Fertilizer Application with No-till Small Grain Seeding Equipment

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Abstract

Several innovative fertilizer application equipment designs have been developed by short line equipment manufacturers for no-till grain drills. The units allow anhydrous application at seeding time offering a new management alternative with potential for reduced production costs. Precise seed-fertilizer placement achieved with these units plus design simplicity make them attractive for adoption in both row crop and small grain seedings in other production areas.

Equipment Objectives

No-till seeding equipment has progressed through a series of design changes in efforts to seed and fertilize as a single pass operation. Need for a single pass operation lies in the inconvenience or incompatibility of other fertilization techniques.

Criteria strived for as design changes have progressed are as follows:

a) Minimal residue disturbance - Fringe area winter wheat production in the northern plains require upright residues to trap and hold a protective snow blanket for both over winter survival and added stored moisture.

b) Minimal seedbed disturbance - Conditions for rapid germination are difficult to establish and maintain in no-till seedbeds. Ideally, fertilizer equipment should assist preparation rather than disturb no-till seedbeds.

c) Maximize trash flow through seeding equipment - Trash plugging in heavy residues is intolerable in any no-till seeding unit design. Fertilizer equipment should compliment features designed to streamline trash flow through equipment.

d) Ammonia application at seeding - Production economics dictate using least cost plant food sources. Anhydrous ammonia applied prior to seeding dries the seedbed unevenly and reduces standing residues essential with winter wheat seedings.

e) Precise seed - fertilizer placement - Germination damage and agronomic needs for maximizing small grain seedling nutrient uptake have intensified efforts for better seed - fertilizer placement equipment. High nitrogen application rates dictate seed-fertilizer separation.

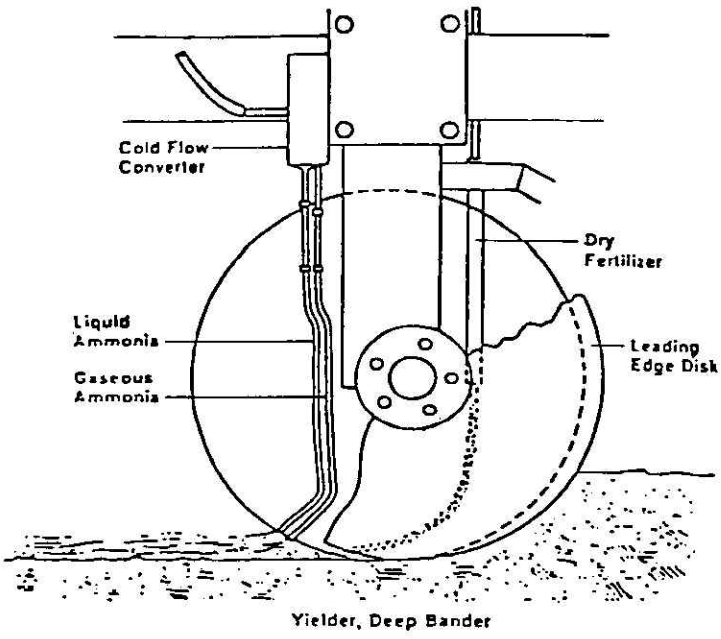
Fertilizer Placement Designs and Evaluation

It is important to recognize tillage management programs are equipment oriented and switch to a new production technique normally involves equipment purchases. Further, adoption of new technology, developed through public fund research, often lags until suitable equipment is available for its implimentation.

In recent years ideas for new field equipment design throughout the Great Plains have come from innovative growers and shortline equipment manufacturers. Little equipment design has been done by public funded institutions and major equipment manufacturers. As a result, most designs are for specific needs and have limited soil condition or geographic area application. This has been true for no-till grain drill designs and their fertilizer application equipment. However, local popularity has lead to market expansion and equipment modification to meet a broader spectrum of soil and seeding conditions.

Disk openers

The Yielder[1/], deep bander design (Figure 1) introduced the first no-till grain drill suitable for anhydrous ammonia application. The deep bander is a conventional yielder seeding unit equipped with a Cold Flo[2/] kit to chill ammonia maintaining it as a liquid until released at the bottom of the disk opener slit. The unit also accommodates simultaneous application of dry granular products.



Yielder, Deep Bander

Fig. 1.

