutrient response by concentrating nutrients in a band where probability of root interception is greater
2. Produce root exudates that enhance nutrient availability
3. Place nutrients in a chemical environment that favors less rapid fixation.

Root interception is a critical factor in uptake because several of the micronutrients are immobile in soils. Early root development of many crops is slow, especially with early plantings in cold, wet soils. Banding close to the row under these environmental conditions greatly increases the chance of roots contacting these balky nutrients. Additionally, banding N and

P to stimulate root proliferation in and around the fertilizer band further increases the amount of root length available for nutrient uptake.

Many plants secrete compounds from their roots that can solubilize unavailable micronutrient compounds and increase uptake. Band placing micronutrients in the root zone increases the probability of nutrient contact by roots, which also increases the effectiveness of these secreted compounds. Increased solubility caused by the exudates, in turn, increases diffusion through the soil by creating a greater concentration gradient around the fertilizer zone and increases the volume of soil enriched by the fertilizer.

### Zinc response/net return

The potential for enhanced micronutrient response through

placement with starters was demonstrated in a three-year dry-bean study in Wyoming. Zinc applied with N and P in a 2 x 2 starter produced significant yield increases over N and P without Zn (Figure 1). The same N-P-Zn combination broadcast before planting produced no response. Early growth and development were improved by starter application, leading to greater yield potential and greater partitioning of photosynthates to the seed during pod fill. In spite of the fact that the field had a high DTPA-extractable soil Zn (2.7 to 3.8), other conditions that compounded the probability of response to starter Zn were:

1. Soil pH at 7.7 to 8.0
2. Low soil organic matter (1.1 to 1.6%)
3. High N supply

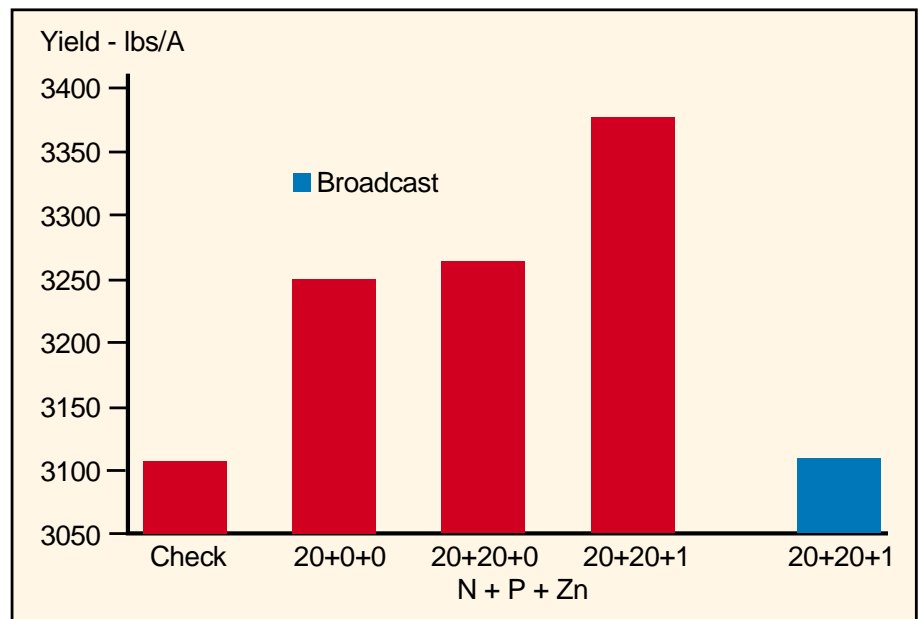


Figure 1. Yield and maturity response of dry beans to starter fertilizer applications, average of two years (1994-1995), two cultivars, four planting dates and four replications.

