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Point Injection: Viable Option for Growers

Studies show improved field responses, minimal soil disturbance, reduced energy costs and increased fertilizer efficiency.

Summary: *Studies are showing that point injection fertilizer application (PIFA) is offering a positive, plausible application alternative for many growers. Spoke wheel, single probe, and high pressure applicators have been field tested over the past decade. Agronomic performance data for a variety of cropping regimes have been promising. Additional research is needed to expand on the agronomic relevance and benefits associated with PIEA.*

The bulk of point injection fertilizer application (PIFA) agronomic

I research has thus far concentrated on the efficiencies of nitrogen placement and split timing in corn and small grains. A variety of data suggests that agronomic benefits can be anticipated through the use of PIFA. Before reviewing these field reports, a brief explanation is in order about the types of equipment developed so far that make PIFA work.

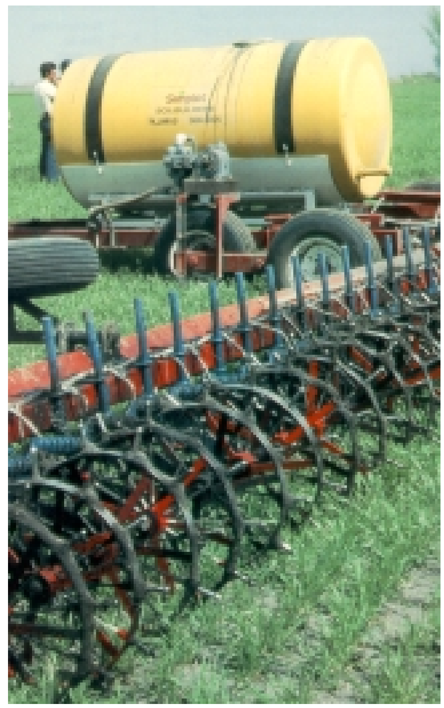
Spoke wheel

Although European and Florida prototypes probably predate it, the spoke wheel researched in FFF-sponsored studies during the mid-'80s by Baker et at. of Iowa State University is the model that stimulated much of the PIFA field studies in the Midwestern U.S. and Canadian prairies. The spoke wheel is a tractor-pulled wheel device that meters fluid fertilizer into a ported axle. Fertilizer flows from the spokes as the wheel rotates. The four to six spoke wheel units commercially available are mounted on a tool bar to accommodate variable row spacings and deliver fertilizer to the soil at eight-inch spacings to a depth of four inches. At forward speeds of 4 to 4.5 miles per hour, a spoke wheel applicator may use only one-third of the power required by certain knife injection systems.

A spoke wheel with a good track record over some 50,000 acres in the western U.S. and Canada is one designed by Pattison Bros. of Lemberg, Saskatchewan. It consists of 12 hollow stainless steel spokes that penetrate the soil as the wheel turns. Fluid fertilizer is placed ("nested") at eight-inch intervals and 3 to 4 inches below the soil surface. Fluid fertilizer, under low pressure, is supplied to each spoke through the wheel hubs. A rotary valve located in the hub meters an accurate amount of fertilizer to each spoke. Both soil penetration and wheel protection under field conditions are afforded by a spring-loaded shank. A strengthened spoke tip makes for durability and the fertilizer outlet is set below the tip to prevent plugging.

The spoke wheel has proven successful for UAN and other clear liquid applications. **I** am aware of only one spoke wheel applicator that was developed for the purpose of applying higher-nutrient-content suspension fertilizers.

Almost ten years of field evaluation have produced design refinements for available spoke wheels. Concerns related to spoke plugging, coping with heavy trash, matching forward speed and fertilizer application rates, hub integrity, durability, and maintenance costs have been largely addressed by manufacturers. Future spoke wheel models will continue to be improved commensurate with acres covered.