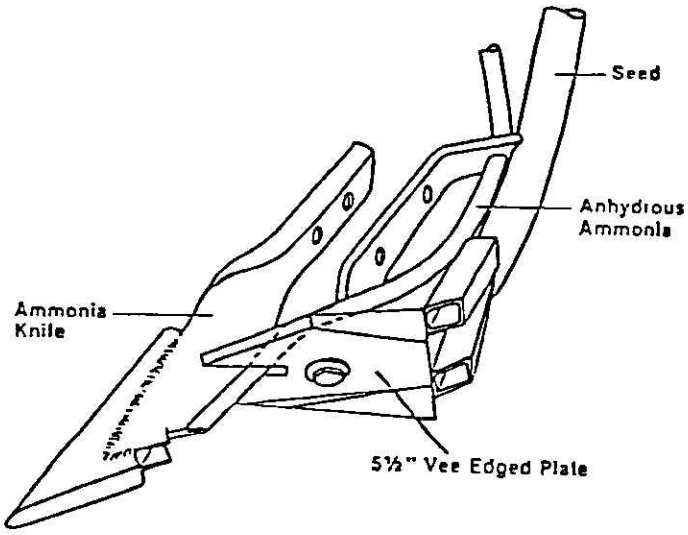


Fig. 2.

1/ Trade names are used solely to provide specific information. Mention of a trade name does not constitute a guarantee or endorsement by North Dakota State University or the U.S. Department of Agriculture.

2/ Ibid.

The deep bander unit is mounted ahead of two seeding units on the same bar. Current drill design mounts bars on 20" centers. Thus fertilizers are applied in rows on 20" centers. Seed-fertilizer spacings are ridgedly controlled by front to rear seeding units mounted on the same bar. Settings on each unit adjust relative operating depths. A hydraulic system controls running depths.

The deep bander followed by two seeding units has given rise to the paired row seeding concept, a system of fertilizer application between two narrow spaced rows with a wide space to the next paired row. Width of paired row and inter row spacings can vary within limits available for 20" fertilizer application centers.

The wide inter row space provides better trash flow in heavy residues. Also, seeding units moved close to the deep band trench have the advantage of operating in soil partially disturbed by the fertilizer application unit.

Shank openers

Haybuster, Inc.[3], Jamestown, North Dakota, introduced the concept of anhydrous ammonia and seed application on the same shank. The original hoe drill design applied ammonia directly below the seed using a horizontal plate to crush the ammonia trench side walls and firm the soil over the trench for a seed bed. A modification of this design concept by Ace Services[4], Colby, Kansas forms two small vee shaped seedbeds in disturbed soil on either side of the ammonia trench (Figure 2). This design duplicates the paired row configuration with narrow seed rows on either side of the fertilizer application trench. Phosphorus can be applied either in the trench or down the drop tube with seed in the seed rows. With a twisted shank, the unit mounts readily on chisel plows or field cultivators using air delivery seeding systems.

Seed-fertilizer placement spacing is fixed with the equipment design but is maintained precisely since both seed and fertilizer are applied on the same shank. In current designs, ammonia is applied 5 1/2 inches deep between 5 1/2 inch row spacings.

Seed and fertilizer on the same shank eliminates extra fertilizer shanks on the drill both reducing cost and improving trash flow through the unit. Seedbed moisture retention is excellent through use of a packer wheel and the fact soil disturbance which promotes drying is minimized.

Air seeders

The Vern knife[5] manufactured in Champion, Alberta, is an adaptation prompted by need for equipment to apply anhydrous ammonia at seeding with air seeders using cultivator sweeps as a seeding shoe (Figure 3). The air seeder uses a chisel plow or field cultivator as its basic seeding unit

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3/, 4/, 5/ Ibid.

and high volume low pressure air for seed delivery. Improved seed covering depth is obtained when seed is delivered beneath the wings of cultivator sweeps.