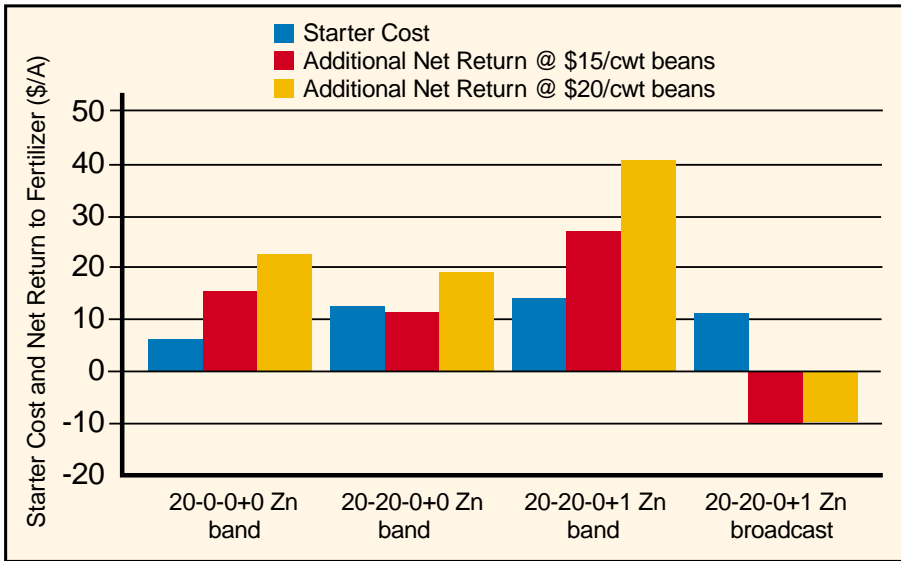


Figure 2. Starter fertilizer cost (quote from dealer) and net return to fertilizer treatments at two bean prices. Net return is calculated by subtracting starter cost shown from increased crop value over no-starter control.

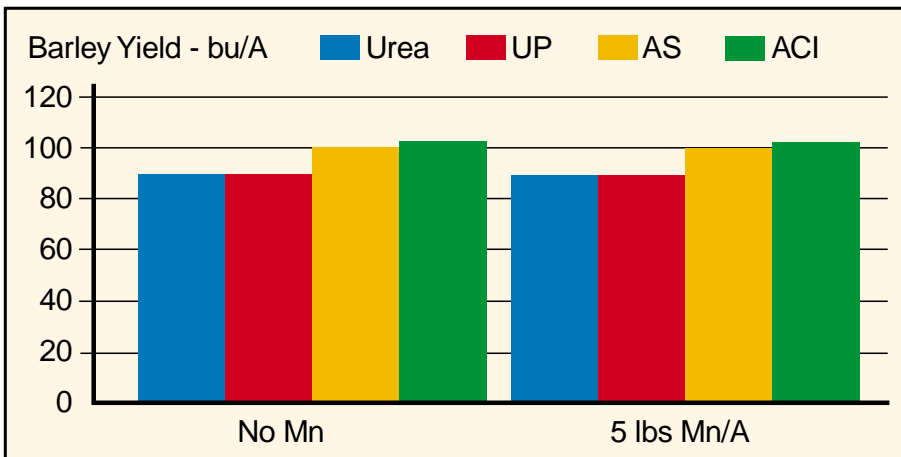


Figure 3. Barley response to Mn banded with starter fertilizers. UP = urea phosphate; AS = ammonium sulfate; ACI = ammonium chloride.

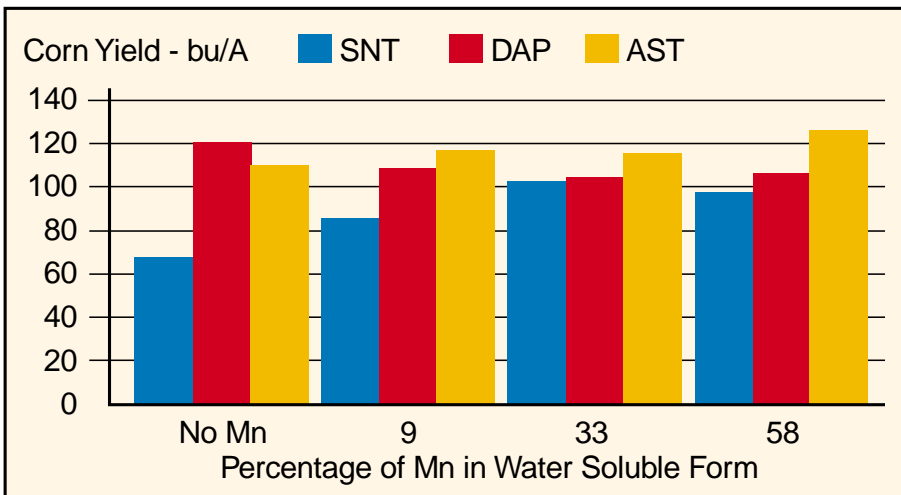


Figure 4. Corn response to Mn applied with starters of varying pH. Manganese was applied at 10 lbs/A. SNT=Mn banded with sodium nitrate + triple super phosphate. AST= Mn banded with ammonium sulfate + triple super phosphate.

