Nitrogen Management of Canola planted at Non traditional times

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Summary

Nitrogen placement is a significant problem in direct seeding systems since high levels of nitrogen can damage seedlings if placed too close to the seed and significant seed bed disruption and subsequent drying can occur when a large double shoot opener is used to reduce the danger of fertilizer damage during establishment. This trial was conducted to determine the safe distances for placement of urea at non traditional seeding dates. Canola was planted using a disc seeder with seed and fertilizer openers spaced 12" (30 cm) apart. The previous crop was wheat in all seasons and in 2000 and 2002 direct seeding only was used Fertilizer openers were on a separate tool bar in front of the seed openers and thus allowed placement of nitrogen (46-0-0) at the same depth as the seed or 2 cm below the seed. For each nitrogen placement depth nitrogen was placed at distances of 2, 4 and 6 cm to the side of the seed row for a total of 6 nitrogen fertilizer placements. All nitrogen placements have nitrogen at 45, 90 and 135 lb/ac at the time of seeding. Sulfate sulfur was broadcast after the early may seeding date and phosphorus was applied with the seed or band prior to planting.

Ammonium levels in the seed row were measured by sampling the wet soil over the seed row and determining the ammonium content by extraction of ammonium from the wet soils. For the dormant seeded canola ammonium sampling was done in the early spring as the crop began to emerge.

In 1999 only one seeding date was possible due to wet soil conditions and *Brassica rapa L.* was planted. In 2000 and 2002 there were 3 seeding dates, 1) dormant seeding the previous fall with the seed treated with Extender to limit fall germination 2) seeding the first week of May 3) seeding the final week of May. Roundup Ready^{TM} *Brassica napus L.* was used and weeds controlled with multiple applications of this herbicide.

Dormant seeded canola survived the winter and produced a crop only in 2000. Thus one of the major recommendations of this trial must be that dormant seeding is still a high risk operation even with the use of a Extender germination retarding system. This is a similar result to other studies conducted across Western Canada and is a result of premature germination in the fall and/or frost damage in the spring.

Plant populations varied between seeding dates with the dormant seeded crop having the lowest plant numbers. There was significant variability in plant numbers due to seeding date even when the low rate of nitrogen was placed 6 cm from the seed row and 2 cm below the seed. Placement of nitrogen 6 cm beside the seed rows was safe at both depths and did not reduce plant numbers at any seeding date or location even at the high nitrogen rates. Placement at the 4 cm beside the seed was generally safe with slight reductions in plant populations at high fertilization rates on the loam sites when the soil was dry. Nitrogen placement 2 cm beside the seed rows or 2 cm below and 2 cm beside was often damaging to plant populations. However, under good growing conditions and adequate moisture this was not a serious problem.

Ammonium levels in the seed row did not differ between tillage systems in 1999 and thus the comparison of zero tillage and conventional seeding was not continued in subsequent years. The total amount varied widely between seeding dates, placements years and soil types. Overall all sites and years ammonium levels in the seed row were highest at the closest placement and highest nitrogen rate.

The major findings of this trial were: 1) fall seeding often failed due to germination in the fall after planting, inability to plant due to early snow or late spring frosts 2) Placing nitrogen either 2 cm to beside the seed row or 2 cm beside and 2 cm below the seed row often resulted in reduced plant stands and reduced yields. 3) unless significant rainfall occurred shortly after seeding ammonium levels in the seed row where greater when nitrogen was applied beside the row rather than beside and below the row 4) delaying spring planting reduced the yield potential of the canola crop and this was overcome by higher nitrogen rates.

Background and Introduction

Accorded to published information and Manitoba Crop insurance data seeding in the last part of May results in reduced canola yields relative to early to Mid May. There has been no published information on the interaction between seeding date, nitrogen rate and nitrogen placement.

Since urea can not be seed placed in the canola seed row in adequate amounts to meet crop requirements due to seedling damage there are continuing questions as to safe distance between nitrogen bands and canola seed rows. Xie et al (1998) found paired row seed/fertilizer placement to be superior to narrow seed row width with sidebanded urea and that 38 cm rows produced higher yields than 25 cm rows.

Urea is converted to ammonia and raises soil pH damaging crop seedlings (Creamer and Fox 1980). These authors found that higher initial soil pH, low soil moisture and low temperature maintained high levels of ammonium and ammonia for longer periods of time. Studies on the movement of ammonia from a band indicates movement of 4-7 cm in most situations (Izaurralde et al,1990, Jacobson et al., 1986). Wheat roots were damaged and did not grow into a zone about 10 cm in diameter (from the band of urea) up to 8 weeks after application of urea (Passioura and Wetselaar (1972). Although roots did not grow into this zone they proliferated around the outside of this cylinder. Dowling (1993) found that germination of canola was sensitive to 54 x 10^{-4} M of atmospheric ammonia while wheat could tolerant twice this level. Radical growth was less tolerant than was germination in most species but similar in wheat and canola 54 x 10^{-4} M.

Since ammonia loss is often increased by shallow placement most studies do not evaluate damage to crops from this type of application. Loss of ammonia to the surface from urea placed 2 cm below the surface was less than 2% after 14 days while mixing the urea into the top 2 cm resulted in losses of over 15% (Singh and Nye, 1998). Low losses from shallow placement would indicate that it should be possible to place urea beside canola will little impact on nitrogen loss. Westfall et al (1996) concluded that nitrogen placement was more important in the moister areas of the Great Plains than the drier. This is contrary to the commonly held view that deep banding increases the availability of nitrogen to crops during periods where rainfall is limiting. Significant levels of nitrification and denitrification occur even when the soil is frozen and thus damage seedlings (Singh et al 1994). The impact of application of nitrogen in the fall with dormant seeded canola may be to reduce seedling damage since some rooting may not occur prior to transformation of urea to nitrate and the transport of ammonium in solution away from the point of application.

Materials and Methods

Canola was planted using a disc seeder with seed and fertilizer openers spaced 12" (30 cm) apart. The target seeding rate was 120 seeds m^{-2} . Seeding depth was 2 cm at all dates. The previous crop was wheat in all seasons and in 2000 and 2002 direct seeding only was used Fertilizer openers were on a separate tool bar in front of the seed openers and thus allowed placement of nitrogen (46-0-0) at the same depth as the seed or 2 cm below the seed. For each nitrogen placement depth nitrogen was placed at distances of 2, 4 and 6 cm to the side of the seed row for a total of 6 nitrogen fertilizer placements. All nitrogen placements have nitrogen at 45, 90 and 135 lb/ac at the time of seeding. Sulfate sulfur was broadcast after the early may seeding date and phosphorus was applied with the seed or band prior to planting

1999:

There were 2 sites a loam and a clay loam soil on cereal grain stubble. A 4 replicate split plot with tillage treatments being main plots and nitrogen rate*placement being subplots. All tillage was conducted just prior to planting.

2000 and 2001

A 4 replicate split plot design was used with seeding date as main plots and nitrogen rate*placement being subplots. Fall seeding was done in early November, using canola treated with Extender™, at a date when freeze up was normally expected. .

Preplant Management:

Roundup was applied at 0.5 L/ac prior to planting.
In 1999 tillage was conducted using a 3 pt hitch mount tandem disc.
Sulfur was broadcast on all sites as ammonium sulfate in 2000 and as potassium sulfate in 2002.

Seeding Details

Due to the extremely wet spring only one seeding date was used in 1999. The variety was changed to a B. rapa Hysyn 101. This information was conveyed to the Manitoba Canola Growers and funding reduced accordingly. The Roundup Ready cultivar LG3235 was planted in 2000 and LG3455 in 2002. Fall seeding occurred in the season prior to the 2000 crop year and was done near November 1. The dormant seeded portion of these trials were reseeded November 13-15 due to unseasonably warm weather causing germination of the first seeding date.

A plot seeder with separate discs for fertilizer and seed placement was used for placing seed and nitrogen fertilizer (as urea) at different distances This seeder planted 6 rows 7 m long on 30 cm spacing with plots on 2 m centers.

Ammonium sampling

In 1999 soil samples were taken to a depth of 3 cm directly over the seed row using a 1 cm diameter core. Six cores were taken per plot and mixed then gravimetric soil moistures were determined. In 2000 and 2002 4 samples 10 cm long by 1 cm wide and 2 cm deep where taken over the seed row to reduce sampling variation. Dormant seeded sampling was done in the spring as soon as the soil was dry enough to allow foot traffic without damaging the plot. Samples extracted with 2 M KCl while wet and corrected for moisture content. Samples were frozen until analysis.

Harvest

The entire plot was harvested for seed by cutting at about 6 cm from the soil surface and the straw weight measured using a weighing bucket attached to the combine. Straw moisture was determined and the straw weights are expressed on a dry weight basis. Seed weights were determined on clean samples.

Results and Discussion

Plant populations

1999
Brassica rapa cv HYSYN 101 was planted on a Carrol loam and a Newdale clay. Soil moisture contents were excellent at seeding and until emergence with no significant differences between tillage treatments. Plant populations, at both sites, were equal on zero and conventional tillage systems at all nitrogen rates (for the same nitrogen placements). Although the same seeding rate was used, establishment was superior on the loam site 76 vs 51 plants m^{-1}, this occurred despite the fact that significant rainfall occurred with 24 hours of seeding at the clay loam site (Table 1,2, 7,8). On the loam site there were significantly fewer plants established when nitrogen was placed below and to the side of the seed rather than to the side of the seed and establishment declined with nitrogen rates applied close to the seed. Rainfall at the clay loam may have moved the urea deeper and thus created a situation where 2 cm beside the row was actually below the seed and plant populations were lower.

2000

Plant stands were higher at the loam site than the clay loam site at all seeding dates (Table 3, 4, 9, 11). Fall planted canola stands were below 20 plants/m^2 regardless of fertilizer rate or placement. Early spring plant numbers were greater than late may planting regardless of placement or soil. Plant stands were reduced by placement 2 cm beside the seed row and at the same depth at all seeding dates at both the loam and clay loam sites. However, in both cases reductions in plants numbers were relatively small and loss of plants did not explain the 12-16% yield reductions that occurred by placement close to the seed.

2002

As in previous seasons plant populations were higher at the loam site than the clay loam site (Table 5, 6, 13, 15) As in 2000 plant stands from early spring planting were greater than late May planting at both sites. Likewise, as in previous seasons, placement of nitrogen 2 cm beside the seed row caused reduction in plant stands at the loam site. Plant stands were lower at the 2 and 4 cm distances on the clay loam site (Table 15).

Summary of plant stands
While it is not possible to statistically compare soil types emergence was consistently greater on the loam soils than the clay loam. This may be due to the seeding tool used or an actual impact of the soil type but this is unclear. Plant stands were often reduced by placement of nitrogen either 2 cm beside or 2 cm below and 2 cm beside the seed row. Thus at higher nitrogen rates caution should be used in ensuring that nitrogen levels do not damage seedling establishment. Under some conditions plant stands were reduced by nitrogen rates above 50 kg/ha when placed this close. However, in most cases this stand reduction was limited relative to differences due to the weather conditions at seeding.

Ammonium levels

1999

Three days after seeding (NH4_3DAS) ammonium levels at the loam site declined as the distance from the fertilizer band increased, when the rate was lower and when the fertilizer was at the same depth as the seed (Table 1, 7) Four days after seeding on the clay loam soil (NH4_4DAS) the results were similar except that the ammonium levels at the seed row were higher when the urea had been placed at the same level as the seed(Table 2, 8). There are literature reports of surface applied nitrogen damaging plant stands when nitrogen was planted directly over the row and then irrigation was applied. Ammonium levels tended to be slightly higher under zero tillage when the nitrogen was below the seed but this effect was small relative to rate and distance from the row. On the loam soil ammonium levels at the seed row declined from 3 to 6 days after seeding at the 2 cm sideband and increased at the 6 cm sideband indicating that diffusion was continuing. At the clay loam site ammonium levels declined to very low levels 10 days after seeding indicating that the major damage occurred earlier.

2000

The sampling procedure for ammonium was modified in 2000 such that 2 depths were measured at 3 days after seeding. At the loam site ammonium levels were greater when nitrogen was placed at the same depth as the seeding (Table 3, 10) While there were mathematical differences indicating higher ammonium rates with higher rates these were not statistically different. At the clay loam site there were differences in ammonium levels due to seeding date, distance from the seed, depth of placement, nitrogen rate and many interactions (Table 4, 12). It was clear that there were elevated levels of ammonium in the seed row even when the fertilizer band was 4 cm from the seed row (Table 12). Ammonium levels were greater when nitrogen was placed beside the seed row at the 0-2 and 2-4 cm sampling depths indicating that in years when there is limited rainfall immediately after planting ammonium levels and thus potential seedling damage will be greater when nitrogen is placed beside the seed row.

