# FLUID DIGEST®

**Research Update from the Fluid Fertilizer Foundation**

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## Up to 23-bushel/A increase

# P is key in starters but multi-nutrient starters are a real plus in producing higher corn yields

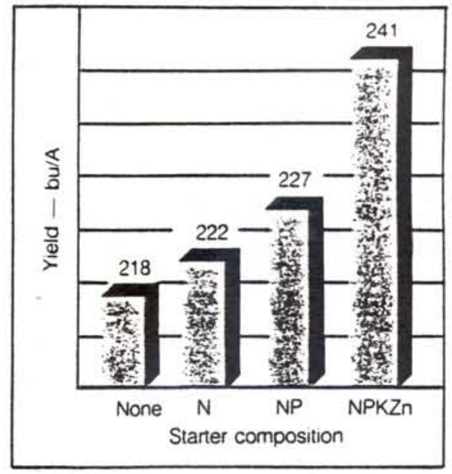


Figure 2. Corn yield response to multi-nutrient fluid starter (Wiese, University of Nebraska).

Two studies dramatically demonstrate the possibilities of improving yields via *multi*-nutrient fluid starters.

In Iowa State University tests spanning 21 years, 6-23-23 starters in combination with plowdown P repeatedly outperformed triple the rate of plowdown P alone (Figure 1), increasing corn yield 4 bushels/A or $10/A. Adopting a systems approach to fertility had obvious benefit over simply increasing the rate of phosphate fertilizer applied at plowdown.

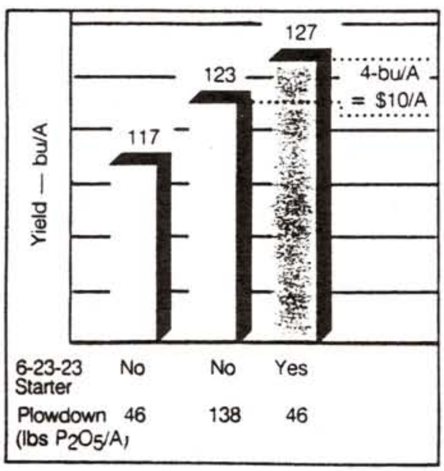


Figure 1. Effect of plowdown P and multi-nutrient starter on corn yield (Iowa State University, 21-year study).

In a University of Nebraska corn study, Wiese showed a 23-bu/A jump over the check (worth $57.50/A) by adding K and Zn to an NP fluid mix (Figure 2). Such complete, multi-nutrient starters offer an excellent beginning point in balanced fertility for crops, helping to overcome antagonistic effects or taking advantage of nutrient synergy.

Although phosphate plays a major role in early crop nutrition as the foremost component in fluid starters, nutrients present in the soil or plant can interact with P (particularly after fertilizer application) to either enhance or depress nutrient efficiency. For example, research has documented synergisms in NP combinations, where nitrogen (as ammonium) enhanced P uptake. PK and PMg combinations have produced similar results. On the other hand, other studies have shown that high applications of P can lead to PS, PZn and PMn antagonisms, where uptake of S, Zn and Mn is reduced.

## Late application of P costly

The agronomic need for adopting a plant fertilization strategy of early P nutrition is well demonstrated by recent Canadian research. A study this year by Barry and Miller of the University of Guelph shows that delaying P supply beyond the six- leaf stage significantly reduced corn yield, largely through limiting the number of kernels per plant (Table 1).

**Table 1**

Effect of timing of P application on corn yield (Barry and Miller, University of Guelph, 1989).

| P supply | Yield bu/A | Kernel number per plant |
|---|---|---|
| Early + continued | 130 | 444 |
| Late only | 113 | 398 |

DIRECT-DIAL HELP!

*If you desire detailed information on studies reported in this issue, call Julian Smith: 314/256-4900*

**INSIDE:**

## Foundation News
### from your Research Director, Julian Smith

The principle of starters is not new. Experiments date back to the 1850s. However, the form, composition and agronomics of starters have come a long way and the practice is now well established in many cropping systems. Ideally suited to this practice are fluid fertilizers. Homogeneous, multi-nutrient fluid starters afford precision placement to maximize root uptake of nutrients. Custom formulation of NPK fluid mixtures with secondary and micronutrients assures flexibility in precise, plant-oriented fertility programs. Data presented in this issue of the *Fluid Digest* attest to the value and effectiveness of fluids in a starter program.

As we all know, the purpose of fertilizer application is to supply essential elements for crops that cannot be supplied by the soil alone. It is the crop's requirements that dictate fertilizer use. In other words, we need to fertilize the *crop*, not the field. Thus, to maximize return on fertilizer investment, while protecting the environment, consideration of plant needs is essential in developing precision fertility programs.

