FLUID DIGEST®

Research Update from the Fluid Fertilizer Foundation

Volume 3, Number 2 June 1990

Interacts with N and P

Including fluid K doubles wheat yield

Intensive wheat management is not just nitrogen fertilizer and fungicides. Other key elements such as phosphorus and potassium are needed to gain maximum nitrogen efficiency. And of these key nutrients, K in particular is probably neglected all too often in many wheat programs.

Research by Westerman of Oklahoma State University, for example, has shown the benefits of applying potassium in combination with N and P to wheat. In one study, yields were more than doubled by applying an NPK mix (Figure 1). Commonly, K is broadcast alone. However, use of N and P can be improved when K is used in combination.

A 1986 study by FFF researcher Kettlewell of Harper Adams Agricultural College in England has shown another benefit of K use: the presence of chloride (Cl), which in most instances is applied with K.

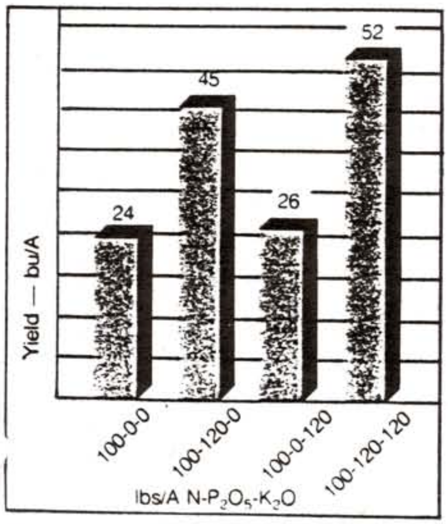

Figure 1. Interaction of NP and K to increase wheat yield (Westerman, Oklahoma State University, 1981)

Disease incidence often is reduced by correcting the imbalance between N and K. Although data varied over Kettlewell's three-year study, there were indications that late-season foliar KCl sprays reduced both ear and leaf incidence of *Septoria*. In one year of the study, flagleaf green area increased significantly with increasing KCl rates. Yield and bushel weight were also increased (Figure 2).

A study by FFF project leader Schumacher of South Dakota State University produced similar results. While disease incidence is often less as already noted, his research demonstrated yield responses to Cl in the absence of disease. (Generally, yield response on high-K-test soils may be due in part to Cl.) Kernel weights were frequently higher and heading date was advanced as a result of Cl fertilization. In one variety, there was also an increase in grain-fill duration.

Research by Granade et al. in Kansas has recorded positive yield responses, improved test weights and reduced disease as a result of K fertilization (Table 1).

Additional benefits of K use with NP are:

- Assures K requirements are met. Estimates put K uptake by wheat at 2 lbs/A/day during peak demand (similar to N). Difference in K uptake between varieties is due to differences in straw production
- N uptake is enhanced when K is in right balance with N. Yield and grain protein are improved, plus improved N efficiency protects environment
- Water balance is improved in plants, which, in turn, maintains or improves photosynthesis under water stress
- Upper stem strength is improved, which is related to increased upper stem diameter. Threat of lodging is reduced.

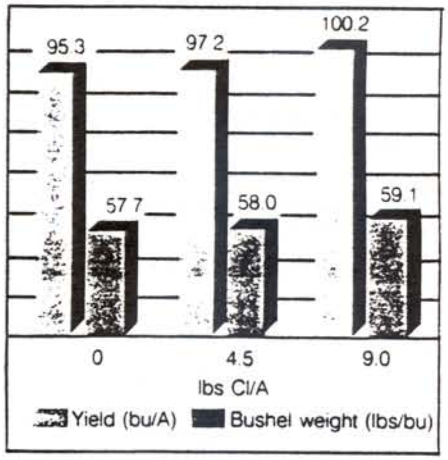

Figure 2. Effect of foliar spray of potassium chloride on yield and bushel weight of winter wheat (Kettlewell, Harper Adams Agricultural College, England, 1986).

Table 1

Effect of K fertilization on wheat yields, test weight and disease ratings (Granade et al., Kansas, 1988, from Griffith, PPI).

K_2O applied (lbs/A)	Test weight lbs/bu	Yield bu/A	Disease rating (%)*
0	59.4	67	20
40	60.6	74	15
80	60.8	75	15

*percent flagleaf affected by leaf rust on May 25

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FFF unveils 1990 research program

The new decade opens full of excitement and promise for those associated with our industry. In 1990 alone, 30 fluid fertilizer research projects will be supported by the FFF! Located at leading research centers in 21 states (as well as England and Canada), many aspects of fluid agronomic and application management will be researched. Overall, the projects will comprise 65 studies featuring 133 experiments at 74 locations.