Single probe

Aiming for the same agronomic traits as the spoke wheel, a single probe-type fluid fertilizer injector has been developed by Tompkins and Womac in a FFF-sponsored study at the University of Tennessee. The hydraulically driven single-spoke injector enters and exits the soil as the unit moves forward. Field evaluation of the prototype has revealed that a variable injection interval of 8 to 24 inches at a depth of about 2.5 inches can be achieved without significant disturbance. Further engineering research will be necessary to increase forward speed and improve soil penetration. A potential development regarding the probe injector is the linking of actuation with an "electronic eye" to ensure that fertilizer is applied only where plants are detected.

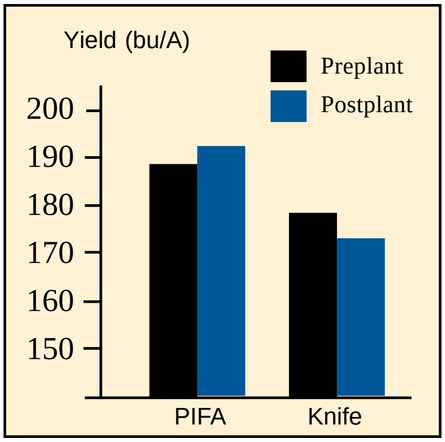


Figure 1. Effect of method and timing of N placement (156 lbs/A) on corn yield, Iowa State University.

Pulse bander

The pulse bander applicator developed by Rogers Engineering, Saskatoon, Saskatchewan, has potential to offer subsurface placement (as PIFA) with minimal soil and residue disturbance. This is of particular importance to no-till farmers of the prairies. Unlike the Nutriblast applicator (Arcadian Corporation), which injects a continuous band of fertilizer under pressure (2,000 psi), the pulse bander uses a pulsating high-velocity jet to inject fertilizer at various intervals to a depth of 3 to 4 inches. Flow volume and distances between pulses are regulated electronically and fluid fertilizer is pressurized up to 6,000 psi.

Paying dividends

Now for a look at the bottom line. Is this concept (PIFA) and the ensuing equipment that has been developed to accomplish point injection producing the desired results? Is it worth the investment? University research suggests that improved yields are afforded by the efficiencies of split timing and PIFA, sometimes even with fertilizer rate reductions.

Iowa. Figure 1 shows the results of work during the ‘80s by Baker et al. of Iowa State University on no-till corn, both preplant and postplant. UAN was injected or knifed at a N rate of 156 lbs/A. Note how PIFA compares even more favorably when applications were made postplant. With PIFA there is none of the root pruning associated with knifing when applications are made postplant.

The same series of studies on no-till corn showed how PIFA reduced N leaching, denitrification, and runoff losses when compared with surface applications (Figure 2).

Montana. FFF-sponsored work by Kushnak and Gallagher at Montana State University in 1989 showed the effect of N application method on yield of no-till winter wheat under both dry-land and irrigated conditions. Site of the study was in northern Montana. UAN was applied at rates of 60 lbs/A (dryland) and 50 lbs/A (irrigated). Band, knife and PIFA row spacing was ten inches. Application methods were knife, broadcast, band, and PIFA. Note that yield differences between methods of application were not as apparent under dryland conditions (Figure 3).

Equipment used for PIFA in both the Iowa and Montana studies was the spoke wheel.

Research reports on the use of PIFA technology beyond corn and small grains are somewhat scarce. However, encouraging results have been reported for alfalfa by Havlin et al. at Kansas State University. Blaylock et al. at the University of Wyoming have reported similarly on sugar beets. Many western dealers and growers have reported yield benefits from using the spoke wheel to fertilize grapes, orchards, melons, strawberries, raspberries, tomatoes, potatoes, and shallow-rooted vegetables. The spoke wheel is also being used to fertilize through plastic mulch.

