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Effect of Placement and Timing of Nitrogen Fertilizer Sources on Efficiency of Nitrogen Use by Durum Wheat and Canola Under Reduced and Conventional Tillage Systems

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Abstract

Efficient fertilizer management is necessary to optimize the economics of production and to avoid excess nutrient carry-over in the soil, with the resultant potential for environmental damage. Results from the first two years of a four year field study conducted on two soil types to evaluate the effect of nitrogen source, timing and placement on canola and durum, under conventional and reduced tillage systems indicated that yield tended be higher under conventional tillage than zero tillage, and was influenced by source, timing and placement of fertilizer N. Initial effects on stand density and weed populations were also determined. Information on nitrogen use efficiency, crop quality and nutrient composition, soil quality and nitrate carry-over with depth will also be assessed over the four years of the study.

Background

Efficient fertilizer management is critical, not only in ensuring economic viability in crop production, but also in maintaining long-term environmental quality and sustainability of the soil resource. Efficient applications of fertilizers which are in balance with the nutrient requirements for crop production contribute to maintenance or improvement in soil quality, by increasing residue cover and return of organic matter to the soil. This aids in reducing erosion and in maintaining organic matter levels within the soil (Campbell et al. 1990). The increased organic residues produced with proper fertilizer management act as nutrient reserves for enhanced biomass production. Nitrogen fertilizer, when used as recommended by soil testing, has been shown to reduce nitrate leaching by encouraging effective root development and crop utilization of N from the soil profile (Campbell et al. 1990). However, excessive N fertilization or the use of ineffective fertilizer application techniques are not only economically inefficient, they can also create environmental problems, by nitrate leaching into the groundwater or emission of nitrous oxide, nitric oxide or ammonia to the atmosphere.

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Efficient fertilizer management considers four major factors:

11) Rate of application
2) Timing of application
3) Placement of fertilizer
4) Source of fertilizer

Optimum rate, timing, placement and source of fertilizer nutrients is influenced greatly by the soil type, climatic conditions, tillage systems and type of crop grown. Other management considerations specific to the particular farming unit, such as equipment availability, time and labour constraints through the growing season, and taxation and cash flow situation may also strongly impact on a producer's fertilizer management decisions. Therefore, it is important for a farm manager to have comparative information on a range of application techniques and fertilizer sources under varying soil, climatic and management situations, in order to select the fertilizer management package best suited to his particular situation.

Objectives

This study was designed to evaluate the effect of nitrogen fertilizer source, placement and timing under reduced (ZT) and conventional tillage (CT) systems on:

1) Seed yield and quality of durum wheat and canola
2) Nutrient accumulation and efficiency of fertilizer use
3) Soil quality, as indicated by bulk density, penetration resistance, soil pH, and nitrate accumulation in the profile
4) Weed density and distribution

Materials and Methods

The study was conducted on two Chernozemic soils in the Black Soil Zone of the Canadian prairies, a fine sandy loam and a clay loam. Both soils were calcareous and both tested low in available N and P. Field experiments were initiated in the spring of 1992, with spring-applied fertilizer treatments. In the fall of 1992, fall fertilizer applications were added to the experiment for the 1993 growing season. These treatments were applied on extra plots which had received spring banded UAN, urea and NH_3.

The fertilizer treatments were as follows:

Fall Applications

1. Anhydrous ammonia (NH_3), banded; P seed-placed
2. Urea ammonium nitrate (UAN), banded; P seed-placed
3. Urea, banded; P seed-placed

Spring Applications

4. Anhydrous ammonia, banded; P seed-placed
5. Urea ammonium nitrate, banded; P seed-placed
6. Urea, banded; P seed-placed
7. Urea ammonium nitrate, dual banded

8. Urea, dual banded
9. Urea ammonium nitrate, spoke application; P seed-placed
10. Urea ammonium nitrate, dribble band; P seed-placed
11. Urea, dribble band; P seed-placed
12. Ammonium nitrate (AN), dribble banded; P seed-placed
13. Ammonium nitrate, broadcast; P seed-placed
14. Urea, broadcast; P seed-placed
15. Control - no N, no P
16. Control - no N, P seed-placed
17. Control - no N, P banded
18. Control - no N, no P, banding action