2001

Ammonium levels measured in the seed row were variable as in previous seasons. Ammonium levels increased in the seed row as the nitrogen rate increased (Tables 5,6, 14, 16). At the loam site there was a significant interaction between placement distance beside*distance below* nitrogen rate 7 days after seeding (Table 5). There was a significant impact of seeding date on ammonium levels at both sites with approximately an order of magnitude increase from early to late seeding dates 3 days after seeding (Table 14, 16). As in previous seasons there was a trend towards greater ammonium levels in the seed row from nitrogen applied at the same depth as the seed even at 4 cm from the seed.

Summary of Ammonium levels

Ammonium levels were highly variable and thus creation of a model to estimate damage has not been possible. Further work, under conditions where soil temperatures and moisture are controlled, is required. As expected ammonium levels in the seeds were higher when the nitrogen rate decreased and the distance from the fertilizer to seed row was decreased. This study is limited by the fact that sampling was not possible on a daily basis and that damage to the seedling will occur over the entire establishment time period. Reducing ammonium levels to near background levels will require placement of the fertilizer band greater than 6 cm from the seed row. However, ammonium levels higher than background can be tolerated by canola and a distance of 4 cm beside and 2 cm below appears to have an adequate safety margin for agronomically normal rates of urea application.

Yields

1999

Yields were low and variable at both sites (Table 1, 2, 7, 8). At the loam site seed yields were lower when the urea was sidebanded below and close to the seed as a result of serious seedling damage and low plant stands particularly at higher nitrogen rates (Table 7). Higher ammonium rates in the seed row were likely responsible for this reduction. At the loam site distance to the side, depth, side*depth, rate and depth*rate all had significant effects on seed yields (Table 1). At the clay loam site nitrogen rate did not affect yields (Table 2, 8). Crop yields at the clay loam site were slightly lower when nitrogen was placed closer and at the same depth as the seed (Table 8). Seed yields were similar under both tillage systems (Table 1 and 2).

2000

Early spring planting resulted in 30-50% greater yields than other planting times depending on the soil type (Tables 3, 4, 11,12). The late seeding at the clay loam site had lower yields due to hail damage. While there are many interactions placing fertilizer 2 cm beside the seed reduced seed yields between 12 and 16% at the early spring planting date. This reduction was greater than the reduction in plant numbers. At the early seeding date, on the clay loam site, seed yields were reduced when fertilizer was placed 2 cm below and 2 cm to the side and unaffected at the other dates. This trend agreed with the reductions in plant numbers but plant numbers may be only part of the equation as these plots had delayed maturity indicating damage which did not kill the plants. Response to nitrogen was low at both sites and yields were well below potential.

Straw weights were similar at both sites and because of the higher yields at the loam site this crop had a greater harvest index (Tables 3, 4 & 9, 11). The total dry matter production at both sites was very low and nitrogen response was limited.

2002

Dormant seeded canola did not survive the winter. As in previous seasons early May planted canola had higher yields than late seeding at the clay loam site but the reverse was true at the loam site(Table 5,6, 13, 15). At both sites there was a significant reduction in seed yields with closer placement to the seed row (Table 5, 6). Highest yields were obtained when fertilizer was applied 6 cm from the seed row (Table 13, 15). Nitrogen response was low due to dry conditions and improvement in yield was minimal even when nitrogen was placed 6 cm from the seed row.

Straw yields at the loam site increased with added nitrogen (Table 5, 13). As with grain yields straw yields were higher at late seeding at the loam site (Table 13). Other interactions were not significant. At the clay loam site there was no impact of seeding date on straw yield (Table 6, 15). There was a significant interaction between nitrogen depth* placement to the side*rate at the clay loam site. There was an overall trend for lower straw yields when nitrogen was placed at 2 or 4 cm beside the seed row at higher rates.

Summary of Yields

Dormant seeded canola survived the winter in only 1 of 2 years and the plant stands were too low for optimal yields. Dormant seeding of canola continues to be a high risk option in Western Manitoba. Early seeding improved seed yields in 3 of the 4 site years of data. Crop yields were lower than expected in all years and thus it is difficult to develop a good nitrogen response curve from this data. We conclude that placement of urea 2 cm from the seed row often results in seedling damage and reduced yields. Nitrogen rates of 150 kg ha-1 should be applied at least 4 cm beside and preferably below the seed row to limit fertilizer damage when row spacings of 30 cm are used.

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Tale 1. Factors with significant differences loam soil 1999							
Source of variance	df	plants m^{-2}	Moisture % 3DAS	Moisture % 10DAS	Seed yield kg ha^{-1}	NH4 4DAS	NH4 10DAS
Tillage	1						
rep*tillage	3						
Rep	3						
Side	2	*			*	*	*
Depth	1	*			*	*	*
Rate	2	*			*	*	*
side*depth	2	*					*
side*rate	4	*			*		
Depth*rate	2	*					*
side*depth*rate	4						
Tillage*side	2						
Tillage*depth	1	*					*
Tillage*rate	2						
Tillage*side*depth	2						
Tillage*side*rate	4						
Tillage*depth*rate	2						
till*side*depth*rate	4						
CV		27.5	10.6	22.2	36.3	79	74.4

Table 2. Factors with significant differences clay loam soil 1999							
Source of variance	df	plants m^{-2}	Moisture % 3DAS	Moisture % 10DAS	Seed yield kg ha^{-1}	NH4 4DAS	NH4 10DAS
Tillage	1						*
rep*tillage	3						*
Rep	3						*
Side	2	*			*	*	*
Depth	1	*				*	
Rate	2					*	*
side*depth	2	*			*	*	*
side*rate	4					*	
depth*rate	2	*				*	
side*depth*rate	4	*				*	
tillage*side	2						
tillage*depth	1						
tillage*rate	2				*		
tillage*side*depth	2						
tillage*side*rate	4						
tillage*depth*rate	2	*					
till*side*depth*rate	4		*				
CV		28.9	10.8	7.2	24.9	93	168

Table 3. Factors with significant differences at the loam site in 2000

Source of variance	plants	seed yield	Straw yield	seed wt	green seed	days to mature	Lodging (1-9)	NH4 3DAS 2cm	NH4 3DAS 4cm
Date	*	*		*	*	*	*		
Side	*	*				*			
Depth	*	*				*		*	
Rate			*		*		*		
Side*Depth	*	*		*		*			
Side*Rate						*			
Depth*Rate									
Side*Depth*Rate		*							
Date*Side							*		
Date*Depth	*	*		*					*
Date*Rate		*			*	*	*		
Date*Side*Depth						*			
Date*Side*Rate									
Date*Depth*Rate									
Date*Side*Depth*Rate									

Date= seeding rate, side = distance (cm) from fertilizer to seed row
Depth=depth(cm) below seed row Rate=kg nitrogen per hectare

Table 4. Factors with significant differences at the clay loam site in 2000									
Source of variance	plants	seed yield	Straw yield	seed wt	green seed	days to mature	lodging	NH4 3DAS 2cm	NH4 3DAS 4cm
Date	*	*	*		*	*	*	*	*
Side	*	*			*	*		*	*
Depth		*						*	*
Rate	*	*	*	*	*	*	*	*	*
Side*Depth	*							*	*
Side*Rate		*							*
Depth*Rate									*
Side*Depth*Rate						*		*	*
Date*Side	*			*		*		*	*
Date*Depth		*						*	*
Date*Rate		*			*	*	*	*	*
Date*Side*Depth									
Date*Side*Rate					*			*	*
Date*Depth*Rate							*		*
Date*Side*Depth*Rate									

Date= seeding rate, side = distance (cm) from fertilizer to seed row
Depth=depth(cm) below seed row Rate=kg nitrogen per hectare

Table 5. Analysis of Variance for loam site in 2002						
Source	DF	moist 3DAS	NH4 3DAS ppm	moist 7DAS	**NH4 7DAS ppm**	**plants m^{-2}**
Date	1	**0.032**	**0.048**	**0.001**	**0.005**	**0.003**
date(Rep)	3	**<.0001**	**0.003**	**0.000**	0.802	0.474
Side	2	0.743	**0.026**	0.244	0.113	**0.016**
Depth	1	0.170	0.849	0.155	**<.0001**	**0.047**
Rate	2	0.959	**0.006**	0.903	0.074	**<.0001**
side*depth	2	0.482	0.709	0.173	**0.008**	0.749
side*rate	4	0.384	0.077	0.223	0.110	0.098
depth*rate	2	0.692	0.581	0.237	0.695	0.974
side*depth*rate	4	0.938	0.140	0.804	0.051	0.304
date*side	2	0.122	**0.026**	0.990	**0.013**	0.132
date*depth	1	0.297	0.311	0.363	**0.000**	**0.011**
date*rate	2	**0.023**	**0.010**	**0.703**	**0.514**	**0.000**
date*side*depth	2	0.945	0.771	0.788	**0.019**	0.809
date*side*rate	4	0.159	0.097	0.129	0.062	0.247
date*depth*rate	2	0.969	0.564	0.519	0.684	0.497
date*side*depth*rate	4	0.998	0.165	0.097	0.081	0.901
				straw yield kg ha^{-1}	seed yield kg ha^{-1}	Harvest index
Date	1			**0.008**	**0.010**	**0.076**
date(Rep)	3			<.0001	0.104	<.0001
Side	2			0.996	**0.011**	**0.008**
Depth	1			0.679	0.868	0.581
rate	2			**<.0001**	**<.0001**	**0.017**
side*depth	2			0.179	0.055	0.567
side*rate	4			0.206	0.080	0.252
depth*rate	2			0.705	0.843	0.922
side*depth*rate	4			0.392	0.087	0.184
date*side	2			0.157	0.871	0.341
date*depth	1			0.281	0.941	0.308
date*rate	2			0.219	**0.017**	**0.000**
date*side*depth	2			0.906	0.530	0.739
date*side*rate	4			0.933	0.870	0.656
date*depth*rate	2			0.885	0.803	0.499
date*side*depth*rate	4			0.904	0.328	0.085

Date= seeding rate, side = distance (cm) from fertilizer to seed row
Depth=depth(cm) below seed row Rate=kg nitrogen per hectare
Bold items are significantly different

Table 6. ANOVA clay loam site 2002						
Source	DF	**moist 3DAS**	**NH4 ppm 3DAS**	**Moist 7DAS**	**NH4 ppm 7DAS**	**plants m^{-2}**
date	1	**0.002**	**0.033**	**0.053**	**0.001**	**0.037**
date(Rep)	3	**0.001**	**0.136**	**0.019**	0.930	0.062
side	2	0.170	**0.889**	0.224	0.932	**0.000**
depth	1	0.115	0.118	0.050	**0.357**	0.517
rate	2	0.702	**0.070**	0.382	0.020	**0.018**
side*depth	2	0.608	0.696	0.895	**0.670**	0.049
side*rate	4	0.538	0.705	0.940	0.788	0.372
depth*rate	2	0.207	0.261	0.369	0.299	0.904
side*depth*rate	4	0.186	0.309	0.064	**0.186**	0.486
date*side	2	0.103	**0.666**	0.965	**0.322**	0.294
date*depth	1	0.754	0.233	0.223	**0.067**	0.463
date*rate	2	**0.599**	**0.129**	**0.485**	0.811	0.449
date*side*depth	2	0.810	0.824	0.779	**0.475**	0.380
date*side*rate	4	0.487	0.688	0.577	0.746	0.308
date*depth*rate	2	0.514	0.387	0.723	0.523	0.742
date*side*depth*rate	4	0.383	0.324	0.664	0.376	0.752
Source	DF			**Straw kg ha^{-1}**	**Seed kg ha-^{1}**	**Harvest Index**
date	1			**0.307**	**0.026**	**0.009**
date(Rep)	3			**0.001**	**0.019**	0.167
side	2			**0.003**	**<.0001**	**<.0001**
depth	1			0.573	0.553	0.849
rate	2			**0.985**	**0.007**	**0.000**
side*depth	2			0.010	0.008	0.099
side*rate	4			0.325	0.491	**0.001**
depth*rate	2			0.119	0.097	0.375
side*depth*rate	4			0.005	0.246	0.921
date*side	2			**<.0001**	**0.001**	**0.012**
date*depth	1			0.139	0.752	0.401
date*rate	2			0.146	0.049	**0.001**
date*side*depth	2			0.368	0.876	0.803
date*side*rate	4			0.687	0.544	0.796
date*depth*rate	2			0.107	0.881	0.226
date*side*depth*rate	4			0.377	0.392	0.173