In very simple terms, rapid root growth after seeding must be encouraged to enhance leaf and canopy development. Photo-synthetic capacity is increased. Dry matter accumulation and, therefore, yield is improved. A wise agronomic axiom to follow is a *good start will lead to a good finish*. This, of course, assumes that weed, water and disease stress are minimized during the growing season.

Once seeds are sown into an adverse environment where there is limitation of climate or growing season and have lost their reserves, seedling roots may have trouble extracting soil nutrients that are unavailable due to soil temperature, lack of moisture, soil compaction or other factors. This is why developing a good start by promoting deep, extensive root system development is so crucial. And this is where fluid starters can play a vital role in adding to your profits!

J. Julian Smith, PhD.
Vice President, Research

## Cotton/sorghum respond to fluid starters

Studies from the southeast in 1986 by Touchton at Auburn University have shown economic yield responses to fluid starters in both cotton and sorghum. It is often easy to pick out sections of fields where starters were missed and one tipoff is drastic differences in plant height during early growth.

As plants mature during the season, these early growth differences translate by harvesttime into sharp yield divergencies, as shown in Figure 3.

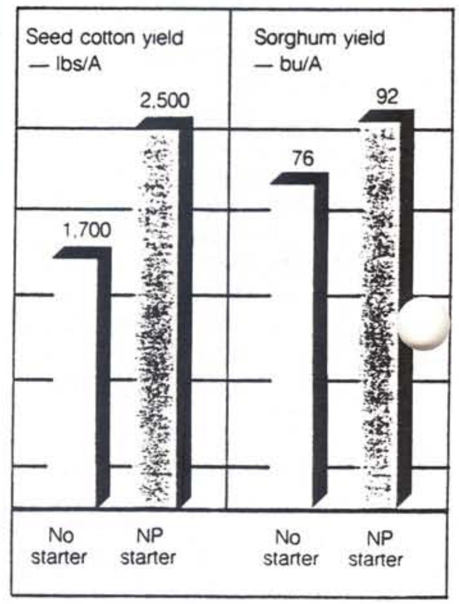


Figure 3. Effect of NP fluid starter on yield of cotton and grain sorghum (Touchton, Auburn University, 1986).

## Starters develop root system!

One of the great benefits in using starter fertilizers is they promote the development of root systems. Healthy, strong roots can go deeper in the soil and even penetrate compacted layers. Research by Newbould on barley at Rothamsted, England, shows that incorporating a complete NPK starter promoted more root growth at lower soil depths, compared to plots where no starter was used, and increased phosphate uptake by the crop at all depths (Table 2). Water intake was also improved by virtue of the well-developed root system. Generally, healthier, stronger roots will:

- improve crop yield and quality
- minimize environmental risk from unused nutrients — *crop* is fertilized, not soil
- make plant more durable against drought.

The agronomic data presented elsewhere in this issue of *Fluid Digest* simply reinforce the root-building benefits derived from applying fluid starter fertilizers. Early development of the root system makes sense when you consider that a seed weighing a fraction of an ounce is placed in many thousands of tons of soil. After exhausting its seed reserves, it's essential that the seedling root system have a readily available nutrient supply for development of a strong, healthy, high-yielding plant.

**Table 2**

Effects of starters on rooting and P uptake of barley (Newbould, Rothamsted, England, 1969).

| Soil depth (inches) | Relative* Root weight | | Relative* P uptake | |
|---|---|---|---|---|
| | No NPK | NPK | No NPK | [illegible] |
| 2 - 4 | 100 | 202 | 100 | [illegible] |
| 6 - 8 | 59 | 157 | 68 | 101 |
| 10 - 12 | 8 | 77 | 22 | 58 |
| 14 - 16 | 10 | 52 | 15 | 32 |

*Relative to 2- to 4-inch depth, unfertilized = 100%

## Soybeans

# Fluid starter adds 12 bu/A

Ample evidence of soybean response to fertilization has already appeared in the *Fluid Digest* (September '88 through March '89 issues) and starters are no exception. In 1986 studies run on the Devillez Farms by Cook of Tri-County Chemical in Eldorado, Illinois, soybeans showed a yield response increase of nearly 12 bu/A to a fluid 2 x 2 starter application of NPKS (Figure 4). The starter application is but a part of a "Strip-Starter-Split" program promoted by Tri-County Chemical and designed to maximize fertilizer efficiency and minimize per-bushel costs.

Cook operates on the philosophy that soil tests are not always a good measure of what the plant is able to use from the soil. Soybeans may be in soils high in nutrients, but where nutrients are in a form not readily available. In such cases, Cook reports that excellent yield responses have been obtained through their Strip-Starter-Split program. He believes fluids are ideally suited to this program and their systems approach called "timing, concentration, placement" (TCP).