Nitrogen was applied at 55 lbs per acre, a rate chosen to provide a reasonable crop, yet allow differences in efficiency of fertilizer use among treatments to be measurable. Phosphorus, as monoammonium phosphate, was applied at 27 lbs P_2O_5 per acre, in a band 3/4 inch to the side and 1.5 inch below the seed. An overall application of 50 lbs per acre of S and elemental sulphur was applied in April in each year, to prevent S deficiencies. Pre-seed band urea ammonium nitrate and urea were applied at the three- to four-inch depth using a 7-foot plot seeder with 0.5 inch points on 8 inch spacing, equipped with both a dry fertilizer box and fluid dispensing apparatus. The anhydrous ammonia was applied at the three- to four-inch depth with a 7 foot cultivator with 1 inch points on 8 inch spacing. Fall bands were applied in mid-October, after the soil temperature had dropped below 10 C. Spring bands were applied the day before seeding. Broadcast applications were broadcast by hand immediately prior to seeding. Surface dribble bands were applied through the drill the day after seeding, by raising the openers out of the ground and dribbling the fertilizer on the soil surface. Spoke wheel applications were applied the day after seeding, using a Pattison Brothers spoke applicator, which nested the fertilizer at 8 inch spacings.

No tillage operations were conducted on the zero till plots, but the stubble was mowed with a gyro-mower simulate the effects of a straw chopper. The conventional tillage treatments received two passes in the fall and one pass in the spring with a cultivator equipped with tine harrows.

The crops grown were Legend canola (*Brassica napus*) and Sceptre durum wheat (*Triticum durum*). Seeding occurred in late April to mid-May, with a 7 foot plot seeder equipped with 0.5 inch hoe-type openers. Canola was seeded to a depth of 0.5 inch at 6 lbs per acre, while the durum was seeded to a depth of 1.0 inch at 95 lb per acre.

A fall treatment of glyphosate was applied to control quackgrass and winter annual weeds. A treatment of glyphosate was also applied in 1992, immediately after seeding and the day before spring fertilizer banding in 1993. Weed control in the canola was accomplished with applications of Poast (1.54 litres per acre), Muster (0.01 lb per acre) and Lontrel (0.60 litre per acre) in 1992 on both sites, Poast in 1993 on the fine sandy loam and Poast and Lontrel in 1993 on the clay loam soil. Canola was dessicated prior to harvest with Reglone at 0.8 litres per acre on both sites in both years. In the durum, weeds were controlled with Achieve (0.9 lb per acre) and Buctril M (0.405 litres per acre) in 1992 and with Stampede CM (1.11 litres per acre) in 1993. Herbicide rotation was practices to slow the build up of herbicide resistance. Weed counts were taken immediately after herbicide application.

Temperature and rainfall data were collected throughout the growing season, using an automated weather station. Stand counts were taken on selected treatments in the durum and canola in mid-June. Mid-season samples collected at heading for the durum and at full flowering for the canola were dried, weighed and analyzed for N, P, Zn and Cd. Plots were harvested at late August to mid-September using a Wintersteiger plot combine, yield of seed and straw were measured and samples were submitted to the laboratory for analysis of N, P, Zn and Cd content. Laboratory analysis of the samples is in progress.

Experimental design was a split plot with four replicate for each crop species and location, for a total of 576 plots. Tillage treatments were the main plots and fertilizer treatments the sub-plots. Statistical analysis was conducted using contrast analysis with the GLM procedure of SAS (Statistical Analysis Systems Institute 1985).

Results

Canola Seed Yield

Clay loam: An early killing frost on August 28, 1992 reduced the final seed yield of canola. Seed yield of canola increased with N application in both years under both tillage systems on the clay loam soil (Table 1 and 2). Seed yield was higher under conventional tillage than no-till in 1992, possibly due to the cool and somewhat moist spring conditions, but differences were not significant in 1993. There was no tillage by treatment interaction observed on the clay loam soil (Table 3), indicating that response to fertilizer management was similar under the two tillage systems.

In 1992, surface dribble applications generally produced lower seed yields than did in-soil band or broadcast applications. Surface applications of ammonium nitrate tended to produce higher seed yields than surface applications of urea on the ZT but not CT, although the difference was only significant in 1992. In 1992, under ZT, the spoke wheel application produced higher yields than did the spring in-soil band.

Table 1: Canola seed yield (bu/acre) as a function of fertilizer source, placement and time of application on a Newdale Clay Loam soil.