Date= seeding rate, side = distance (cm) from fertilizer to seed row
Depth=depth(cm) below seed row Rate=kg nitrogen per hectare
Bold items are significantly different

Table 7. Effect of nitrogen rate and placement on plant emergence yield and ammonium levels in the seed row during emergence on loam in 1999

tillage	Side cm	depth cm	nitrogen rate kg ha^{-1}	plants m^{-2} mean	SE	seed yield kg ha^{-1} mean	SE	NH4 4 Days after seeding mean	SE	NH4 10 Days after seeding mean	SE
			0	77	6	602	46	1.6	0.4	0.6	0.3
			50	61	4	543	31	158.5	33.2	141.4	23.5
			100	52	4	456	42	349.2	58.6	341.0	48.0
			150	47	5	403	38	497.5	81.9	465.1	69.7
		0		67	3	550	19	94.4	20.2	99.2	20.1
		2		41	4	388	37	566.4	59.1	522.3	46.9
		0	0	77	6	602	46	1.6	0.4	0.6	0.3
		0	50	69	4	529	40	30.4	15.8	45.4	11.1
		0	100	68	5	598	32	120.5	43.9	140.6	49.6
		0	150	61	5	507	30	163.2	44.4	144.4	40.2
		2	50	53	5	557	47	286.5	53.2	237.3	36.4
		2	100	36	6	313	65	577.9	86.9	541.4	58.8
		2	150	34	6	290	65	846.4	125.1	799.8	95.0
	0			77	6	602	46	1.6	0.4	0.6	0.3
	2			30	4	309	40	544.8	79.4	404.1	63.0
	4			56	4	533	28	322.0	54.3	347.6	45.2
	6			74	3	568	32	130.7	34.2	190.1	46.9
	0		0	77	6	602	46	1.6	0.4	0.6	0.3
	2		50	45	6	461	53	284.0	72.1	212.6	50.7
	2		100	27	6	254	77	576.3	127.6	364.6	71.8
	2		150	18	4	211	63	773.9	172.2	635.2	153.2
	4		50	64	6	554	32	155.6	54.6	138.8	32.3
	4		100	53	7	531	63	320.0	70.8	424.2	88.8
	4		150	51	7	513	46	490.4	126.4	479.8	76.2
	6		50	75	4	624	67	35.8	11.9	72.8	30.1
	6		100	75	5	591	41	151.2	69.8	234.3	85.7
	6		150	72	4	493	57	210.2	71.5	268.1	107.6
	0	0		77	6	602	46	1.6	0.4	0.6	0.3
	2	0		48	4	493	39	176.3	48.4	128.0	29.0
	2	2		11	3	147	47	913.3	107.7	680.3	93.6
	4	0		71	4	563	23	120.3	39.2	191.1	53.8
	4	2		42	5	501	51	523.8	83.5	504.0	57.7
	6	0		79	4	573	39	17.5	10.4	11.3	4.1
	6	2		69	3	562	54	248.9	60.2	376.6	79.2
	0	0	0	77	6	602	46	1.6	0.4	0.6	0.3
	2	0	50	63	8	485	99	63.1	43.7	70.1	21.8
	2	0	100	48	5	544	55	249.9	115.6	165.9	60.8
	2	0	150	34	3	452	43	215.8	70.5	148.0	58.2
	2	2	50	27	4	441	54	504.9	80.2	355.0	68.9
	2	2	100	5	1	0	0	902.8	161.1	563.4	84.5
	2	2	150	2	1	0	0	1332.1	182.0	1122.4	171.4
	4	0	50	72	9	507	25	9.3	5.3	62.5	19.2
	4	0	100	74	6	649	50	80.3	33.8	237.5	130.0
	4	0	150	66	7	543	30	271.3	93.4	273.4	87.3
	4	2	50	56	8	608	57	301.9	81.4	215.1	49.4

	4	2	100	33	6	427	99	559.8	62.4	610.9	83.3
	4	2	150	36	11	478	95	709.6	214.5	686.1	71.4
	6	0	50	74	5	608	75	18.9	16.9	3.6	1.9
	6	0	100	80	9	600	61	31.3	26.9	18.5	11.0
	6	0	150	83	6	520	71	2.5	1.2	11.9	5.1
	6	2	50	76	5	638	111	52.8	15.3	141.9	50.2
	6	2	100	70	5	580	55	271.1	126.8	450.0	134.4
	6	2	150	62	5	456	99	447.6	89.1	561.0	176.2
CT				56	3	462	29	273.2	42.4	248.5	37.6
ZT				54	3	485	30	360.0	56.6	348.5	46.1
CT			0	72	11	558	59	1.8	0.6	1.0	0.4
CT			50	63	5	526	44	117.8	37.7	101.5	25.1
CT			100	50	6	426	61	348.8	87.3	278.8	65.3
CT			150	51	7	417	54	398.4	83.8	406.3	84.9
ZT			0	82	4	661	68	1.5	0.6	0.3	0.3
ZT			50	59	6	561	43	199.2	54.3	181.3	38.5
ZT			100	53	7	483	59	349.5	80.1	403.3	69.4
ZT			150	44	6	388	54	601.0	141.5	526.5	112.1
CT		0		64	4	513	23	117.6	32.7	94.4	25.2
CT		2		46	5	406	55	446.2	72.0	419.7	63.4
ZT		0		70	3	588	28	71.2	23.6	104.0	31.7
ZT		2		35	5	370	49	690.0	90.5	627.9	65.4
CT		0	0	72	11	558	59	1.8	0.6	1.0	0.4
CT		0	50	66	6	476	49	40.7	29.7	49.3	16.3
CT		0	100	62	7	550	48	180.3	79.9	104.3	43.9
CT		0	150	61	8	500	36	170.4	61.9	160.6	66.6
CT		2	50	60	7	576	71	194.8	63.0	153.7	43.2
CT		2	100	39	9	313	98	517.3	142.5	453.3	101.9
CT		2	150	40	10	327	102	626.3	126.8	652.1	121.4
ZT		0	0	82	4	661	68	1.5	0.6	0.3	0.3
ZT		0	50	73	6	586	62	20.2	11.8	41.5	15.9
ZT		0	100	73	6	638	42	60.7	31.9	176.9	90.2
ZT		0	150	61	7	515	50	155.9	66.4	128.3	47.6
ZT		2	50	45	7	537	63	378.2	79.7	321.0	49.0
ZT		2	100	33	9	313	91	638.4	103.1	629.6	51.7
ZT		2	150	27	8	249	80	1086.5	204.0	960.9	137.4
CT	0			72	11	558	59	1.8	0.6	1.0	0.4
CT	2			28	5	284	53	559.8	94.6	387.5	82.0
CT	4			61	5	557	40	203.0	50.7	271.0	59.0
CT	6			75	4	527	48	102.1	38.1	128.1	49.8
ZT	0			82	4	661	68	1.5	0.6	0.3	0.3
ZT	2			31	6	332	61	529.7	129.5	420.8	97.3
ZT	4			51	6	507	38	441.0	90.8	424.2	66.0
ZT	6			73	4	611	42	160.7	57.6	254.7	79.5
CT	0		0	72	11	558	59	1.8	0.6	1.0	0.4
CT	2		50	44	8	460	77	278.4	82.7	197.3	56.0
CT	2		100	24	7	201	98	716.0	193.0	391.4	111.7
CT	2		150	17	6	201	77	685.1	164.7	573.9	201.3
CT	4		50	68	6	569	57	61.0	36.7	91.4	24.9
CT	4		100	53	7	530	100	256.1	74.9	264.1	100.8
CT	4		150	63	11	569	61	291.9	118.1	457.5	117.9
CT	6		50	79	5	544	97	13.9	10.4	15.9	7.5

CT	6		100	74	9	546	67	74.3	31.0	180.9	127.3
CT	6		150	73	5	491	92	218.1	100.6	187.6	73.8
ZT	0		0	82	4	661	68	1.5	0.6	0.3	0.3
ZT	2		50	46	10	462	78	289.6	124.2	227.9	88.4
ZT	2		100	29	10	300	119	436.6	164.1	337.9	97.2
ZT	2		150	19	7	222	110	862.8	312.6	696.5	242.9
ZT	4		50	60	11	538	24	250.1	94.2	186.3	56.7
ZT	4		100	54	12	531	86	383.9	121.2	584.3	127.7
ZT	4		150	40	9	448	66	689.0	208.0	502.0	104.2
ZT	6		50	71	6	719	81	57.8	18.9	129.6	53.9
ZT	6		100	76	6	637	45	228.1	135.1	287.6	120.3
ZT	6		150	72	8	494	74	201.1	109.7	360.1	219.0
CT	0	0		72	11	558	59	1.8	0.6	1.0	0.4
CT	2	0		43	5	423	45	278.3	81.7	169.1	49.7
CT	2	2		14	4	168	76	841.4	127.9	605.9	130.3
CT	4	0		70	5	534	29	92.6	44.7	133.3	58.6
CT	4	2		52	8	578	73	313.4	80.8	408.8	87.5
CT	6	0		77	7	553	47	20.5	18.1	11.9	7.4
CT	6	2		73	3	492	95	183.7	67.4	244.3	88.6
ZT	0	0		82	4	661	68	1.5	0.6	0.3	0.3
ZT	2	0		54	6	557	58	74.3	34.9	86.9	27.2
ZT	2	2		9	3	126	57	985.1	176.7	754.6	136.5
ZT	4	0		72	7	589	35	147.9	65.5	249.0	89.8
ZT	4	2		31	6	408	60	734.1	120.7	599.3	67.8
ZT	6	0		81	4	598	67	14.6	11.2	10.8	4.0
ZT	6	2		65	5	625	56	320.0	101.3	520.9	124.4
CT	0	0	0	72	11	558	59	1.8	0.6	1.0	0.4
CT	2	0	50	56	14	404	154	113.5	84.0	79.0	27.9
CT	2	0	100	41	3	470	69	411.0	193.6	234.8	104.8
CT	2	0	150	31	5	403	21	310.3	116.6	193.5	105.2
CT	2	2	50	32	7	503	87	443.3	82.3	315.5	67.5
CT	2	2	100	7	2	0	0	1021.0	272.7	548.0	175.6
CT	2	2	150	3	1	0	0	1060.0	139.3	954.3	285.7
CT	4	0	50	66	10	477	40	5.5	2.5	65.3	32.5
CT	4	0	100	70	1	600	63	72.5	57.1	54.8	31.7
CT	4	0	150	73	14	541	46	199.8	110.6	279.8	158.0
CT	4	2	50	69	9	660	91	116.5	65.1	117.5	37.3
CT	4	2	100	35	6	478	176	439.8	20.7	473.5	131.0
CT	4	2	150	52	18	598	121	384.0	217.3	635.3	137.2
CT	6	0	50	77	9	529	81	3.0	1.5	3.8	2.1
CT	6	0	100	75	19	572	102	57.3	53.9	23.5	22.5
CT	6	0	150	79	9	558	82	1.3	0.9	8.5	4.3
CT	6	2	50	80	5	564	230	24.8	20.6	28.0	12.6
CT	6	2	100	74	6	513	98	91.3	37.0	338.3	242.0
CT	6	2	150	66	2	401	198	435.0	125.9	366.8	63.5
ZT	0	0	0	82	4	661	68	1.5	0.6	0.3	0.3
ZT	2	0	50	69	10	545	141	12.8	12.1	61.3	37.2
ZT	2	0	100	55	7	599	77	88.8	87.1	97.0	55.6
ZT	2	0	150	37	3	517	91	121.3	60.3	102.5	57.8
ZT	2	2	50	22	3	379	62	566.5	143.8	394.5	128.7
ZT	2	2	100	4	1	0	0	784.5	193.4	578.8	47.9
ZT	2	2	150	1	1	0	0	1604.3	293.1	1290.5	191.6

ZT	4	0	50	78	17	537	28	13.0	10.7	59.8	25.6
ZT	4	0	100	78	13	685	75	88.0	45.1	420.3	235.8
ZT	4	0	150	60	5	545	47	342.8	158.4	267.0	102.9
ZT	4	2	50	42	9	540	51	487.3	61.7	312.8	60.5
ZT	4	2	100	30	11	377	114	679.8	90.2	748.3	51.0
ZT	4	2	150	21	8	318	108	1035.3	311.2	737.0	56.9
ZT	6	0	50	71	7	768	88	34.8	34.1	3.5	3.5
ZT	6	0	100	86	5	629	81	5.3	4.3	13.5	6.5
ZT	6	0	150	86	8	482	126	3.8	2.1	15.3	9.6
ZT	6	2	50	72	10	694	121	80.8	12.2	255.8	54.4
ZT	6	2	100	67	8	647	33	451.0	228.2	561.8	131.8
ZT	6	2	150	58	9	511	80	464.3	153.8	820.0	387.9