"In the end, it comes down to the bottom line — ours or our customers' — and fertilizing soybeans our way means added profit all around," Cook says.

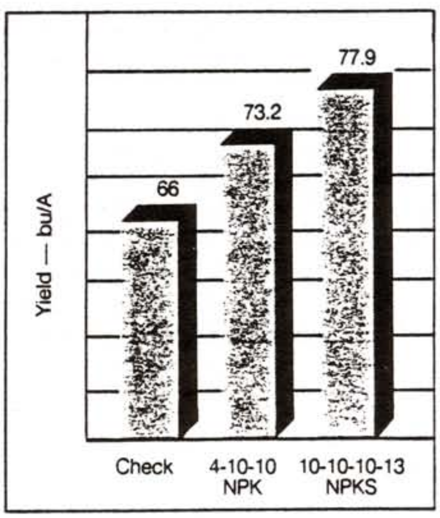


Figure 4. Soybean response to a fluid 2 x 2 starter in southern Illinois, Devillez Farms (Tri-County Chemical, 1986).

# Multi-nutrient fluid starters boost small grain yields

Research shows that small-grain cereals such as wheat and barley respond favorably to balanced, early-season applications of fluid starters.

Studies by Leikam et al. at Kansas State University have shown up to 25-bu/A yield response increases through applications of fluid NP starters in wheat (Figure 5). Note that band placement (knife or dribble) is superior to broadcasting. Limited root systems, short growing seasons, cool temperatures and the drier conditions under which many of these crops are grown may contribute to this response.

The benefits of K in a starter application are also apparent in 1984 studies made on barley in Montana (Table 3). Note the effect of seeding date on yield, partially offset by K fertilizer. K availability will be restricted in compacted and cold soils but its uptake will increase as soil temperature increases — a response well documented in corn.

**Table 3**

Effect of K (20 lbs/A) application on yield of early-seeded barley in Montana (Tisdale et al., 1984).

| Seeding date | Yield | |
|---|---|---|
| | No K | K |
| 4/6 | 48 | 55 |
| 5/6 | 36 | 42 |
| 6/3 | 30 | 33 |

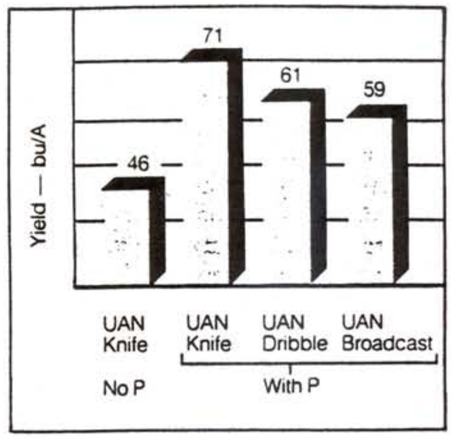


Figure 5. Effect of fluid N (75 lbs/A) and P (40 lbs/A) fertilization on wheat yield (Leikam et al., Kansas State University, 1983).

In addition to supplying K, potash used in fluid starters also supplies chloride (Cl). Fixen, when at South Dakota State University in 1987, reported spring wheat yields increased an average 5.4 bu/A in response to Cl. The beneficial effects of chloride on yield have been ascribed to improved plant moisture retention and reduced root/leaf diseases.

# Why fluids are superior as starters

As growers fine tune fertility programs for their crops, more attention is being given to "precision fertility" to maximize agronomic response in an economic and environmentally sound manner.

Phosphate has been long recognized as a key component in starter fertilizers because of its major influence on early root development. Applying phosphate is a balancing act between supplying as much of the root system as possible yet minimizing loss of availability through soil "lock-up." There are several aspects in battling this dilemma where fluid fertilizer sources exhibit superiority over other fertilizer forms:

*Placement*. The work of Barber of Purdue clearly indicates that for maximum root uptake and nutrient efficiency, the volume of soil to be fertilized should be 2 to 20%. Uniform starter fluids can be placed with great accuracy, precisely where roots can use the nutrients, while minimizing possible seed damage.

*Water solubility*. Although crops vary in their response, research data on corn yield response compiled at Iowa State University show that 100% water-soluble P fertilizers (as in fluids) are the most efficient in early crop nutrition when compared to other sources (Table 4).

*Flexibility*. Flexible, custom formulation in multi-nutrient starter mixtures provides homogeneous fluid mixes whereby micronutrients can receive even distribution of small quantities for root interception.