Treatment	Conventional Till			Zero Till		
	1992	1993	Mean	1992	1993	Mean
NH_3 Fall Band (PS)	.	20.2	20.2	.	30.4	30.4
UAN Fall Band (PS)	.	28.5	28.5	.	24.5	24.5
Urea Fall Band (PS)	.	23.5	23.5	.	27.2	27.2
NH_3 Spring Band (PS)	25.6	30.9	28.3	22.9	28.8	25.9
UAN Spring Band (PS)	25.2	30.1	27.7	17.6	26.2	21.9
Urea Spring Band (PS)	23.9	32.9	28.4	18.4	23.6	21.0
UAN Dual Band	27.4	24.0	25.7	22.7	21.0	21.9
Urea Dual Band	22.0	27.9	25.0	17.4	27.0	22.2
UAN Spoke (PS)	26.3	27.5	26.9	24.3	24.0	24.2
UAN Dribble (PS)	22.2	28.1	25.2	20.4	26.0	23.2
Urea Dribble (PS)	18.4	30.3	24.4	17.1	22.3	19.7
A.N. Dribble (PS)	18.7	24.4	21.6	21.1	26.2	23.7
A.N. Broadcast (PS)	25.9	29.0	27.5	22.2	26.8	24.5
Urea Broadcast (PS)	25.4	28.4	26.9	21.8	21.1	21.5
No N, No P	21.8	21.4	21.6	15.5	17.0	16.3
No N, P Seed-placed	19.2	18.3	18.8	17.4	19.3	18.4
No N, P Banded	20.4	18.4	19.4	15.9	17.4	16.7
No N, No P, Band	18.6	16.3	17.5	16.2	13.2	14.7
Mean	22.7	25.6	24.3	19.4	23.4	22.16

Under ZT, spring banded NH_3 was consistently higher yielding than spring banded urea or UAN, with differences significant except for the UAN comparison in 1993. Under conventional tillage, spring banded NH_3 was not superior to spring banded UAN or urea. Under CT, fall banded NH_3 produced lower seed yield than fall banded UAN, while under ZT, the converse was true. The canola on the NH_3 fall band was less mature than that on the UAN fall band in the CT treatment, due to higher N availability and may have been damaged by early light frosts that occurred in 1993. Under ZT, the difference in maturity was not as apparent and differential injury did not play a role in final yield.

Table 2. F-values for contrast analysis of effects of fertilizer source, timing and placement on yield of canola on a Newdale Clay Loam Soil.

Contrast	Conventional Till		Zero Till	
	1992	1993	1992	1993
Band vs. surface N	0.0142	ns	ns	ns
Urea vs. UAN	ns	ns	ns	ns
Broadcast vs. Dribble	0.0001	ns	0.0360	ns
No N vs. N	0.0152	0.0009	0.0002	0.0002
Am.N vs. Urea, Surface	ns	ns	ns	0.0311
P seed vs. P dual	ns	0.0897	ns	ns
NH_3 vs. Urea, Spring	ns	ns	0.0208	0.0979
NH_3 vs. UAN, Spring	ns	ns	0.0067	ns
NH_3 vs. UAN, Fall	.	0.0722	.	0.0618
NH_3 vs. urea, Fall	.	ns	.	ns
Urea vs. UAN, Fall	.	ns	.	ns
UAN Band vs. Spoke	ns	ns	0.0018	ns
UAN in soil vs Dribble	0.0911	ns	ns	ns
Banding effect - no N	ns	ns	ns	ns
P vs. no P check	ns	ns	ns	ns
C.V.	14.8	25.3	13.7	18.4

<u>Fine sandy loam:</u> Seed yield of canola increased with N application in 1993, but not 1992 under both tillage systems on the fine sandy loam soil (Table 3 and 5). The lack of response to N in 1992 relates to the high variability observed in 1992, relating to seedling emergence problems and the early fall frost. As on the clay loam soil, seed yield was higher under conventional tillage than no-till in 1992, possibly due to the cool and somewhat moist spring conditions, but differences were not significant in 1993 (Tables 3 and 4).

There was a tillage by treatment interaction observed in 1993, indicating that response to fertilizer management differed under the two tillage systems.

Table 3: P-values for significance of effects of tillage and tillage by treatment interactions for grain yield of canola and durum on a Newdale Clay Loam and Marringhurst Fine Sandy Loam in 1992 and 1993.