Table 8. Effect of nitrogen rate and placement on plant emergence yield and ammonium levels in the seed row during emergence clay loam 1999

	Side	depth	nitrogen	plants m^{-2}		seed yield kg ha^{-1}		NH4_4DAS		NH4_10das	
tillage	cm	cm	rate kg ha^{-1}	mean	SE	mean	SE	mean	SE	mean	SE
			0	45.5	4.1	363	49	40.9	28.7	3.1	0.2
			50	46.8	2.1	412	20	51.2	9.2	23.3	7.3
			100	41.3	2.3	440	25	141.2	27.0	35.0	7.9
			150	42.2	3.0	428	23	190.2	38.0	64.8	17.3
		0		39.5	2.0	411	18	179.5	28.0	54.4	11.5
		2		48.0	1.7	437	19	63.0	8.5	22.4	5.2
		0	0	45.5	4.1	363	49	40.9	28.7	3.1	0.2
		0	50	46.6	2.8	394	28	46.6	11.7	5.9	2.3
		0	100	35.3	3.6	428	37	219.6	46.6	52.3	13.7
		0	150	34.5	4.6	427	33	307.1	66.5	120.1	30.8
		2	50	46.9	3.1	431	29	55.9	14.5	40.0	13.4
		2	100	47.3	2.6	452	35	59.4	12.5	17.8	6.3
		2	150	49.9	3.1	429	33	73.3	17.2	9.5	3.1
	2			36.0	3.0	375	18	222.5	38.2	63.3	17.2
	4			45.8	2.3	486	21	145.7	24.6	42.3	8.7
	6			48.1	1.6	411	23	22.7	6.5	15.9	5.6
	2		50	40.5	3.7	397	29	70.6	14.3	25.8	16.9
	2		100	36.5	5.4	370	36	278.9	65.8	42.8	16.3
	2		150	30.9	6.1	358	32	321.5	82.2	121.2	43.5
	4		50	50.1	3.3	432	36	63.1	19.3	31.6	12.3
	4		100	39.2	3.3	530	36	135.3	22.9	40.3	14.3
	4		150	48.0	4.8	497	35	228.4	59.5	54.3	18.0
	6		0	45.5	4.1	363	49	40.9	28.7	3.1	0.2
	6		50	49.7	3.4	408	40	21.4	12.4	13.1	7.2
	6		100	48.2	2.6	420	51	18.1	8.2	22.1	9.9
	6		150	47.7	2.9	429	46	20.7	12.1	18.9	15.6
	2	0		21.6	3.1	432	21	379.4	57.7	106.4	30.3
	2	2		50.3	3.0	318	26	58.8	14.8	20.1	11.5
	4	0		43.9	3.1	514	35	196.0	44.6	54.6	15.5

	4	2		47.6	3.4	459	23	95.4	15.7	30.5	7.9
	6	0		49.5	2.1	318	23	12.4	6.8	15.3	8.3
	6	2		46.2	2.3	535	31	36.0	11.6	16.7	7.2
	2	0	50	36.7	3.5	464	22	94.6	21.9	4.1	1.4
	2	0	100	19.5	3.8	420	39	467.9	68.9	82.6	26.2
	2	0	150	8.6	3.0	412	45	575.6	96.6	232.4	67.2
	2	2	50	44.3	6.4	330	42	46.6	15.1	47.5	32.9
	2	2	100	53.5	5.4	320	57	62.9	27.4	2.9	0.4
	2	2	150	53.3	3.1	305	38	67.4	33.9	10.0	7.9
	4	0	50	49.8	3.6	433	54	41.9	13.8	3.3	0.6
	4	0	100	35.9	5.1	549	65	184.0	34.2	59.9	26.6
	4	0	150	46.1	6.3	561	58	342.9	103.0	94.3	30.3
	4	2	50	50.4	5.8	431	53	84.4	35.7	56.4	19.5
	4	2	100	42.6	4.1	511	33	86.5	19.7	20.6	7.5
	4	2	150	49.8	7.7	433	27	113.9	28.7	14.4	4.7
	6	0	0	45.5	4.1	363	49	40.9	28.7	3.1	0.2
	6	0	50	53.3	5.5	285	42	2.8	0.2	10.0	6.5
	6	0	100	50.6	4.0	314	62	6.9	4.6	14.3	10.9
	6	0	150	48.8	3.5	310	25	2.8	0.4	33.8	31.3
	6	2	50	46.1	4.0	532	30	40.1	23.6	16.1	13.3
	6	2	100	45.7	3.2	526	65	29.3	15.2	29.9	16.8
	6	2	150	46.7	5.0	548	65	38.6	23.1	4.1	1.4
Conv				42.9	1.9	444	18	110.5	20.3	39.9	11.0
Conv				44.2	2.0	402	18	137.9	24.6	38.4	7.4
Conv			0	48.8	5.2	335	38	2.7	0.7	3.0	0.4
Conv			50	46.0	2.6	410	28	44.0	13.9	13.4	7.1
Conv			100	39.3	3.4	498	37	133.5	39.3	30.5	11.3
Conv			150	42.4	4.4	443	32	162.0	43.0	80.8	30.4
ZT			0	42.2	6.6	390	97	69.5	47.4	3.3	0.3
ZT			50	47.5	3.3	414	30	57.9	12.4	32.8	12.4
ZT			100	43.2	3.3	382	31	149.2	37.8	39.5	11.2
ZT			150	42.0	4.1	413	34	218.4	63.2	48.8	16.7
Conv		0		37.9	2.8	428	27	160.7	35.2	63.8	19.9
Conv		2		48.5	2.4	462	25	56.1	13.8	14.0	5.5
ZT		0		41.1	3.0	394	23	197.3	43.4	45.3	11.8
ZT		2		47.6	2.4	412	28	69.9	10.2	30.9	8.7
Conv		0	0	48.8	5.2	335	38	2.7	0.7	3.0	0.4
Conv		0	50	45.9	3.6	396	41	36.6	11.9	2.9	0.4
Conv		0	100	34.6	5.1	478	57	215.8	69.9	45.8	19.7
Conv		0	150	29.5	5.8	442	53	258.8	72.2	157.9	52.9
Conv		2	50	46.0	3.8	425	39	51.4	25.6	23.0	13.2
Conv		2	100	44.1	4.2	519	49	51.3	18.3	15.3	9.9
Conv		2	150	55.3	4.1	444	37	65.2	28.5	3.7	1.2
ZT		0	0	42.2	6.6	390	97	69.5	47.4	3.3	0.3
ZT		0	50	47.3	4.4	392	40	55.8	19.7	8.7	4.3
ZT		0	100	36.1	5.2	377	45	223.3	64.7	58.8	19.8
ZT		0	150	39.5	7.0	413	40	355.4	113.5	82.3	30.4

ZT		2	50	47.8	5.0	437	45	60.0	15.9	57.0	22.9
ZT		2	100	50.4	2.9	386	45	68.3	17.4	20.3	8.1
ZT		2	150	44.5	4.4	414	56	81.4	20.3	15.3	5.7
Conv	2			36.8	4.6	389	25	197.8	48.0	67.8	28.8
Conv	4			45.4	3.1	514	33	141.2	29.6	35.6	14.3
Conv	6			46.0	2.1	432	31	7.9	2.6	19.5	10.1
ZT	2			35.1	3.9	361	27	248.3	60.5	58.7	19.5
ZT	4			46.2	3.5	459	25	149.8	39.1	48.7	10.2
ZT	6			50.2	2.2	390	35	37.0	12.0	12.3	5.0
Conv	2		50	45.9	4.8	393	35	58.0	13.8	15.3	12.4
Conv	2		100	32.2	8.6	421	48	273.3	93.2	35.8	23.1
Conv	2		150	32.4	9.7	352	49	262.1	98.2	152.4	77.1
Conv	4		50	47.1	4.3	418	57	80.7	42.7	23.6	18.9
Conv	4		100	40.0	4.4	585	59	114.8	39.4	25.6	20.4
Conv	4		150	49.0	7.0	539	44	213.1	59.0	56.1	32.8
Conv	6		0	48.8	5.2	335	38	2.7	0.7	3.0	0.4
Conv	6		50	44.9	4.7	420	55	2.5	0.2	2.6	0.3
Conv	6		100	45.9	2.6	489	76	12.6	6.4	30.1	17.1
Conv	6		150	45.9	5.1	437	55	10.6	5.7	33.9	31.3
ZT	2		50	35.0	5.1	401	48	83.3	25.2	36.4	32.1
ZT	2		100	40.8	6.8	318	48	285.3	100.4	49.8	24.4
ZT	2		150	29.5	8.2	365	44	380.9	135.2	90.0	43.4
ZT	4		50	53.1	5.0	446	49	50.0	13.2	38.6	16.9
ZT	4		100	38.5	5.2	476	33	155.8	23.8	54.9	19.9
ZT	4		150	46.9	7.1	455	52	243.6	107.8	52.5	17.8
ZT	6		0	42.2	6.6	390	97	69.5	47.4	3.3	0.3
ZT	6		50	54.5	4.5	397	62	40.4	23.6	23.5	13.8
ZT	6		100	50.4	4.5	351	64	23.5	15.4	14.0	10.3
ZT	6		150	49.6	3.2	421	77	30.8	23.7	4.0	1.5
Conv	2	0		21.6	5.1	419	35	328.6	76.3	124.8	53.1
Conv	2	2		52.0	4.5	359	36	67.0	26.6	10.8	8.3
Conv	4	0		40.8	4.2	553	55	189.7	49.1	55.5	26.9
Conv	4	2		49.9	4.3	475	36	92.7	28.4	17.3	11.0
Conv	6	0		47.8	2.6	342	33	5.1	2.4	23.8	16.2
Conv	6	2		43.6	3.6	553	37	11.5	4.9	13.8	10.0
ZT	2	0		21.6	3.6	446	23	430.2	87.3	88.0	30.9
ZT	2	2		48.6	4.1	277	34	49.8	11.8	29.4	21.7
ZT	4	0		47.0	4.5	475	42	201.8	74.9	53.8	18.0
ZT	4	2		45.4	5.4	442	29	97.8	16.7	43.6	10.3
ZT	6	0		51.2	3.4	294	31	19.3	13.0	6.8	3.3
ZT	6	2		48.8	2.7	517	50	60.5	20.8	19.7	10.6
Conv	2	0	50	41.0	5.7	442	23	79.8	7.7	2.8	0.3
Conv	2	0	100	15.2	6.4	428	58	470.8	111.1	68.5	42.2
Conv	2	0	150	8.6	4.5	387	95	435.3	142.8	303.0	112.4
Conv	2	2	50	50.8	7.8	344	60	36.3	22.8	27.8	24.8
Conv	2	2	100	49.2	10.5	415	87	75.8	46.5	3.0	0.6
Conv	2	2	150	56.1	6.3	318	39	89.0	67.8	1.8	0.3

Conv	4	0	50	46.7	5.4	437	94	24.7	20.2	3.3	1.3
Conv	4	0	100	37.7	4.5	598	118	165.3	69.8	44.5	41.2
Conv	4	0	150	38.1	11.2	624	58	338.0	52.1	105.8	58.0
Conv	4	2	50	47.5	7.7	399	78	136.7	74.8	38.8	32.8
Conv	4	2	100	42.2	8.1	572	47	64.3	26.2	6.8	3.8
Conv	4	2	150	59.8	5.0	455	32	88.3	56.0	6.5	3.2
Conv	6	0	0	48.8	5.2	335	38	2.7	0.7	3.0	0.4
Conv	6	0	50	50.0	8.4	310	72	2.5	0.3	2.8	0.5
Conv	6	0	100	50.8	3.3	408	107	11.5	9.2	24.3	21.9
Conv	6	0	150	41.8	2.9	315	36	3.0	0.7	65.0	62.7
Conv	6	2	50	39.8	4.1	531	33	2.5	0.3	2.5	0.3
Conv	6	2	100	41.0	2.0	570	106	13.8	10.4	36.0	29.3
Conv	6	2	150	50.0	10.0	560	51	18.3	10.6	2.8	0.5
ZT	2	0	50	32.4	3.6	487	38	109.5	45.2	5.5	2.8
ZT	2	0	100	23.8	3.7	413	60	465.0	99.0	96.8	36.0
ZT	2	0	150	8.6	4.8	437	6	716.0	100.1	161.8	71.5
ZT	2	2	50	37.7	10.1	316	66	57.0	21.8	67.3	64.6
ZT	2	2	100	57.8	3.4	224	36	45.7	25.5	2.8	0.5
ZT	2	2	150	50.4	0.8	292	73	45.8	21.0	18.3	15.6
ZT	4	0	50	52.9	4.9	429	67	54.8	18.2	3.3	0.6
ZT	4	0	100	34.0	9.9	500	64	202.8	19.1	75.3	38.1
ZT	4	0	150	54.1	3.8	497	98	347.8	216.2	82.8	28.6
ZT	4	2	50	53.3	9.7	462	80	45.3	21.6	74.0	22.4
ZT	4	2	100	43.0	3.7	451	24	108.8	28.2	34.5	11.1
ZT	4	2	150	39.8	13.6	412	45	139.5	16.4	22.3	7.1
ZT	6	0	0	42.2	6.6	390	97	69.5	47.4	3.3	0.3
ZT	6	0	50	56.6	8.0	261	50	3.0	0.0	17.3	12.6
ZT	6	0	100	50.4	7.9	220	23	2.3	0.3	4.3	2.3
ZT	6	0	150	55.7	4.1	305	39	2.5	0.5	2.5	0.5
ZT	6	2	50	52.5	5.5	533	55	77.8	40.8	29.8	26.4
ZT	6	2	100	50.4	5.5	483	84	44.8	28.4	23.8	20.8
ZT	6	2	150	43.4	2.7	537	131	59.0	45.7	5.5	2.9