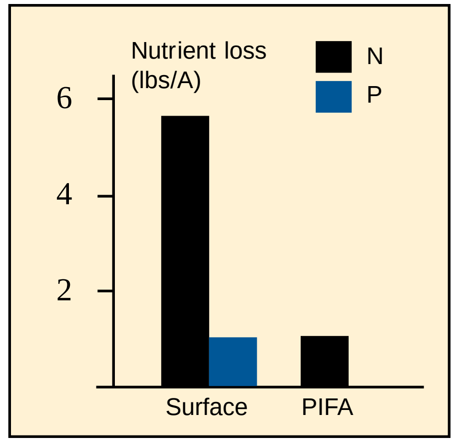


Figure 2. Effectiveness of PIFA in reducing surface runoff losses, Iowa State University.

Additional field research is needed to expand on the agronomic relevance and benefits associated with PIFA for a variety of western crops. Those crops more suited to PIFA include row crops and others likely to respond to postplanting placement but liable to damage and moisture loss following knife applications. Some interest in PIFA has been expressed by sod growers and amenity turf specialists.

Fluids spur technology

To a large extent, the physical characteristics of a fertilizer material will determine application efficacy. Despite tremendous advances in dry fertilizer placement and broadcast technology, the simple ability to pump

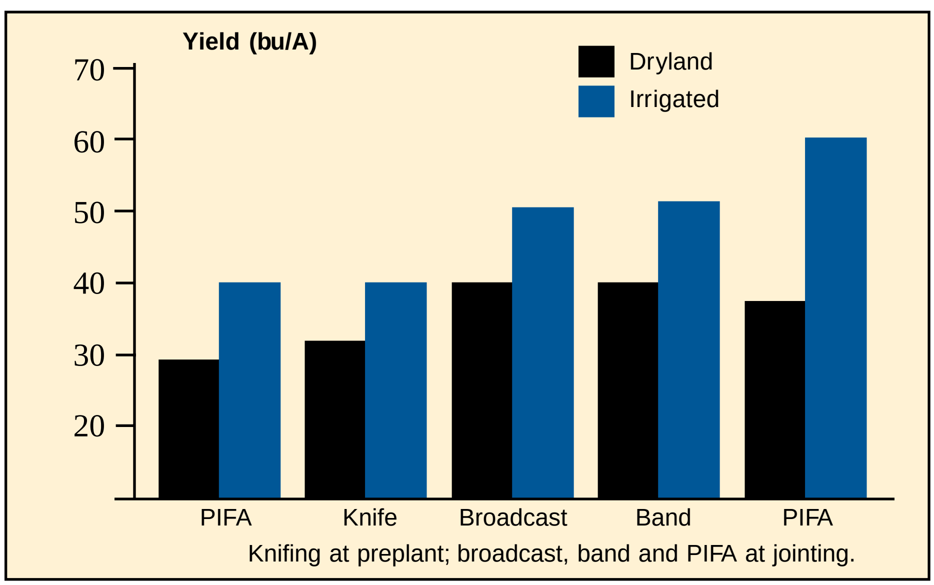


Figure 3. Effect of nitrogen application method on yield of no-till winter wheat in northern Montana, Kushnak & Gallagher, Montana State University, 1989

and accurately meter homogeneous nutrient solutions means that many new and developing application technologies must involve fluid fertilizers.

PIFA has enjoyed engineering and field research in both Europe and North America over the past 10 to 15 years. Agronomic performance data remain encouraging, particularly as more crops over a wider geographic and climatic range are tested. It is the integration of modern crop agronomy with substantial advances in engineering, material, and computer sciences, however, which still makes fertilizer application a dynamic research area.

Future

Currently available PIFA technology focuses on the spoke wheel and will likely continue to do so. Ongoing field experience can only enhance spoke wheel engineering, durability, economics, and agronomics. Studies of crops other than those mentioned in this article will need to evaluate the economic and environmental benefits of PIFA, along with the other placement options such as the pressure injector/thin profile coulter combinations.

Irrespective of fertilizer form, application technology must keep pace with agronomic advances and must also meet the following three criteria: 1) it works, 2) it is durable, and 3) it is not cost prohibitive to the grower.

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