Source of Variation	Clay Loam		Fine Sandy Loam	
	1992	1993	1992	1993
Canola				
Tillage	0.0456	ns	0.0353	ns
MSE (tillage)	284818	368082	603320	87850
Tillage x Treatment	ns	ns	ns	0.0237
MSE-(Till x Treat)	20913	66816	88466	24073
Durum				
Tillage	0.0894	ns	ns	ns
MSE (tillage)	1070822	147923	230522	1462335
Tillage x Treatment	0.0216	0.0508	ns	ns
MSE-(Till x Treat)	23190	9594	193224	14619

Due to the problems with seedling emergence and early fall frost in 1992, treatment differences can not be accepted at face value and will not be discussed.

In 1993, under CT, dribble banded applications of ammonium nitrate and urea produced higher yields than broadcast applications (Tables 4 and 5). In 1993, under ZT, banded applications produced higher yields than did surface applications of N. Spring in-soil banded applications of UAN produced higher seed yields than did surface dribble applications.

Seed yields of fall-banded nitrogen decreased in the order NH_3 > urea > UAN, while with spring band application, NH_3 produced slightly higher yields than UAN.

Table 4: Canola seed yield (bu/acre) as a function of fertilizer source, placement and time of application on a Marringhurst Fine Sandy Loam soil.

Treatment	Conventional Till			Zero Till		
	1992	1993	Mean	1992	1993	Mean
NH_3 Fall Band (PS)	.	29.2	29.2	.	35.7	35.7
UAN Fall Band (PS)	.	25.5	25.5	.	21.7	21.7
Urea Fall Band (PS)	.	28.2	28.2	.	29.3	29.3
NH_3 Spring Band (PS)	26.9	31.6	29.3	19.9	31.8	25.8
UAN Spring Band (PS)	25.3	28.3	26.8	14.5	28.4	21.5
Urea Spring Band (PS)	23.7	29.4	26.6	19.6	29.6	24.6
UAN Dual Band	33.0	31.7	32.4	27.3	25.6	26.4
Urea Dual Band	30.8	27.7	29.2	27.6	24.8	26.2
UAN Spoke (PS)	25.2	29.3	27.2	19.4	28.1	23.8
UAN Dribble (PS)	28.6	28.0	28.3	29.6	24.2	26.9
Urea Dribble (PS)	14.8	29.9	22.3	14.0	26.3	20.2
A.N. Dribble (PS)	26.6	28.5	27.5	25.5	26.7	26.1
A.N. Broadcast (PS)	25.7	26.7	26.2	27.4	28.8	28.1
Urea Broadcast (PS)	27.8	23.6	25.7	25.2	26.8	26.0
No N, No P	23.5	16.7	20.1	23.3	12.4	17.9
No N, P Seed-placed	20.8	15.5	18.2	25.0	14.3	19.6
No N, P Banded	21.0	17.8	19.4	23.3	13.1	18.2
No N, No P, Band	25.7	13.7	19.7	24.9	15.1	20.0
Mean	25.9	25.6	25.8	22.4	24.6	23.5

Table 5: F-values for contrast analysis of effects of fertilizer source, timing and placement on yield of canola on a Marringhurst Fine Sandy Loam soil.

Contrast	Conventional Till		Zero Till	
	1992	1993	1992	1993
Band vs. surface N	ns	ns	ns	0.0078
Urea vs. UAN	ns	ns	0.0175	ns
Broadcast vs. Dribble	0.0653	0.0354	0.0560	ns
No N vs. N	ns	0.0001	ns	0.0001
Am.N vs. Urea, Surface	ns	ns	0.0461	ns
P seed vs. P dual	0.0277	ns	0.0031	0.0077
NH_3 vs. Urea, Spring	ns	ns	ns	ns
NH_3 vs. UAN, Spring	ns	ns	ns	0.0899
NH_3 vs. UAN, Fall	.	ns	.	0.0001
NH_3 vs. urea, Fall	.	ns	.	0.0018
Urea vs. UAN, Fall	.	ns	.	0.0003
UAN Band vs. Spoke	ns	ns	ns	ns
UAN in soil vs Dribble	ns	ns	0.0088	0.0186
Banding effect - no N	ns	ns	ns	ns
P vs. no P check	ns	ns	ns	ns
C.V.	21.5	14.4	29.8	11.2

Durum Wheat

Clay loam: Grain yield of durum increased with N application in both years under both tillage systems on the clay loam soil (Tables 6 and 7). As with canola, grain yield was higher under conventional tillage than no-till in 1992, possibly due to the cool and somewhat moist spring conditions, but differences were not significant in 1993. A tillage by treatment interaction was observed on the clay loam soil (Table 3), indicating that response to fertilizer management differed under the two tillage systems.