Table 9. Agronomic traits 2000 loam										
Seeding	Nitrogen	Nitrogen	plants m^{-2}		Seed kg Ha^{-1}		straw kg Ha^{-1}		Harvest index	
Date	placement	rate	mean	SE	mean	SE	mean	SE	mean	SE
			47.1	2.0	1250	26	3267	50	39.5	0.9
		0	58.9	11.2	1147	117	3080	150	37.6	3.9
		50	48.6	3.6	1258	46	3091	75	41.5	1.5
		100	46.2	3.5	1224	41	3312	96	38.8	1.6
		150	44.5	3.5	1287	50	3430	97	38.7	1.5
	2-0		34.6	3.5	1046	47	3348	132	32.4	1.7
	2-2		50.6	5.7	1290	64	3219	131	41.5	2.2
	4-0		44.6	4.5	1263	59	3237	121	40.3	2.1
	4-2		53.1	6.0	1342	63	3266	140	42.0	1.6
	6-0		46.6	4.5	1330	58	3175	104	43.2	2.1
	6-2		51.6	4.7	1235	68	3336	115	38.3	2.2
	2-0	50	38.1	6.3	1097	104	2985	140	37.1	3.5
	2-0	100	31.5	5.8	1027	55	3621	260	29.7	2.5
	2-0	150	33.8	6.2	1015	83	3438	244	30.3	2.4
	2-2	50	55.9	10.5	1253	129	3099	220	42.0	4.1
	2-2	100	52.6	11.0	1199	102	3096	204	40.1	4.0
	2-2	150	44.0	8.8	1417	102	3463	257	42.5	3.3
	4-0	50	49.9	7.9	1193	108	2997	150	40.7	4.4
	4-0	100	43.3	8.2	1335	76	3289	276	42.8	3.3
	4-0	150	40.3	7.6	1262	122	3425	182	37.3	3.5
	4-2	50	52.6	11.3	1376	98	3113	217	44.9	2.6
	4-2	100	54.8	8.9	1243	110	3305	210	38.4	3.4
	4-2	150	51.8	11.9	1407	122	3380	302	42.7	2.2
	6-0	50	47.0	8.0	1314	100	3012	125	44.1	3.5
	6-0	100	45.1	8.0	1285	98	3089	187	43.1	4.3
	6-0	150	47.7	8.3	1392	107	3424	212	42.2	3.5
	6-2	0	58.9	11.2	1147	117	3080	150	37.6	3.9
	6-2	50	49.0	9.2	1313	131	3337	240	40.2	3.6
	6-2	100	49.5	8.8	1253	137	3473	266	38.4	4.5
	6-2	150	48.8	9.2	1227	165	3453	258	36.9	6.0
Fall_99			16.4	1.1	933	27	3094	89	31.9	1.2
earMay			73.7	2.6	1559	37	3579	89	44.9	1.2
LatMay			52.0	2.1	1259	35	3130	73	41.8	1.6
Fall_99		0	13.3	1.6	743	111	3123	197	23.4	2.3
Fall_99		50	15.8	1.2	844	41	2828	136	31.5	2.1
Fall_99		100	19.2	3.0	955	51	3256	163	31.1	2.1
Fall_99		150	14.6	1.1	1032	46	3191	177	34.7	2.4
earMay		0	83.7	17.1	1375	217	3376	337	40.7	5.1
earMay		50	75.9	4.3	1551	55	3432	110	45.6	1.4
earMay		100	72.2	4.6	1459	68	3413	215	45.8	3.0
earMay		150	71.5	4.7	1697	66	3924	116	44.0	2.1
LatMay		0	79.7	5.7	1324	99	2741	163	48.9	4.7

LatMay		50	54.8	3.3	1377	52	3012	117	47.4	2.7
LatMay		100	47.4	3.5	1257	52	3267	107	39.4	2.1
LatMay		150	48.0	3.7	1130	74	3176	162	37.3	3.2
Fall_99	2-0		12.8	1.4	855	54	3158	140	27.4	1.8
Fall_99	2-2		16.5	1.9	942	89	2978	266	34.6	4.4
Fall_99	4-0		15.7	1.4	1038	80	3164	153	33.2	2.4
Fall_99	4-2		17.4	1.9	974	62	2772	254	37.4	2.8
Fall_99	6-0		17.8	1.7	969	50	3122	231	32.9	2.9
Fall_99	6-2		17.6	4.4	850	57	3299	227	27.6	2.6
earMay	2-0		54.6	3.8	1265	74	3710	295	35.8	2.8
earMay	2-2		83.7	7.4	1597	91	3575	248	46.1	2.9
earMay	4-0		69.2	3.5	1516	87	3603	242	43.1	2.6
earMay	4-2		83.2	8.4	1656	89	3896	191	43.2	2.6
earMay	6-0		71.4	4.8	1625	70	3176	177	52.5	3.2
earMay	6-2		78.7	5.6	1660	93	3528	151	47.6	2.7
LatMay	2-0		36.7	2.7	1018	71	3177	204	33.8	3.5
LatMay	2-2		51.9	4.5	1330	61	3105	119	43.9	3.1
LatMay	4-0		49.9	5.8	1237	94	2944	195	44.6	4.9
LatMay	4-2		60.5	5.4	1395	68	3130	159	45.4	2.7
LatMay	6-0		51.6	4.9	1396	64	3226	138	44.1	2.8
LatMay	6-2		58.9	4.7	1195	95	3181	216	39.6	4.3
Fall_99	2-0	50	12.5	1.8	710	81	2792	157	26.0	4.2
Fall_99	2-0	100	11.9	1.8	835	45	3566	182	23.6	1.9
Fall_99	2-0	150	13.9	3.6	1019	85	3116	239	32.7	1.1
Fall_99	2-2	50	20.1	3.4	743	139	3031	636	29.4	9.6
Fall_99	2-2	100	17.8	3.2	901	83	2900	206	31.5	3.6
Fall_99	2-2	150	11.7	1.9	1182	167	3004	574	42.9	8.5
Fall_99	4-0	50	14.4	2.6	916	88	2736	108	33.6	3.5
Fall_99	4-0	100	16.4	1.7	1258	139	3315	349	38.6	3.8
Fall_99	4-0	150	16.2	3.2	940	135	3440	177	27.3	3.6
Fall_99	4-2	50	12.9	3.1	992	120	2674	475	38.5	3.3
Fall_99	4-2	100	22.6	1.6	971	145	3369	332	29.5	5.2
Fall_99	4-2	150	16.8	3.1	960	82	2274	414	44.2	3.7
Fall_99	6-0	50	19.5	4.2	902	74	2967	129	30.3	1.8
Fall_99	6-0	100	16.2	1.8	953	48	2892	417	34.6	4.3
Fall_99	6-0	150	17.6	2.8	1053	125	3507	566	33.8	8.1
Fall_99	6-2	0	13.3	1.6	743	111	3123	197	23.4	2.3
Fall_99	6-2	50	15.6	1.5	802	56	2768	361	31.2	6.0
Fall_99	6-2	100	30.6	17.6	815	152	3498	776	28.5	9.1
Fall_99	6-2	150	11.1	1.4	1041	101	3808	225	27.4	2.3
earMay	2-0	50	60.0	5.6	1390	118	3407	277	41.1	3.1
earMay	2-0	100	49.8	7.6	1200	75	3943	759	33.4	5.6
earMay	2-0	150	54.0	7.5	1204	180	3781	505	33.0	5.8
earMay	2-2	50	87.9	14.4	1610	138	3316	267	48.8	2.9
earMay	2-2	100	88.9	13.2	1402	192	3218	595	46.9	8.2
earMay	2-2	150	74.2	13.2	1778	105	4191	242	42.8	3.0
earMay	4-0	50	72.3	4.7	1355	170	3514	238	38.4	3.3

earMay	4-0	100	73.7	7.7	1458	126	3525	736	44.6	6.0
earMay	4-0	150	61.7	5.2	1733	117	3771	183	46.3	3.7
earMay	4-2	50	82.9	16.3	1640	43	3771	243	44.1	3.2
earMay	4-2	100	78.2	12.6	1464	210	3684	488	40.9	6.8
earMay	4-2	150	88.5	18.0	1865	123	4232	215	44.5	3.9
earMay	6-0	50	75.9	7.3	1499	102	2941	259	51.3	2.0
earMay	6-0	100	68.4	9.8	1606	124	2796	226	58.9	7.8
earMay	6-0	150	69.8	9.7	1771	124	3793	181	47.2	4.7
earMay	6-2	0	83.7	17.1	1375	217	3376	337	40.7	5.1
earMay	6-2	50	76.6	10.1	1813	120	3646	285	49.9	1.9
earMay	6-2	100	74.0	11.7	1623	235	3312	325	49.8	7.2
earMay	6-2	150	80.5	8.5	1830	114	3776	325	50.2	6.6
LatMay	2-0	50	41.8	5.0	1189	129	2757	161	44.2	6.5
LatMay	2-0	100	33.3	3.1	1046	59	3355	275	32.0	3.7
LatMay	2-0	150	33.3	4.4	821	111	3418	518	25.2	4.0
LatMay	2-2	50	60.9	6.2	1404	83	2951	180	47.8	2.5
LatMay	2-2	100	50.5	12.5	1295	152	3168	206	41.9	7.3
LatMay	2-2	150	46.1	4.9	1293	90	3196	264	41.9	6.3
LatMay	4-0	50	62.9	2.5	1309	230	2742	214	50.1	11.9
LatMay	4-0	100	38.5	0.5	1291	141	3027	368	45.1	7.7
LatMay	4-0	150	44.0	17.3	1113	128	3062	466	38.5	6.7
LatMay	4-2	50	65.3	7.9	1496	110	2894	98	52.0	4.7
LatMay	4-2	100	66.7	2.4	1295	159	2863	157	44.8	3.7
LatMay	4-2	150	49.4	13.8	1395	78	3634	341	39.5	4.3
LatMay	6-0	50	45.7	10.4	1543	88	3129	283	50.8	5.8
LatMay	6-0	100	52.7	5.1	1295	132	3578	195	35.9	1.9
LatMay	6-0	150	58.5	8.3	1351	92	2972	163	45.6	3.0
LatMay	6-2	0	79.7	5.7	1324	99	2741	163	48.9	4.7
LatMay	6-2	50	56.9	8.6	1324	46	3598	510	39.6	6.8
LatMay	6-2	100	43.8	8.2	1322	127	3611	240	36.9	3.8
LatMay	6-2	150	54.7	4.9	811	294	2773	589	33.1	15.8