**Table 4**

100% water-soluble P superior to other sources.

| % Water-soluble P | Corn yield increase (bu/A) | Value of yield increase ($/A) |
|---|---|---|
| 14 | 12 | 30.00 |
| 41 | 14 | 35.00 |
| 57 | 19 | 47.50 |
| 70 | 20 | 50.00 |
| 100 | 23 | 57.50 |

# Placement of fluid P boosts alfalfa yields

Studies by Goos of North Dakota State University show that deep injection of P fertilizer in alfalfa plots, at the rate of 80 lbs/A $P_2O_5$, improved P uptake and yields by as much as 160 lbs/A of dry matter on the first cutting (Figure 6). At two of three locations, injected liquid ammonium polyphosphate outperformed surface applications of dry superphosphate.

Researchers conducting such studies conclude that deep-applying fluid P in alfalfa fields using thin profile knives can be a very practical technique — especially on soils testing quite low in available P.

Deep banding of fluid P in alfalfa should be performed in late fall or early spring when stands are dormant and very little remains of the previous year's growth.

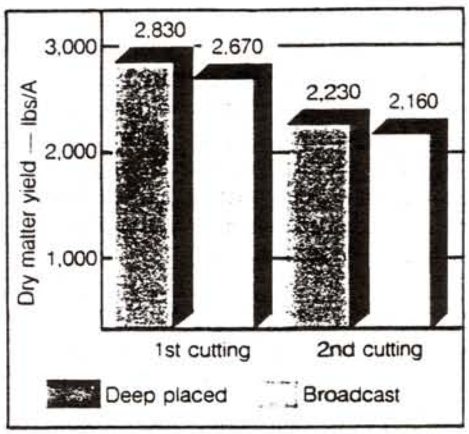


Figure 6. Effect of P application (80 lbs/A $P_2O_5$) on alfalfa dry matter yield, 2 cuttings (Goos et al., North Dakota State University, 1983).

## Involves sound establishment/management practices

# Systems approach is key to profitable alfalfa yields

There's much more than just fertilizing and seeding involved in producing alfalfa yields that make that bottom line look good. Involved is a systems approach that can be grouped under two categories we'll briefly examine:

**Establishment of crop**

*Fertilization*. Soil test before anything! One generally recommended practice is to put half the P and all the K down at plowdown. Follow-up nutrients at planting may be application of an NP + micronutrient fluid. P promotes photosynthesis, carbohydrate/protein synthesis, cell division, root development and other processes. K promotes leaf growth, winter survival and stand life. (K is required in alfalfa in greater quantities than any other element.) Boron promotes protein synthesis, which in turn promotes plant maturity, yield and quality. Examples of recommended rates of application are shown in Table 5.

*Seeding*. Fluid suspensions make an ideal vehicle for seeding through floater booms. The methodology is efficient, flexible, speedy and ever-increasing in use. Extra trips across the field are saved, as well as valuable time. Micronutrients, inoculants, insecticides and herbicides can also be included in the mix. Cultipacking should be performed for good seed-to-soil contact.

**Table 5**

Fertility recommendation for alfalfa (Willard Agri-Service, Inc., Frederick, Maryland, 1989).

| Yield tons/A | Pounds $P_2O$ | $K_2O$ | B |
|---|---|---|---|
| 4 | 60 | 240 | 1.4 |
| 5 | 75 | 300 | 1.6 |
| 6 | 90 | 360 | 1.8 |
| 7 | 105 | 420 | 2.0 |
| 8 | 120 | 480 | 2.2 |
| 9 | 135 | 540 | 2.4 |
| 10 | 150 | 600 | 2.6 |

**Management**

*Site selection*. Ideally, fields with well-drained loam or clay soils should be selected for alfalfa crops.

*Liming*. Liming should be done before seeding (pH 6.8 to 7.0).

*Harvesting*. Harvesting should be done at 28- to 32-day intervals. A good rule of thumb to follow is not to harvest between September 15 and the first killing frost, unless 45 days have elapsed since the last cut. A sample cutting schedule is shown in Table 6.

**Table 6**

Recommended harvesting schedule for alfalfa (Willard Agri-Service, Inc., Frederick, Maryland, 1989).

| | |
|---|---|
| 1st cutting | May 10 to May 28 |
| 2nd cutting | June 8 to June 30 |
| 3rd cutting | July 6 to July 30 |
| 4th cutting | August 4 to September 1 |
| 5th cutting | September 1 to September 15 |
| 6th cutting | After killing frost or after October 20 |

*Fertility maintenance*. Following the final cutting, a maintenance application should be made to restore nutrients removed by the previous crop. Recommended are 20 lbs P and 60 lbs K per ton of alfalfa harvested.


FLUID FERTILIZER FOUNDATION
339 CONSORT DR.
MANCHESTER, MO 63011
(314) 256-4900