Table 6: Durum grain yield (bu/acre) as a function of fertilizer source, placement and time of application on a Newdale Clay Loam soil.

Treatment	Conventional Till			Zero Till		
	1992	1993	Mean	1992	1993	Mean
NH_3 Fall Band (PS)	.	39.0	39.0	.	40.3	40.3
UAN Fall Band (PS)	.	38.3	38.3	.	35.8	35.8
Urea Fall Band (PS)	.	39.8	39.8	.	38.8	38.8
NH_3 Spring Band (PS)	35.0	40.7	37.8	33.7	31.5	32.6
UAN Spring Band (PS)	38.4	40.3	39.3	29.8	35.5	32.6
Urea Spring Band (PS)	37.2	41.1	39.2	35.7	34.7	35.2
UAN Dual Band	34.4	38.3	36.3	33.4	36.2	34.8
Urea Dual Band	40.5	37.0	38.8	34.9	36.4	35.7
UAN Spoke (PS)	38.1	38.4	38.3	33.4	36.9	35.1
UAN Dribble (PS)	37.5	39.4	38.5	31.5	37.3	34.4
Urea Dribble (PS)	37.7	39.2	38.4	35.8	29.1	32.5
A.N. Dribble (PS)	38.1	33.4	35.7	38.5	31.1	34.8
A.N. Broadcast (PS)	36.1	36.5	36.4	28.8	38.3	33.6
Urea Broadcast (PS)	38.2	38.2	38.2	30.9	35.4	33.2
No N, No P	28.3	25.6	27.0	26.1	21.7	23.9
No N, P Seed-placed	32.6	25.6	29.1	29.5	27.7	28.6
No N, P Banded	35.8	28.6	32.2	24.8	24.4	24.6
No N, No P, Band	26.1	22.8	24.4	22.9	21.4	22.2
Mean	36.0	36.0	36.0	31.6	33.3	32.5

Durum grain yield increased with application of monoammonium phosphate on both the CT and ZT in both years (Tables 6 and 7). On the ZT in 1992, grain yield was higher when ammonium nitrate and urea were dribble banded as compared to broadcast, while in 1993 the reverse was true, due mainly to higher yields with broadcast as compared to dribble banded ammonium nitrate. Also on the ZT in 1992, the UAN spring band tended to be slightly lower yielding than the spoke wheel application.

On the CT in 1993, urea produced higher grain yields than ammonium nitrate when surface applied, either as a broadcast or a band. This is contrary to the normal result and may just be an anomaly. Grain yield was slightly higher under CT when the P was applied at the time of seeding as compared to dual banded with the N. On the ZT in 1993, the ammonia spring band produced lower yields than both the UAN and the urea, while in 1992, NH_3 spring band produced slightly higher yields than the UAN. Relative performance of the sources and placements obviously varies from year to year.

Table 7: F-values for contrast analysis of effects of fertilizer source, timing and placement on yield of durum wheat on a Newdale Clay Loam Soil.

Contrast	Conventional Till		Zero Till	
	1992	1993	1992	1993
Band vs. surface N	ns	ns	ns	ns
Urea vs. UAN	ns	ns	ns	ns
Broadcast vs. Dribble	ns	ns	0.0001	0.0086
No N vs. N	0.0001	0.0001	0.0001	0.0001
Am.N vs. Urea, Surface	ns	0.0582	ns	ns
P seed vs. P dual	ns	0.0562	ns	ns
NH_3 vs. Urea, Spring	ns	ns	ns	0.0775
NH_3 vs. UAN, Spring	ns	ns	0.0635	0.0262
NH_3 vs. UAN, Fall	.	ns	.	ns
NH_3 vs. urea, Fall	.	ns	.	ns
Urea vs. UAN, Fall	.	ns	.	ns
UAN Band vs. Spoke	ns	ns	0.0821	ns
UAN in soil vs Dribble	ns	ns	ns	ns
Banding effect - no N	ns	ns	ns	ns
P vs. no P check	0.0002	0.0387	0.0708	0.0048
C.V.	10.1	9.1	9.2	7.6

Fine sandy loam: Grain yield of durum increased with N application in both years under both tillage systems on the fine sandy loam soil as on the clay loam soil (Tables 8 and 9). Grain yield did not differ between ZT and CT and no tillage by treatment differences existed on this soil in either year (Table 3).