Table 10. Impact of seeding date and nitrogen rate and placement on ammonium levels in the seed row loam soil 2000						
Seeding	Nitrogen	Nitrogen	NH4_ppm 3das 0-2cm		NH4ppm 3das 2-4 cm	
		0	4.6	0.7	4.3	0.7
		50	15.5	4.1	13.7	3.0
		100	12.6	3.3	42.2	20.5
		150	47.9	22.3	25.8	13.4
	2-0		36.6	10.4	65.6	40.9
	2-2		9.3	1.8	8.4	1.4
	4-0		57.3	42.4	74.2	38.6
	4-2		8.4	1.3	15.0	3.1
	6-0		35.4	17.0	9.0	2.2
	6-2		6.0	0.8	7.2	1.1
	2-0	50	18.9	6.8	15.1	6.4
	2-0	100	43.1	18.0	147.4	111.7
	2-0	150	50.7	27.2	25.3	11.8
	2-2	50	9.4	4.7	6.1	1.4
	2-2	100	8.5	1.9	6.9	2.3
	2-2	150	10.0	2.3	12.2	3.3
	4-0	50	19.7	7.4	30.4	18.9
	4-0	100	9.6	4.6	87.3	70.9
	4-0	150	150.2	135.2	109.1	100.7
	4-2	50	6.0	1.2	12.8	3.9
	4-2	100	5.7	1.1	17.0	6.1
	4-2	150	13.9	3.3	15.1	6.5
	6-0	50	30.2	22.2	10.6	5.4
	6-0	100	5.7	0.9	5.4	1.0
	6-0	150	67.8	44.1	10.9	3.6
	6-2	0	4.6	0.7	4.3	0.7
	6-2	50	8.6	2.5	11.3	3.4
	6-2	100	4.3	0.6	7.4	2.6
	6-2	150	6.4	1.4	6.3	1.2
Fall_99			16.1	4.4	7.1	1.5
earMay			33.3	18.3	48.6	19.1
LatMay			21.7	8.3	19.0	3.2
Fall_99		0	3.5	0.6	2.8	0.5
Fall_99		50	7.9	3.1	6.0	2.5
Fall_99		100	7.0	1.8	3.9	0.5
Fall_99		150	35.5	12.7	12.0	3.9
earMay		0	5.9	2.0	6.0	1.8
earMay		50	19.2	11.1	19.7	6.7
earMay		100	19.9	8.6	92.6	51.9
earMay		150	65.4	56.5	42.4	32.0
LatMay		0	4.5	0.7	4.1	0.8
LatMay		50	19.2	4.8	17.8	4.7

LatMay		100	10.5	3.8	24.7	6.1
LatMay		150	41.2	29.6	20.6	8.2
Fall_99	2-0		49.7	22.9	17.3	8.1
Fall_99	2-2		7.8	2.4	8.5	2.9
Fall_99	4-0		14.0	8.0	5.4	1.8
Fall_99	4-2		8.7	2.6	5.8	2.3
Fall_99	6-0		16.3	9.9	3.3	0.4
Fall_99	6-2		4.1	0.5	3.2	0.4
earMay	2-0		34.8	16.3	136.1	100.5
earMay	2-2		6.9	0.9	8.8	1.8
earMay	4-0		123.3	112.9	159.6	83.1
earMay	4-2		7.4	1.2	10.2	1.8
earMay	6-0		30.0	22.1	12.3	4.4
earMay	6-2		6.5	0.8	7.8	1.1
LatMay	2-0		21.4	9.3	23.3	13.6
LatMay	2-2		13.5	5.1	6.8	0.9
LatMay	4-0		23.4	10.8	45.0	
LatMay	4-2		9.1	2.9	38.9	7.7
LatMay	6-0		62.1	48.1	13.6	5.5
LatMay	6-2		7.3	2.1	11.6	3.3
Fall_99	2-0	50	21.5	17.8	17.8	14.8
Fall_99	2-0	100	18.3	9.0	6.4	1.5
Fall_99	2-0	150	109.4	59.7	27.9	20.7
Fall_99	2-2	50	3.4	0.7	3.2	1.0
Fall_99	2-2	100	5.5	2.3	3.9	1.1
Fall_99	2-2	150	14.6	5.6	18.5	6.3
Fall_99	4-0	50	9.5	5.7	4.8	1.3
Fall_99	4-0	100	4.5	0.3	3.5	0.5
Fall_99	4-0	150	27.9	23.7	8.0	5.5
Fall_99	4-2	50	2.9	0.8	3.3	0.6
Fall_99	4-2	100	6.6	3.0	3.6	1.3
Fall_99	4-2	150	16.6	5.8	10.6	6.7
Fall_99	6-0	50	3.8	0.8	3.3	0.5
Fall_99	6-0	100	4.0	1.0	2.9	0.7
Fall_99	6-0	150	41.1	27.6	3.8	1.1
Fall_99	6-2	0	3.5	0.6	2.8	0.5
Fall_99	6-2	50	6.6	1.0	4.0	0.9
Fall_99	6-2	100	3.1	0.7	3.0	0.9
Fall_99	6-2	150	3.3	1.1	3.0	1.2
earMay	2-0	50	11.6	5.0	15.6	3.1
earMay	2-0	100	77.3	44.1	411.0	312.2
earMay	2-0	150	15.5	7.6	21.8	10.4
earMay	2-2	50	6.8	1.6	9.1	2.8
earMay	2-2	100	5.3	1.1	10.2	5.9
earMay	2-2	150	8.6	1.7	7.4	1.8
earMay	4-0	50	6.8	1.7	59.8	49.1
earMay	4-0	100	17.5	11.1	171.1	137.0

earMay	4-0	150	345.6	339.5	244.0	234.5
earMay	4-2	50	9.4	2.8	13.6	4.2
earMay	4-2	100	5.5	1.7	9.0	3.0
earMay	4-2	150	7.3	1.7	8.0	2.0
earMay	6-0	50	74.0	66.4	20.1	13.0
earMay	6-0	100	8.3	2.0	7.5	1.6
earMay	6-0	150	7.6	1.8	9.3	2.9
earMay	6-2	0	5.9	2.0	6.0	1.8
earMay	6-2	50	6.6	1.4	9.9	3.6
earMay	6-2	100	5.8	1.6	5.9	1.5
earMay	6-2	150	7.6	1.9	9.4	1.5
LatMay	2-0	50	23.5	11.8	2.0	
LatMay	2-0	100	30.7	24.7	34.0	14.5
LatMay	2-0	150	3.5	1.5		
LatMay	2-2	50	18.0	14.3	6.0	1.0
LatMay	2-2	100	14.9	3.6	9.0	
LatMay	2-2	150	5.8	2.2	6.0	
LatMay	4-0	50	42.8	17.1	45.0	
LatMay	4-0	100	4.0	2.0		
LatMay	4-0	150	4.0	1.0		
LatMay	4-2	50	5.8	1.1	24.5	10.7
LatMay	4-2	100	4.9	1.1	45.7	9.4
LatMay	4-2	150	19.3	8.7	61.5	
LatMay	6-0	50	12.9	7.9	6.0	1.0
LatMay	6-0	100	4.7	0.3	6.3	1.8
LatMay	6-0	150	154.5	129.2	28.5	11.0
LatMay	6-2	0	4.5	0.7	4.1	0.8
LatMay	6-2	50	12.5	7.7	22.8	8.7
LatMay	6-2	100	4.0	0.6	15.2	8.7
LatMay	6-2	150	8.3	3.4	6.7	1.9

Table 11. Agronomic traits 2000 clay loam

Seeding	Nitrogen	Nitrogen	plants m^{-2}		Seed kg Ha^{-1}		straw kg Ha^{-1}		Harvest index	
Date	placement	rate	mean	SE	mean	SE	mean	SE	mean	SE
		0	40.98	6.65	477	68	1864	204	24.69	1.81
		50	36.51	2.51	679	29	2481	80	27.46	0.84
		100	34.95	2.44	790	37	2807	93	28.43	1.01
		150	32.58	2.55	804	41	2942	93	27.40	1.08
	2-0		32.49	3.30	740	50	2700	143	28.07	1.54
	2-2		28.81	2.86	656	42	2663	115	25.07	1.30
	4-0		33.70	3.61	795	54	2782	135	28.24	1.13
	4-2		37.39	3.95	704	53	2724	133	26.23	1.55
	6-0		37.80	3.69	823	57	2787	133	29.28	1.45
	6-2		38.67	3.18	739	46	2568	121	28.44	1.05
	2-0	50	35.99	6.03	694	81	2348	226	29.58	2.40
	2-0	100	31.08	5.06	749	86	2769	239	28.13	2.95
	2-0	150	30.39	6.36	777	97	2983	259	26.51	2.80
	2-2	50	33.76	5.54	672	65	2380	139	28.58	2.21
	2-2	100	29.15	4.82	666	91	2769	212	24.29	2.55
	2-2	150	23.53	4.40	631	67	2840	224	22.32	1.67
	4-0	50	34.60	6.29	704	65	2618	208	26.86	1.17
	4-0	100	35.12	6.52	777	99	2586	241	29.66	2.16
	4-0	150	31.38	6.47	903	111	3142	233	28.20	2.43
	4-2	50	37.53	6.80	595	74	2348	192	25.98	2.78
	4-2	100	37.83	6.96	781	91	2983	252	26.16	2.08
	4-2	150	36.81	7.36	735	104	2840	219	26.54	3.28
	6-0	50	38.61	6.91	666	88	2578	258	25.37	2.01
	6-0	100	39.15	6.57	909	90	2904	194	31.28	2.45
	6-0	150	35.64	6.20	896	111	2880	241	31.19	2.82
	6-2	0	40.98	6.65	477	68	1864	204	24.69	1.81
	6-2	50	38.59	6.51	742	66	2610	157	28.39	1.60
	6-2	100	37.40	6.36	856	91	2832	261	31.06	2.34
	6-2	150	37.71	6.68	882	96	2967	223	29.64	2.32
Fall_99			9.89	0.48	694	25	3019	75	23.88	0.99
May_01			57.86	1.14	1037	30	3142	67	33.12	0.77
May_20			37.29	1.03	497	19	1930	57	25.80	0.70
Fall_99		0	11.88	1.98	571	43	2118	131	27.33	2.86
Fall_99		50	10.36	0.94	615	44	2678	116	23.49	1.78
Fall_99		100	10.32	0.85	743	41	3150	128	24.96	1.93
Fall_99		150	8.65	0.77	744	44	3380	106	22.61	1.66
May_01		0	63.23	3.50	634	116	2332	302	26.92	2.14
May_01		50	59.20	1.48	917	35	2920	106	31.79	1.07
May_01		100	56.77	2.24	1097	51	3292	95	33.53	1.51
May_01		150	56.73	2.36	1163	51	3348	120	35.08	1.43
May_20		0	47.85	2.67	227	62	1142	285	19.81	3.39
May_20		50	39.97	1.69	504	29	1844	86	27.10	0.88

May_20		100	37.77	1.41	528	35	1979	102	26.80	1.26
May_20		150	32.36	1.96	504	32	2098	88	24.51	1.42
Fall_99	2-0		9.81	0.81	701	59	3070	219	24.02	2.71
Fall_99	2-2		9.72	1.17	648	63	3023	177	22.70	2.73
Fall_99	4-0		8.51	1.28	753	56	3007	188	25.73	2.03
Fall_99	4-2		9.93	1.75	613	83	3173	201	19.99	2.80
Fall_99	6-0		10.03	1.32	729	63	3031	171	24.61	2.78
Fall_99	6-2		10.96	0.81	713	43	2862	175	25.63	1.69
May_01	2-0		54.33	2.10	1060	44	3181	170	34.20	1.92
May_01	2-2		45.52	3.69	844	73	2959	136	28.46	1.90
May_01	4-0		58.23	1.74	1120	79	3380	166	33.08	1.84
May_01	4-2		64.98	1.97	1005	66	3007	198	33.99	1.69
May_01	6-0		60.38	2.00	1188	63	3348	119	35.75	2.02
May_01	6-2		62.28	1.60	1012	79	3017	166	33.23	1.68
May_20	2-0		33.32	2.98	459	40	1848	133	26.00	2.52
May_20	2-2		31.21	2.01	476	40	2007	130	24.04	1.81
May_20	4-0		34.36	2.74	512	41	1960	111	25.92	1.27
May_20	4-2		37.25	2.08	494	44	1991	119	24.69	1.69
May_20	6-0		42.98	2.33	553	62	1983	180	27.48	1.48
May_20	6-2		42.78	1.44	493	50	1827	154	26.47	1.52
Fall_99	2-0	50	9.33	1.21	623	132	2523	409	25.72	6.49
Fall_99	2-0	100	10.28	1.73	693	118	3284	368	22.87	5.89
Fall_99	2-0	150	9.83	1.62	788	43	3404	273	23.46	1.63
Fall_99	2-2	50	11.98	2.95	636	132	2452	279	27.13	5.58
Fall_99	2-2	100	8.48	1.34	605	134	3166	188	19.94	5.21
Fall_99	2-2	150	8.70	1.43	704	83	3451	234	21.04	3.74
Fall_99	4-0	50	9.33	0.82	695	68	2761	230	25.43	2.65
Fall_99	4-0	100	9.55	3.63	722	115	2785	340	27.07	4.81
Fall_99	4-0	150	6.65	1.54	842	111	3475	331	24.68	3.74
Fall_99	4-2	50	9.13	3.68	463	99	2618	253	18.70	4.74
Fall_99	4-2	100	11.98	2.20	800	103	3499	410	24.22	4.78
Fall_99	4-2	150	8.70	3.61	575	191	3404	241	17.06	5.64
Fall_99	6-0	50	11.58	3.05	664	168	3023	376	20.99	4.64
Fall_99	6-0	100	10.15	1.93	791	74	3046	240	26.58	3.79
Fall_99	6-0	150	8.38	2.12	733	88	3023	351	26.25	6.50
Fall_99	6-2	0	11.88	1.98	571	43	2118	131	27.33	2.86
Fall_99	6-2	50	10.85	2.03	611	52	2690	207	22.94	1.97
Fall_99	6-2	100	11.48	1.96	846	48	3118	377	29.08	5.59
Fall_99	6-2	150	9.63	0.60	823	99	3522	216	23.18	2.08
May_01	2-0	50	55.43	1.99	977	58	2904	247	33.95	1.53
May_01	2-0	100	49.18	4.41	1084	33	3166	225	34.91	3.18
May_01	2-0	150	58.40	3.19	1120	115	3475	392	33.74	5.29
May_01	2-2	50	54.18	5.55	865	90	2690	157	32.21	2.87
May_01	2-2	100	42.93	5.29	897	181	3189	137	27.57	4.38
May_01	2-2	150	39.45	7.16	771	119	2999	342	25.60	2.15
May_01	4-0	50	56.68	3.12	888	125	3213	287	27.27	2.34
May_01	4-0	100	59.73	3.65	1124	124	3213	337	35.18	2.40