In addition to fine-tuning current fluid fertilizer agronomic recommendations, other project areas sure to bring innovation and new technology include:

- new application technology such as spatial variable application methods and spoke wheel injection
- new approaches to formulation of starter fertilizers, including a better understanding of early N nutrition
- new experimentation with compounds used to slow nutrient release during the growing season to improve crop efficiency
- a practical evaluation of gelled fertilizers, part of a novel application technique geared to reducing N loss and improving nutrient availability to plants
- complete systems management of major crops involving fluids
- foliar nutrition.

Up to 3 bu/A

Spokewheel injection of UAN increases N efficiency and wheat yields

Work by Janzen et al. in Canada shows that point injection of UAN improved both grain yield and recovery of N, when compared with broadcast methods (Figure 3). The Canadian data suggest that for wheat drilled in 8-inch rows, optimum spacing for crop response and N

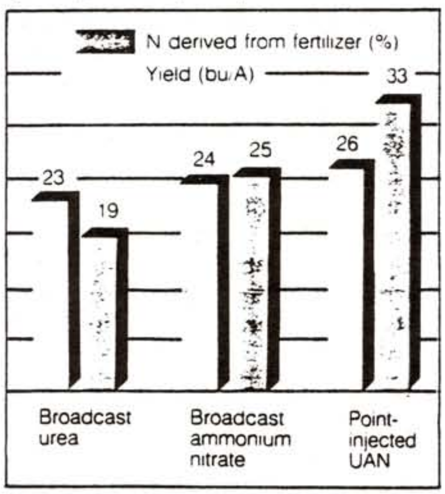

Figure 3. Effect of N source and placement on winter wheat yield and N derived from fertilizer (Janzen, et al., Southern Alberta, 1985-87).

recovery of spoke-injected or "nested" UAN is 16 inches by 16 inches by 4 inches deep.

Point injection fertilizer application (PIFA) is probably the most widely researched new fertilizer application technique at the present time. The system is proved in the application of clear liquids and is being tested for application of suspension fertilizers. It is well-suited to most crop production systems. As the vehicle of precision placement of fluids, coupled with minimal soil/residue disturbance, its use makes agronomic, environmental and economic sense.

The spoke wheel injector is tractor-pulled and feeds fluid fertilizer into a ported axle and out its spokes and into the soil as the wheel rotates. At a forward speed of 5 to 6 mph, a spoke wheel may use only a third of the power required for a knife injection system. Spoke wheels also overcome any deleterious effects of root pruning associated with post-emergent knife applications. Despite these advantages, per row costs and durability of wheels must be resolved prior to widespread adoption of the spoke wheel.

Probe-type injector also shows promise

An experimental single probe-type fluid fertilizer injector, agronomically similar to the spoke wheel injector, has been developed by FFF researchers Tompkins and Womac of the University of Tennessee. According to the researchers, the hydraulically driven, single-spoke injector has shown less soil disturbance than the spoke wheel during tests. Field evaluation of the prototype also has revealed that a variable injection interval of 8 to 24 inches can be achieved without significant soil disturbance. Penetration was about 2.5 inches. Also being explored is linking actuation of the probe injector with an electronic eye to ensure that fertilization occurs only where plants are detected.

Up to 6 bu/A

Knifing fluids boosts grain sorghum yield

Research by Sweeney of Kansas State University has shown the benefits of knifing NPK suspensions in grain sorghum. In a 1986 study, knifing proved superior to broadcast and dribble by 6 bushels/acre on lower PK-testing soils (Figure 4). He conducted his tests on three conservation tillage systems: reduced tillage, ridge-till and no-till.

While yield was not affected by the tillage system selected at two of the sites, in every case yield was increased (via increased kernels/heads) by the addition of NPK suspensions.

Sweeney's studies suggest that as acreage of conservation tillage increases in some areas, a fluid fertility management system may well provide an excellent option for sorghum production. As his tests show, the ability to place suspensions precisely in high residue situations will enhance nutrient availability and uptake leading to improved yield and quality.

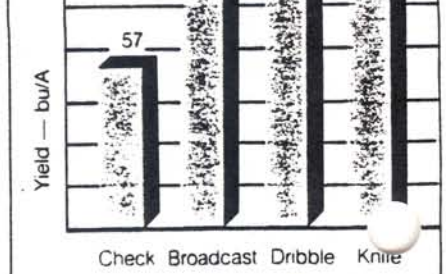

Figure 4. Effect of NPK suspension (150-100-150 lbs/A N-P_2O_5-K_2O) placement on grain sorghum yield (Sweeney, Kansas State University, 1986).