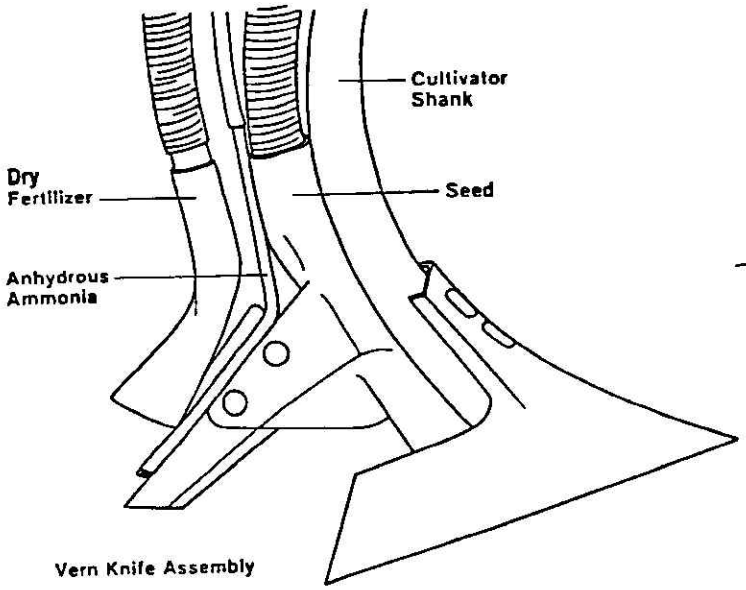

Fig. 3.

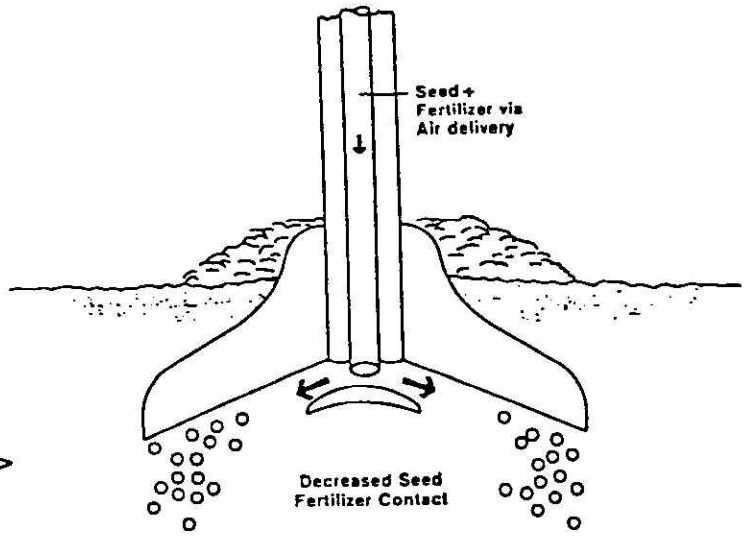

Fig. 4.

The design effectively separates seed and fertilizer in a fixed configuration with two rows of seed 5 to 7 inches apart on either side of the fertilizer band.

A similar, competing design, has a different ammonia tool mounting adaptable for both small grains and row crop seedings.

Air seeders are used in both no-till and conventional till seedings. The Vern knife performs especially well in prepared seedbeds with mellow free flowing surface soils. Cultivator sweep size and operating speeds determine the degree of weed control tillage achieved during seeding operations.

Fertilizer placement evaluations

Application of urea fertilizers to the soil surface with residues present is of concern because of the potential for nitrogen loss as ammonia. Recent research (3) has shown high urease activity in this environment with increased potential for ammonia loss. Since the potential for loss exists, one solution is to apply the fertilizer beneath surface residues. Equipment with this capability has been largely developed to provide subsurface fertilizer application in conjunction with seeding. The importance of properly designed equipment cannot be over emphasized.

Two North Dakota field studies evaluate no-till fertilizer placement. In Table 1 Deibert and his co-workers (1) evaluate results of a 4-year study on deep band vs. surface band placement of urea-ammonium nitrate on three tillage treatments. Placement treatments were in a band applied 4" deep in 12" spacings or dribbled on the surface band at the same spacing.

Table 1. Spring Wheat Yields* as Influenced by Tillage System and Fertilizer Placement - Minot, ND (1981-84).

Fertilizer Placement	No-till	Plow	Sweep	Avg.
	----------Bu/A----------			
Surface band	36.4	39.2	36.4	37.4
Deep band	38.7	41.8	38.6	39.7
Avg.	37.6	40.5	37.6	

*Sawfly damage in 1982 on no-till and sweep treatments.

Although the data suggest a trend toward increased yields with plowing and deep placement, the differences are not statistically significant. Sawfly damage to sweep and no-till plots in 1982 reduced yields. When this crop year is excluded, yield differences in Table 1 diminish further.