Table 8: Durum grain yield (bu/acre) as a function of fertilizer source, placement and time of application on a Marringhurst Fine Sandy Loam soil.

Treatment	Conventional Till			Zero Till		
	1992	1993	Mean	1992	1993	Mean
NH_3 Fall Band (PS)	.	32.6	32.6	.	41.2	41.2
UAN Fall Band (PS)	.	30.5	30.5	.	34.8	34.8
Urea Fall Band (PS)	.	30.4	30.4	.	37.5	37.5
NH_3 Spring Band (PS)	39.9	32.1	36.0	52.7	38.1	45.4
UAN Spring Band (PS)	51.0	31.1	41.1	54.1	36.3	45.2
Urea Spring Band (PS)	47.9	31.7	39.8	53.9	35.2	44.6
UAN Dual Band	51.7	32.4	42.0	52.6	36.6	44.6
Urea Dual Band	59.5	30.9	45.2	52.0	35.1	43.6
UAN Spoke (PS)	42.3	32.9	37.6	43.3	38.3	40.8
UAN Dribble (PS)	44.2	31.0	37.6	48.1	37.9	43.0
Urea Dribble (PS)	43.8	33.9	38.8	50.3	36.5	43.4
A.N. Dribble (PS)	46.3	31.5	38.9	46.1	36.0	41.1
A.N. Broadcast (PS)	47.3	33.0	40.2	48.3	37.4	42.9
Urea Broadcast (PS)	51.2	29.7	40.4	47.4	34.2	40.8
No N, No P	31.5	21.9	26.7	26.9	22.8	24.8
No N, P Seed-placed	33.3	24.4	28.8	33.2	26.5	29.8
No N, P Banded	40.9	24.1	32.5	32.1	25.1	28.6
No N, No P, Band	24.1	22.3	23.2	32.0	23.1	27.5
Mean	44.4	29.8	37.1	45.7	34.0	39.9

Durum grain yield increased with application of monoammonium phosphate on both the CT and ZT, but differences were only significant in CT in 1992 and ZT in 1993 (Tables 8 and 9). In contrast to the results on the clay loam soil, in 1992 on the ZT, (and nonsignificantly on the CT) the UAN spring band tended to be higher yielding than the spoke wheel application, both of which had seed-placed P, while in 1993, the two treatments did not differ.

In 1993, on the ZT, spring banded NH_3 produced a higher grain yield than did the spring banded urea, while fall banded NH_3 produced a higher grain yield than either UAN or urea banded in the fall.

Table 9: F-values for contrast analysis of effects of fertilizer source, timing and placement on yield of durum wheat on a Marringhurst Fine Sandy Loam Soil.

Contrast	Conventional Till		Zero Till	
	1992	1993	1992	1993
Band vs. surface N	ns	ns	ns	ns
Urea vs. UAN	ns	ns	ns	ns
Broadcast vs. Dribble	ns	ns	ns	ns
No N vs. N	0.0001	0.0001	0.0001	0.0001
Am.N vs. Urea, Surface	ns	ns	ns	ns
P seed vs. P dual	ns	ns	ns	ns
NH_3 vs. Urea, Spring	ns	ns	ns	0.0784
NH_3 vs. UAN, Spring	ns	ns	ns	ns
NH_3 vs. UAN, Fall	.	ns	.	0.0003
NH_3 vs. urea, Fall	.	ns	.	0.0260
Urea vs. UAN, Fall	.	ns	.	ns
UAN Band vs. Spoke	ns	ns	0.0604	ns
UAN in soil vs Dribble	ns	ns	ns	ns
Banding effect - no N	ns	ns	ns	ns
P vs. no P check	0.0836	ns	ns	0.0164
C.V.	23.4	9.2	17.4	6.7

Stand Density

In 1992, on the clay loam soil, stand density of canola was higher with CT as compared to ZT. Canola stand density was also higher with banded N application than with surface application and with spring banded NH_3 as compared to spring banded UAN or urea (data not presented). On the fine sandy loam soil, stand was lower with seed-placed P as compared to banded P, but there was no difference due to tillage. Stand counts were not taken for durum in 1992 on either soil.

In 1993, in the canola on the clay loam soil, stand density was again higher with NH_3 banded as compared to UAN banded in the spring. Also, stand density was higher with in-soil applications of UAN as compared to the surface dribble applications, and was higher when P was applied as compared to when no P was added. On the fine sandy loam soil, canola stand density was higher on the CT as compared to the ZT treatments.