4. Beans planted into wet soil
5. Dry beans that are very sensitive to Zn deficiency.

When combinations of factors favoring response occur simultaneously, they increase the likelihood of dramatic response, even in high-testing soils. Though the observed yield increases in Figure 2 may seem modest, they were economically important. The starter response was consistent across varieties and was not limited to early plantings in cool soils. Response of late plantings to starter was similar to early plantings. Seed quality from late plantings that were subjected to frost before harvest was significantly improved by adding Zn in the starter.

#### With acidic starter

One opportunity for enhancing micronutrient availability in starters is through placement with acid or acid forming N and P fertilizers. Because micronutrient availability is so strongly affected by soil pH, a small pH change in the presence of an elevated micronutrient concentration can considerably enhance availability. One study showed improved Mn uptake and increased yields on alkaline soils in Oregon when Mn was banded with ammonium sulfate or ammonium chloride but not when Mn was banded with urea (Figure 3). Manganese uptake increased with ammonium sulfate or ammonium chloride without Mn application, but the greatest Mn uptake and yields occurred with the combination. Broadcasting the same combinations produced smaller yield increases and no increase in Mn uptake. Ammonium sulfate and ammonium chloride decreased soil pH and increased soil solution Mn concentration in the band.

Studies in acid soils of North Carolina (Figure 4) reported similar results with band combinations of Mn in three starters of varying pH:

1. Diammonium phosphate (DAP)
2. Sodium nitrate + triple super phosphate (SNT)
3. Ammonium sulfate + triple super phosphate (AST)

Manganese uptake and corn yields were of the order Mn + AST > Mn + DAP > Mn + SNT. Soil pH in the starter band was lowest with AST and highest with SNT. The acid starters (AST and DAP) applied in a band without Mn were more effective in increasing Mn uptake than SNT with Mn. Extractable soil Mn, Mn uptake, and average response to Mn increased with increasing water solubility of the Mn fertilizer. Other studies have reported improved micronutrient uptake by combination with acid phosphates, sulfuric acid, and elemental sulfur. Results with elemental sulfur seem to be less consistent than results with ammonium sulfate and acid phosphates. This is probably related to varying biological oxidation of S with variations in the soil environment.

#### **Advantages of fluids**

Fluid fertilizers offer special advantages in enhancing micronutrient availability. Because micronutrients are used at low rates distribution in the soil is poor. Fluid bands enhance micronutrient distribution because they are:

1. More or less continuous
2. Provide better distribution
3. Generally eliminate spaces occurring between granules.

It has been proposed that much of the advantage of chelated and complex forms applied in fluids results from superior distribution and root interception in addition to nutrient chemistry. Zinc sources banded in suspension with ammonium polyphosphate suspensions have been studied. Suspending zinc materials in fluids produced similar responses among products, eliminating the disadvantages of the insolubility of some zinc carriers such as zinc oxide.

#### **Watch compatibility**

Compatibility of micronutrient fertilizers with starters is typically only a problem when mixing solutions. Probably the greatest concern for dry blended materials is blend uniformity and adequate distribution of a very small amount of micronutrient in the blend. Mixed solutions, however, create intimate contact between nutrient compounds in the various carriers combined.

Many chemical reactions are possible in the solution. Compatibility with liquid phosphate sources is usually the greatest problem. As a general rule of thumb, the true chelates are most compatible and inorganic salts are the least compatible. Compatibility is in order of the stability constant of the nutrient compound. A variety of fluid carriers may be used, but compatibility should be checked and the final solution grade may be limited by the compatibility of the carriers.

In a number of studies, polyphosphate solutions have produced somewhat better responses than orthophosphate solutions. Polyphosphates are essential for sequestering many inorganic micronutrients. For example, low polyphosphate products cannot hold as much zinc in solution. Chelates provide greater compatibility, but are much more costly. A higher rate of a lower cost material may be more economical if compatibility problems are accounted for.

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