A great deal of speculation surrounds nitrogen loss from surface applications. Nitrogen uptake trends from the study, Table 2, like yield trends were not statistically significant. In the spring wheat production area 2.4-2.6 lbs of nitrogen needs to be available to the crop for each bushel of yield anticipated. Conclusions from the study are that well managed surface applications can be as effective as deep banding.

Table 2. Spring wheat nitrogen uptake* as influenced by tillage system and fertilizer placement - Minot, ND (1981-84).

Fertilizer Placement	No-till	Plow	Sweep	Avg.
	----------lbs/A----------			
Surface band	50	56	52	52
Deep band	52	58	54	56
Avg.	51	57	53	

*Sawfly damage in 1982 on no-till and sweep treatments.

Using air seeders, with cultivator sweeps as a seeding-fertilizer shoe, opportunity exists to increase band widths and decrease seed fertilizer contact (Figure 4). Using double disk openers on 6" spacings in a high moisture spring grain seedbed 30 lbs/A nitrogen applied with the seed is a practical upper limit. Table 3 reports results of a study by Deibert and his co-workers (2) where the seed-fertilizer contact band varied from 1 to 12 inches.

In this study yield decline did not occur in spring wheat seedings until about 35% stand loss occurred. The data demonstrates feasibility for application of all the nitrogen needed to grow a crop across much of the low rainfall production spring grain production area, at seeding time, by equipping an air seeder with the proper seeding shoe.

Table 3. Stand loss with air seeder dry fertilizer-seed placement.

Seed-Fertilizer Spread Pattern	Nitrogen Rate (lb/A)		
	0	40	80
	-Relative stand count (%)-		
Urea			
12"	100	85	70
6"	100	70	50
1"	100	25	5
Ammonium nitrate			
12"	100	97	97
6"	100	90	85
1"	100	80	65

Winter wheat research at the Central Great Plains Research Station, Akron, Colorado has shown results similar to those found in North Dakota (Table 4). There was a definite advantage to wide seed-to-fertilizer

Table 4. Effect of fertilizer source, rate, and application method on winter wheat yields, Akron, Colorado.

Phosphorus Source	Nitrogen Source	Nitrogen Balance Added	Total Fertilizer Rate		Grain Yield		
			N	P_2O_5	BS[1]	CS[2]	DR[3]
		lbs/A	lbs/A		-------bu/A------		
Check	--	--	-	-	22	36	21
UP	UAN	34	45	30	27	31	29
UP	UAN	79	90	30	13	18	38
MAP	UAN	39	45	30	30	23	--
MAP	UAN	84	90	30	45	30	--
DAP	UAN	33	45	30	31	10	--
DAP	UAN	78	90	30	11	15	--
UUP[4]	-	--	45	30	40	38	31
UUP	-	--	90	30	14	35	33
UP	NH_3	34	45	30	31	--	--
UP	NH_3	79	90	30	18	--	--
MAP	NH_3	39	45	30	47	--	--
MAP	NH_3	84	90	30	33	--	--
DAP	NH_3	33	45	30	6	--	--
DAP	NH_3	78	90	30	1	--	--

1/ Blade seeder, liquid fertilizer applied 2 inches to the side of seed, dry with the seed, NH applied 5 inches to the side of seed.

2/ Chisel opener for seeding with liquid appied 3/4 inch directly below the seed and dry applied with the seed, NH application capabilities not available.

3/ Deep banded fertilizer 1.5 inches to the side and 2 inches below the seed.

4/ Experimental fertilizer from TVA.

separation distance when 90 lbs of N per acre was used regardless of fertilizer source or configuration distance. Source of fertilizer was also important with diammonium phosphate (DAP) in conjunction with either urea ammonium nitrate (UAN) or anhydrous ammonia (NH_3) resulting in greater yield decreases than monammonium phosphate (MAP) or urea phosphate (UP). The importance of separating seed from an ammonia source was evident when DAP was placed with the seed. These results emphasize the importance of equipment that can provide proper fertilizer placement for small grain production.

References

1. E. J. Deibert, B. K. Hoag and R. J. Goos. Nitrogen Fertilizer Placement on No-till and Conventional Systems with Continuous Wheat Fertilizer Issues. Vol. 2, #2, pp. 105-110, 1985.

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3. Goos, R. J. Effect of Assay Conditions and Field Exposure on Urease Activity Associated with Cereal Residues. Commun. in Soil Sci. Plant Anal. (16):399-409, 1985.