May_01	4-0	150	58.30	2.96	1347	53	3713	227	36.78	2.96
May_01	4-2	50	62.70	2.64	839	109	2618	376	33.29	4.08
May_01	4-2	100	67.08	2.59	1063	128	3356	262	31.61	2.53
May_01	4-2	150	65.15	5.09	1112	79	3046	361	37.09	1.81
May_01	6-0	50	63.95	3.21	926	73	3142	178	29.66	2.60
May_01	6-0	100	61.18	3.40	1279	32	3380	297	38.88	4.04
May_01	6-0	150	56.03	3.38	1360	46	3522	103	38.71	1.80
May_01	6-2	0	63.23	3.50	634	116	2332	302	26.92	2.14
May_01	6-2	50	62.30	2.96	1008	79	2951	293	34.37	0.89
May_01	6-2	100	60.55	4.42	1138	171	3451	225	33.03	4.84
May_01	6-2	150	63.03	3.06	1269	33	3332	261	38.58	2.15
May_20	2-0	50	43.23	3.78	482	88	1618	202	29.06	2.71
May_20	2-0	100	33.78	1.84	471	43	1857	158	26.61	5.08
May_20	2-0	150	22.95	3.39	423	87	2071	309	22.34	5.40
May_20	2-2	50	35.13	0.50	514	7	1999	165	26.41	2.76
May_20	2-2	100	36.05	2.10	495	105	1952	324	25.37	3.87
May_20	2-2	150	22.45	1.13	417	70	2071	228	20.33	2.54
May_20	4-0	50	37.80	6.78	530	69	1880	192	27.88	1.18
May_20	4-0	100	36.08	4.58	485	99	1762	200	26.73	2.68
May_20	4-0	150	29.20	1.33	520	63	2237	137	23.16	2.24
May_20	4-2	50	40.75	2.02	483	97	1809	230	25.95	3.24
May_20	4-2	100	34.43	3.15	480	80	2094	249	22.65	1.75
May_20	4-2	150	36.58	5.15	519	74	2071	152	25.48	3.99
May_20	6-0	50	40.30	6.91	408	80	1571	228	25.47	1.88
May_20	6-0	100	46.13	0.95	656	101	2285	239	28.37	2.43
May_20	6-0	150	42.53	2.30	595	120	2094	396	28.60	3.55
May_20	6-2	0	47.85	2.67	227	62	1142	285	19.81	3.39
May_20	6-2	50	42.63	1.98	609	56	2190	202	27.86	1.31
May_20	6-2	100	40.18	3.98	584	92	1928	361	31.06	1.76
May_20	6-2	150	40.48	1.45	553	47	2047	62	27.15	2.72

Table 12. Impact of seeding date and nitrogen rate and placement on ammonium levels in the seed row clay loam soil 2000

Seeding	Nitrogen	Nitrogen	NH4_ppm 3das 0-2cm		NH4ppm 3das 2-4 cm	
Date	placement	rate	mean	SE	mean	SE
		0	4.3	1.1	3.8	0.8
		50	19.5	5.4	40.9	15.2
		100	59.1	21.9	53.8	16.7
		150	101.0	32.6	134.7	43.8
	2-0		164.9	58.7	239.3	75.6
	2-2		12.2	2.2	32.8	14.8
	4-0		136.9	49.2	149.0	54.1
	4-2		24.3	6.3	13.0	3.3
	6-0		7.4	1.4	3.7	0.4
	6-2		12.5	2.9	20.1	10.6
	2-0	50	54.6	22.4	164.5	76.8
	2-0	100	140.0	89.5	168.0	74.1
	2-0	150	312.5	153.4	398.7	211.0
	2-2	50	7.1	1.3	18.0	11.1
	2-2	100	13.7	5.0	53.4	46.1
	2-2	150	15.7	4.1	29.3	11.9
	4-0	50	31.3	20.6	49.1	28.1
	4-0	100	158.5	90.6	76.1	38.3
	4-0	150	220.8	113.1	313.3	143.0
	4-2	50	9.8	4.1	4.9	1.2
	4-2	100	24.9	11.8	14.3	7.0
	4-2	150	38.3	13.7	19.9	6.5
	6-0	50	6.5	1.4	3.7	0.7
	6-0	100	6.1	1.3	3.6	0.7
	6-0	150	9.4	3.7	3.7	0.8
	6-2	0	4.3	1.1	3.8	0.8
	6-2	50	7.5	1.8	4.2	0.9
	6-2	100	11.2	3.2	7.3	3.2
	6-2	150	27.0	10.1	65.0	40.8
Fall_99			31.1	5.3	6.4	1.8
May_01			132.1	35.8	205.4	44.0
May_20			6.4	1.3	7.6	1.4
Fall_99		0	3.6	0.6	3.0	0.8
Fall_99		50	13.8	3.2	3.2	0.3
Fall_99		100	31.0	7.4	3.4	0.2
Fall_99		150	53.0	13.5	13.3	5.6
May_01		0	6.9	3.0	5.6	2.0
May_01		50	41.1	15.1	116.6	42.6
May_01		100	141.1	62.8	153.9	44.7
May_01		150	234.9	90.3	373.0	116.3

May_20		0	2.4	0.2	2.8	0.3
May_20		50	3.6	0.3	4.7	1.2
May_20		100	5.1	1.4	6.3	1.7
May_20		150	11.3	3.9	12.5	3.6
Fall_99	2-0		60.3	22.9	6.4	2.4
Fall_99	2-2		18.0	5.3	14.2	10.4
Fall_99	4-0		33.5	11.2	4.9	1.6
Fall_99	4-2		53.6	15.2	8.4	4.3
Fall_99	6-0		9.6	3.7	2.7	0.2
Fall_99	6-2		16.5	6.4	3.1	0.3
May_01	2-0		411.6	148.4	676.3	158.5
May_01	2-2		9.1	1.7	70.6	41.6
May_01	4-0		373.0	123.9	464.0	130.9
May_01	4-2		15.4	5.1	22.8	7.7
May_01	6-0		9.2	1.6	5.3	1.1
May_01	6-2		13.8	4.2	54.1	30.7
May_20	2-0		10.0	5.5	16.7	5.6
May_20	2-2		9.4	3.4	13.7	5.1
May_20	4-0		4.2	1.0	4.3	1.0
May_20	4-2		4.1	0.7	7.9	3.6
May_20	6-0		3.3	0.1	3.0	0.2
May_20	6-2		7.2	4.2	3.1	0.1
Fall_99	2-0	50	19.9	9.8	2.9	0.4
Fall_99	2-0	100	35.4	15.4	3.5	0.5
Fall_99	2-0	150	125.5	57.0	12.9	6.4
Fall_99	2-2	50	10.6	2.4	3.4	0.9
Fall_99	2-2	100	22.0	12.9	3.8	0.6
Fall_99	2-2	150	21.3	10.2	35.4	31.2
Fall_99	4-0	50	17.1	12.3	3.1	0.7
Fall_99	4-0	100	40.6	24.4	3.3	0.7
Fall_99	4-0	150	42.9	22.1	8.3	4.7
Fall_99	4-2	50	18.0	11.9	4.1	0.9
Fall_99	4-2	100	61.3	29.3	3.9	0.7
Fall_99	4-2	150	81.5	28.9	17.3	12.8
Fall_99	6-0	50	5.6	1.1	2.4	0.2
Fall_99	6-0	100	8.4	3.2	2.8	0.3
Fall_99	6-0	150	14.8	11.0	2.9	0.3
Fall_99	6-2	0	3.6	0.6	3.0	0.8
Fall_99	6-2	50	11.8	4.3	3.1	0.6
Fall_99	6-2	100	18.3	7.4	3.0	0.4
Fall_99	6-2	150	32.4	24.3	3.3	0.8
May_01	2-0	50	139.1	42.6	485.1	115.9
May_01	2-0	100	379.5	243.0	488.6	94.2
May_01	2-0	150	716.3	354.0	1055.0	427.0
May_01	2-2	50	7.0	1.9	37.0	29.7
May_01	2-2	100	8.4	2.9	162.5	152.8
May_01	2-2	150	12.0	4.1	35.4	19.5

May_01	4-0	50	73.1	60.3	171.3	65.3
May_01	4-0	100	432.0	228.0	221.9	74.5
May_01	4-0	150	613.8	250.6	925.8	193.5
May_01	4-2	50	8.6	2.1	7.9	3.3
May_01	4-2	100	8.5	2.0	31.9	19.0
May_01	4-2	150	29.0	13.5	28.5	12.7
May_01	6-0	50	10.8	3.4	5.8	1.7
May_01	6-0	100	6.5	1.7	4.9	2.2
May_01	6-0	150	10.3	2.9	5.1	2.3
May_01	6-2	0	6.9	3.0	5.6	2.0
May_01	6-2	50	7.8	2.5	6.3	2.5
May_01	6-2	100	12.0	4.6	15.9	8.6
May_01	6-2	150	28.4	14.8	188.5	103.5
May_20	2-0	50	4.8	1.6	5.4	1.4
May_20	2-0	100	5.1	2.1	12.0	8.0
May_20	2-0	150	23.5	20.5	38.0	10.3
May_20	2-2	50	3.6	0.7	12.3	9.1
May_20	2-2	100	10.8	8.1	10.3	4.3
May_20	2-2	150	13.8	6.5	17.3	11.8
May_20	4-0	50	3.8	1.0	3.5	0.9
May_20	4-0	100	3.0	0.5	3.3	0.6
May_20	4-0	150	5.8	2.9	6.0	2.9
May_20	4-2	50	2.9	0.4	2.8	0.3
May_20	4-2	100	4.9	2.1	7.1	4.5
May_20	4-2	150	4.5	0.9	13.9	10.0
May_20	6-0	50	3.3	0.1	2.9	0.4
May_20	6-0	100	3.5	0.2	3.1	0.4
May_20	6-0	150	3.3	0.3	3.1	0.2
May_20	6-2	0	2.4	0.2	2.8	0.3
May_20	6-2	50	3.1	0.2	3.3	0.3
May_20	6-2	100	3.3	0.3	3.1	0.3
May_20	6-2	150	20.1	16.6	3.3	0.1