In 1993, on the clay loam soil, stand density of durum tended to be slightly higher with UAN as compared to urea. Stand density of durum was also somewhat higher when P was seed-placed and N was banded as compared to where N and P were dual banded, with the N as either urea or UAN. Stand density also tended to be higher with UAN spring banded as compared to the spoke UAN with seed-placed P. On the fine sandy loam, stand density tended to be higher on the ZT as compared to the CT. Other factors did not significantly affect stand density.

Weed populations

Weed populations at the time of herbicide application were relatively low and did not generally differ substantially with treatment. This is not unexpected in the first year of the study, as populations will not necessarily have had time to shift.

In 1992, on both soils and for both crops, populations of volunteer cereals tended to be higher under CT than ZT. On the clay loam soil, populations of wild buckwheat and smartweed were higher under CT than ZT on both the canola and the durum, while green foxtail and cleavers populations were higher and population of miscellaneous weeds lower under CT than ZT in the canola. In the canola on the fine sandy loam in 1992, populations of field horsetail were lower under CT than ZT in both the canola and the durum wheat. On the fine sandy loam, kochia populations in the canola and Russian thistle populations in the durum were higher under ZT than CT while populations of green foxtail, wild mustard, shepherd's purse and miscellaneous weeds did not differ between tillage systems in either crop.

Effect of fertilizer applications were small and inconsistent. On the clay loam soil, fertilizer applications did not influence weed populations in the canola, but smartweed population in the durum tended to be higher with spring banded NH_3 than with spring banded UAN or urea. On the fine sandy loam, volunteer cereal populations in the canola tended to be higher with broadcast as compared to banded nitrogen applications, with broadcast urea having the highest populations. Nitrogen management did not influence weed populations in the durum on the fine sandy loam soil in 1992.

Analysis of weed population information for 1993 is incomplete.

Discussion

The first two years of this study was cooler than normal, with higher than normal effective precipitation. Under these conditions, CT generally produced slightly higher yields than did ZT, although differences were not always significant. Differences among timing, placement and source of N differed between sites and years, indicating that relative performance of the fertilizer management options varies with environmental conditions. When applied as a fall-band, NH_3 tended to produce higher yields of both canola and durum than did UAN or urea, particularly under ZT and on the fine sandy loam soil, where leaching losses may have occurred. Efficacy of surface dribble application as compared to surface broadcast differed from year to year. It was poorer on the clay loam in canola under both tillage systems in 1992 and in the durum under ZT in 1993, but superior on the fine sandy loam in the canola in 1993, under both tillage systems and in the durum in 1992 under ZT.

On the clay loam soil in 1992, under ZT, the nested applications of UAN produced higher canola seed yields but lower durum yields than did the spring band application. On the fine sandy loam soil, grain yield of durum also tended to be lower with spoke as compared to band applications of UAN on ZT in 1992. The higher seed yield of canola with nested application on the clay loam in 1992 may have reflected delayed maturity of the canola receiving the band application, due to the increased N fertilizer use efficiency. This delayed maturity would have led to greater yield loss from the early frost which occurred on August 28, 1992, and produced substantial damage to immature seed.

During the next two years of this study, effects of nitrogen source, timing and placement under varying environmental conditions will be assessed and conclusions as to average relative efficiency over time under a range of conditions will be drawn.

Stand density of canola tended to be higher under CT as compared to ZT, while with durum, the trend was reversed. The effects of fertilizer source and placement on stand density were variable, and information from the upcoming years of the experiment should help to clarify the effects.

The general increase in volunteer cereals noted under CT as compared to ZT in 1992 may relate to lack of incorporation leading to the seeds from the previous season's crop remaining on the soil surface under ZT, where germination was restricted and the seeds may have dessicated. Differences in weed populations among treatments may become more apparent as the experiment progresses.

Conclusions

In the first two years of a four year study, yield of canola and durum under conventional tillage management was higher than or did not differ from yield under zero tillage management on a fine sandy loam and a clay loam soil. Fall-banded applications of NH_3 tended to produce higher yields of canola and durum than did urea or UAN, particularly under zero till management. Relative efficiency of dribble band applications varied with site, year and tillage system. Volunteer cereal population tended to be lower under ZT as compared to CT, but differences in weed population due to fertilizer management were not consistent.

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