Between inorganic and organic fertilizers?

Do the plants know the difference?

Of course not. Since both inorganic and organic fertilizer sources are subject to the same soil biological transformations that convert them to the same form, plant roots do not discriminate. As far as crops are concerned, a nutrient is a nutrient. And those supplied by manures, sludge or legumes are no different from those in commercial fertilizers.

The issue of inorganic versus organic is heating up and will be sharply debated as Congress shapes the 1990 Farm Bill. Behind moves designed to move farmers away from "conventional farming" are pressure groups or lobbyists who are suggesting that synthetic fertilizers are inherently bad for the environment. This simply is not so. The notion that inorganic fertilizers are inherently bad for crops and soils has led to proposed legislation that is inconsistent with established scientific principles.

Among fertility options suggested to reduce commercial fertilizer usage are animal manures, municipal wastes and legumes, which are far from being without their problems.

Animal manures/sludge

Not enough. The catch here is most crops are grown in regions where animal manures simply aren't available in quantities to replace commercial fertilizers. For those who might suggest major increases in livestock numbers to compensate, envision just an eightfold increase in the Corn Belt alone. Land availability for essential crops would shrink. Worse still, crop production would be pushed onto marginal, unfertile and highly erodible soils. And while land availability was shrinking, feed requirements for animals would expand enormously — meaning the need for close to an *additional* million acres of corn in Iowa alone!

Transporting costly. Transporting manure of variable and low concentrated value is costly and energy inefficient, doing little to reduce variable costs. To be worthwhile, manure has to be used by farms close to feedlots or livestock farms.

Imprecise. The variable nature of manures/sludge makes it difficult to properly determine rate for crop growth and nutrient use efficiency. As we know, environmentally safe modern crop production relies on precision nutrient application via prescription mixes for optimal crop yield. Thus, manures/sludge could pose a threat to the environment as a result of runoff, leading to eutrophication of streams, potential bacterial/viral contamination, nitrate release and spread of non-nutrient elements in toxic quantities. In addition, biological processes in manure continue to release nitrate *after* crop use, adding to the potential for leaching and groundwater contamination (Table 2). Note the high level of nitrate for alfalfa. This "natural" source appears in substantially greater quantities when compared to commercial sources.

Table 2

Nitrate levels beneath corn grown at 5-foot depth, related to management (Michigan State University).

Management	Date sampled	Nitrate content soil solution mg N/liter
No N, no irrigation	August	8.4
Fertilizer N, no irrigation	July	10.0
Fertilizer N, irrigated	July	25.0
Manure N, no irrigation	July	49.0
Legume N*, no irrigation	July	62.0

*alfalfa

Legumes

Just nitrogen. While legumes fix atmospheric nitrogen into plant-usuable form, this process does not supply other essential plant nutrients, such as P and K.

Imprecise. While N supplied to the soil can be significant, this supply, like manures, cannot be fully controlled to optimize crop production and minimize environmental risks. The bulk of legume nitrogen is available only upon decay of plant residue. As shown in Table 3, losses of nitrate-N into groundwater from an unfertilized legume (e.g. soybeans) can be substantial. Note how application of fertilizer closer to the corn crop's use (spring) enhanced return and reduced losses.

Table 3

Corn and soybean yield, margin over fertilizer and nitrate-nitrogen lost through tile lines (U of Minnesota).

Crop	N rate lbs/A	Timing	Yield avg. 5 years bu/A	Value of yield less cost N ($)	Nitrate nitrogen lost through tile lines, 4 yrs lbs/A
Corn	—	—	66	165	28
Corn	120	Fall	130	301	107
Corn	120	Spring	150	351	75
Corn	180	Fall	159	362	136
Corn	180	Spring	167	382	106
Soybean	—	—	44	253	119

Rob other nutrients. Harvesting of legumes removes significant quantities of P and K, which will have to be replaced for subsequent crops.

Alter crop patterns. Increased dependence on legumes as a nitrogen source would adversely alter crop patterns. For example, putting legumes in rotation with corn would drastically reduce corn acreage. Estimates suggest that 12 million acres would be lost in the Corn Belt alone, with a resulting approximate loss of $3 billion to the farm economy!

New technology

Gelled fertilizers answer to N loss?

Could be. Research is showing that nutrients held in the interstices of a gel are less susceptible to loss, thus maintaining their availability to plants.

Essentially, gelled fertilizers are produced by gelling fertilizer solutions with a water-soluble polysaccharide to produce a viscous solution.

Nitrogen leaching, N uptake and plant yield studies by TVA, following application of gelled UAN, look promising. Applicators equipped with positive displacement pumps will allow both soil-injected and broadcast applications.

Comprehensive field testing in 1989-90 will furnish more practical, agronomic information.

ATS promising as herbicide extender

Previous reports in the *Fluid Digest* have demonstrated the influence of ammonium thiosulphate (ATS) in improving N fertilizer efficiency and crop response. The nitrification and urease inhibiting properties of ATS covered in these reports suggest that ATS slows conversion of urea and ammonium-N to nitrate-N by slowing activity of soil microbes.

As a result, Goos of North Dakota State University has expanded his work in this area to see if ATS would slow the microbial degradation of soil-applied herbicides to extend their activity and improve season-long weed control.

Figure 5 shows results of one of his greenhouse experiments. Note that after 35 days of incubation (lower bar), there is strong herbicidal control of oat shoot growth. After 49 days (upper bar), there is none. However, this changes dramatically after 0.1 ml/kg or more of ATS is added.

Various herbicides and inhibiting agents have been used in studies by Goos, but with variable results. Further work is needed to explore the effectiveness of ATS at various depths of herbicide incorporation and the effect of rainfall on ATS movement.

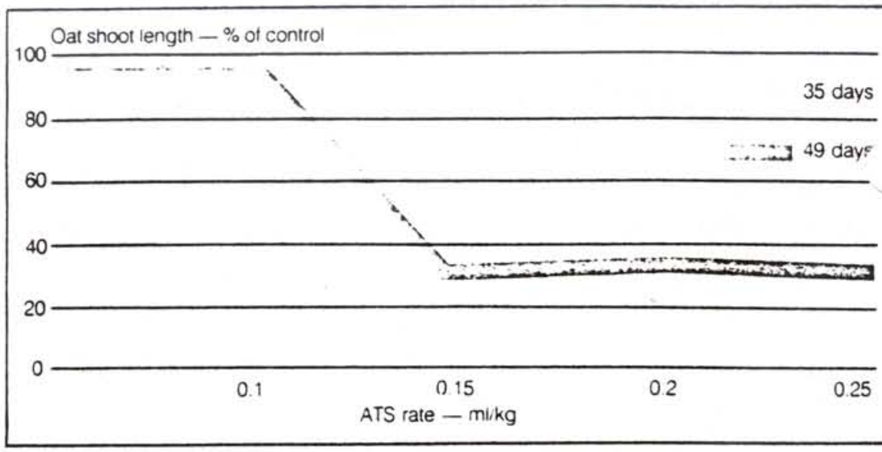

Figure 5. Shoot length as index of herbicidal activity when ATS is used at varying rates to slow decomposition of herbicides (Goos, North Dakota State University, 1988).

Fluids on corn

N alone limiting on ridge-till

In ridge-till studies during 1989 by Mainz of the University of Illinois, failure to use a complete NPKSZn starter reduced N response and corn yields by 5 to 13 bu/A (Figure 6).

UAN applications in the study were either preplant injected or split 50% feed and weed and 50% side-dress. Nitrogen rate was 170 lbs N/A.

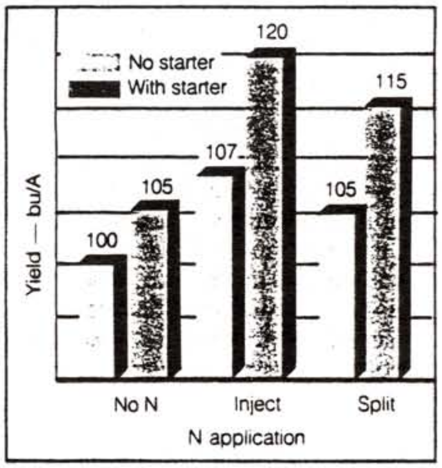

Figure 6. N response to complete fertility in ridge-till corn (Mainz, University of Illinois, 1989).

Fluid starter was 7-18-6-2-0.5 (NPKSZn) applied as a 2 by 2 placement at planting.

Maximum use of nitrogen in corn requires a well-conceived and *complete* fertility program. In the above study, complete nutrition produced yield responses to N worth between $25 and $32.50 an acre.

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