Table 13. Agronomic traits 2002 loam										
Seeding	Nitrogen	Nitrogen	plants m^{-2}		Seed kg Ha^{-1}		straw kg Ha^{-1}		Harvest index	
Date	placement	rate	mean	SE	mean	SE	mean	SE	mean	SE
		0	58.9	6.4	595.2	83.6	1744.7	278.1	35.8	2.7
		50	55.1	2.5	1068.5	46.6	2663.6	128.2	41.4	1.3
		100	45.6	1.6	1274.0	44.1	2967.2	140.2	45.5	1.9
		150	44.7	1.7	1337.6	47.8	3288.7	159.2	43.5	1.9
	2-0		43.3	2.9	1115.1	61.8	2886.5	221.9	41.3	2.4
	2-2		46.7	3.5	1187.2	59.9	3057.4	198.1	40.9	2.2
	4-0		47.3	2.1	1226.0	73.9	2937.5	208.0	43.5	2.3
	4-2		52.2	3.4	1289.0	68.1	3018.3	182.3	44.4	2.5
	6-0		52.1	2.5	1145.4	77.4	2723.0	209.2	43.8	2.1
	6-2		51.6	2.6	1214.6	82.0	2890.1	222.3	44.3	2.6
	2-0	50	49.6	5.7	1016.4	93.4	2616.8	327.8	40.3	2.5
	2-0	100	43.1	5.1	1145.7	104.9	3006.2	407.8	40.8	4.7
	2-0	150	37.1	3.7	1183.3	125.6	3036.5	442.8	42.7	5.5
	2-2	50	56.8	7.4	1101.0	93.2	2707.2	318.7	42.9	3.3
	2-2	100	46.9	5.1	1288.6	101.5	3212.7	359.2	42.1	3.5
	2-2	150	36.6	3.6	1171.9	117.7	3252.4	360.4	37.8	4.8
	4-0	50	51.9	4.6	933.9	129.2	2446.0	353.6	40.0	3.9
	4-0	100	45.8	3.6	1386.2	96.3	3095.6	286.4	46.5	4.1
	4-0	150	44.1	2.0	1358.0	97.2	3270.9	406.5	44.1	4.3
	4-2	50	61.1	8.5	1138.3	106.9	2792.0	256.3	41.6	3.2
	4-2	100	46.5	1.6	1294.3	134.6	2832.1	330.1	48.5	5.7
	4-2	150	49.1	4.9	1435.1	102.9	3430.7	341.2	43.7	4.3
	6-0	0	58.9	6.4	595.2	83.6	1744.7	278.1	35.8	2.7
	6-0	50	57.9	4.9	1237.6	120.5	2866.9	381.9	45.2	3.7
	6-0	100	43.3	4.1	1318.7	116.6	2874.6	387.3	48.9	4.8
	6-0	150	48.1	2.2	1430.3	103.0	3406.0	438.3	45.2	4.4
	6-2	50	53.3	5.3	983.6	136.4	2552.7	314.7	38.6	3.0
	6-2	100	48.2	3.8	1212.9	111.3	2782.1	367.8	46.8	5.5
	6-2	150	53.2	4.5	1447.2	141.1	3335.6	454.4	47.3	4.7
earmay			56.3	1.8	1041.7	40.4	2126.5	61.6	49.5	1.5
latmay			41.8	1.0	1346.1	34.9	3690.5	92.8	36.6	0.6
earmay		0	69.4	8.5	405.3	25.3	1162.3	178.6	37.1	5.0
earmay		50	67.0	3.2	860.1	43.6	1962.3	83.1	44.9	2.3
earmay		100	50.9	2.3	1118.3	60.8	2136.4	78.6	53.1	2.8
earmay		150	48.7	2.7	1252.9	68.3	2441.4	114.9	52.4	2.5
latmay		0	48.3	6.8	785.0	89.2	2327.1	320.8	34.4	2.6
latmay		50	43.2	1.6	1276.8	56.6	3364.8	132.3	38.0	0.9
latmay		100	40.3	1.5	1436.5	44.0	3798.0	118.8	37.6	1.0
latmay		150	40.7	1.7	1422.4	63.5	4136.0	167.1	34.5	1.0
earmay	2-0		49.8	5.0	996.2	84.3	2041.4	95.1	49.0	3.4
earmay	2-2		59.2	4.4	1017.1	73.8	2246.5	127.4	46.4	3.5
earmay	4-0		51.3	3.6	1063.7	103.3	2195.4	167.7	49.3	4.0
earmay	4-2		59.9	6.1	1166.0	98.0	2375.3	133.7	49.9	4.0

earmay	6-0		57.8	3.8	970.4	102.1	1892.6	149.0	50.4	3.3
earmay	6-2		59.3	3.5	1060.8	127.8	2085.7	193.6	51.4	4.4
latmay	2-0		36.7	1.4	1234.0	79.5	3731.6	258.9	33.6	1.6
latmay	2-2		34.2	2.2	1357.3	65.7	3868.3	168.4	35.4	1.6
latmay	4-0		43.3	1.6	1388.4	85.7	3679.6	229.4	37.8	1.0
latmay	4-2		44.6	1.1	1423.2	79.7	3661.3	214.3	38.4	1.6
latmay	6-0		46.4	2.6	1320.5	101.2	3553.5	258.2	37.2	1.1
latmay	6-2		43.9	2.2	1368.4	86.5	3694.6	226.9	37.1	1.0
earmay	2-0	50	61.3	7.0	81.9	2.8	1931.0	188.8	828.6	60.4
earmay	2-0	100	47.1	10.2	81.9	3.6	2111.9	111.2	1000.1	164.9
earmay	2-0	150	41.0	7.3	84.4	2.8	2081.2	212.6	1160.0	170.3
earmay	2-2	50	74.8	4.1	85.6	2.6	2006.6	297.2	934.9	76.8
earmay	2-2	100	58.5	4.5	83.1	2.4	2308.2	211.2	1088.4	116.3
earmay	2-2	150	44.4	4.5	83.1	2.1	2424.7	120.1	1027.9	190.9
earmay	4-0	50	61.0	6.0	81.3	2.4	1655.0	279.8	677.7	104.1
earmay	4-0	100	46.7	7.0	82.5	5.1	2413.5	172.6	1246.8	146.4
earmay	4-0	150	46.0	2.9	82.5	4.2	2517.7	231.2	1266.6	103.1
earmay	4-2	50	79.6	10.5	79.4	3.1	2252.0	144.9	956.3	87.0
earmay	4-2	100	49.2	1.6	80.0	2.3	2143.6	304.6	1122.0	190.9
earmay	4-2	150	50.8	10.3	84.4	2.1	2730.4	133.9	1419.8	157.4
earmay	6-0	0	69.4	8.5	73.8	2.2	1162.3	178.6	405.3	25.3
earmay	6-0	50	62.3	9.4	80.0	3.5	2042.4	148.4	1057.6	116.2
earmay	6-0	100	48.5	4.6	80.0	4.3	1889.1	53.5	1091.6	143.2
earmay	6-0	150	50.8	4.2	83.1	3.3	2476.8	297.2	1326.9	132.4
earmay	6-2	50	63.3	7.4	80.6	2.4	1887.0	90.5	705.5	93.4
earmay	6-2	100	55.6	3.5	81.9	2.1	1952.4	185.8	1160.6	199.2
earmay	6-2	150	59.0	7.4	85.0	3.7	2417.6	560.3	1316.2	253.1
latmay	2-0	50	37.9	3.2	106.9	2.4	3302.7	390.2	1204.3	116.3
latmay	2-0	100	39.2	2.0	110.0	2.7	3900.4	480.1	1291.2	100.3
latmay	2-0	150	33.1	1.2	108.8	1.6	3991.7	511.2	1206.6	210.3
latmay	2-2	50	38.8	4.7	108.1	3.1	3407.7	241.9	1267.1	127.5
latmay	2-2	100	35.2	3.4	112.5	1.8	4117.3	109.7	1488.8	88.3
latmay	2-2	150	28.8	0.7	110.0	1.4	4080.0	367.7	1315.9	119.9
latmay	4-0	50	42.7	2.9	103.8	3.3	3236.9	296.8	1190.0	152.6
latmay	4-0	100	45.0	3.1	108.1	2.1	3777.7	207.0	1525.6	94.4
latmay	4-0	150	42.1	2.7	108.1	2.8	4024.1	582.8	1449.5	167.0
latmay	4-2	50	42.7	1.1	103.8	3.9	3332.1	301.8	1320.4	153.8
latmay	4-2	100	43.8	2.2	111.9	4.7	3520.6	315.9	1524.0	88.2
latmay	4-2	150	47.3	2.1	107.5	1.4	4131.1	445.2	1450.4	156.3
latmay	6-0	0	48.3	6.8	97.5	1.8	2327.1	320.8	785.0	89.2
latmay	6-0	50	53.5	3.4	110.0	2.0	3691.4	453.4	1417.6	180.6
latmay	6-0	100	38.1	6.2	110.0	0.0	3860.2	222.9	1545.8	92.2
latmay	6-0	150	45.4	1.2	112.5	2.3	4335.2	482.4	1533.7	157.6
latmay	6-2	50	43.3	3.0	106.3	1.6	3218.3	398.3	1261.6	163.1
latmay	6-2	100	40.8	4.2	105.6	3.3	3611.9	371.2	1265.2	127.8
latmay	6-2	150	47.5	4.4	111.9	0.6	4253.7	296.2	1578.3	132.0

Table 14. Impact of seeding date and nitrogen rate and placement on ammonium levels in the seed row loam soil 2002

Seeding	Nitrogen	Nitrogen	% moisture 3das		NH4_ppm 3das		% moisture 7 DAS		NH4_ppm 7das	
Date	placement	rate	mean	SE	mean	SE	mean	SE	mean	SE
		0	29.44	4.80	5.53	1.92	34.14	6.52	14.56	8.16
		50	29.49	1.48	38.81	10.13	36.10	2.47	36.63	9.65
		100	28.99	1.65	55.89	14.90	35.76	2.52	42.10	10.62
		150	29.00	1.78	92.82	21.23	36.26	2.43	71.79	17.11
	2-0		29.90	2.03	107.80	33.35	37.26	3.42	89.57	22.64
	2-2		27.61	2.16	79.68	24.72	36.98	3.53	41.98	20.41
	4-0		30.43	2.48	42.33	14.31	35.41	3.49	94.80	26.70
	4-2		29.23	2.42	50.16	19.42	35.91	3.75	11.84	3.39
	6-0		29.05	2.24	34.59	12.69	33.64	2.88	28.24	6.27
	6-2		28.93	2.24	53.59	25.51	37.20	3.67	30.03	11.59
	2-0	50	31.05	2.42	49.91	15.42	40.79	6.78	115.06	41.84
	2-0	100	30.94	4.63	126.86	68.95	33.95	5.73	25.19	8.96
	2-0	150	27.54	3.87	154.89	78.08	37.05	5.75	128.47	48.19
	2-2	50	29.26	3.86	70.84	38.60	36.89	6.77	28.66	13.39
	2-2	100	27.18	4.32	68.44	27.81	36.01	5.65	22.78	7.91
	2-2	150	26.40	3.46	99.75	60.61	38.04	6.67	74.50	60.29
	4-0	50	29.21	3.85	80.47	40.02	34.80	5.91	43.00	23.03
	4-0	100	30.04	3.88	20.94	8.45	34.73	6.45	135.56	48.68
	4-0	150	32.05	5.48	25.59	5.80	36.70	6.55	105.84	59.07
	4-2	50	28.10	4.48	10.88	4.95	33.55	6.75	11.28	4.03
	4-2	100	28.43	3.60	81.44	50.87	38.28	8.04	4.75	1.52
	4-2	150	31.16	4.89	58.16	27.12	35.91	5.14	19.50	8.90
	6-0	0	29.44	4.80	5.53	1.92	34.14	6.52	14.56	8.16
	6-0	50	28.61	4.35	10.63	3.46	33.61	5.73	17.53	9.37
	6-0	100	29.00	4.74	35.41	17.00	33.75	5.87	50.84	17.94
	6-0	150	29.15	4.91	86.78	44.20	33.05	6.08	30.03	10.20
	6-2	50	30.69	3.54	10.13	4.09	36.94	5.87	4.22	1.27
	6-2	100	28.58	4.30	11.13	3.71	37.85	6.83	13.50	6.09
	6-2	150	27.51	4.21	139.53	69.31	36.81	7.19	72.38	29.90
Earmay			37.66	1.08	12.13	2.44	20.02	0.63	61.09	11.02
Latmay			20.92	0.61	105.25	15.81	51.86	0.72	35.51	8.94
Earmay		0	41.55	2.88	1.81	0.66	17.20	2.10	9.25	2.68
Earmay		50	35.69	2.07	14.34	5.16	20.52	1.31	44.31	16.16
Earmay		100	37.91	1.79	6.21	1.63	19.35	0.86	64.24	19.39
Earmay		150	38.77	2.02	17.52	5.29	20.66	1.18	83.35	23.73
Latmay		0	17.33	1.13	9.25	2.74	51.08	1.66	19.88	16.88
Latmay		50	23.28	1.14	63.27	18.47	51.68	1.43	28.94	10.70
Latmay		100	20.43	1.10	103.50	25.79	52.17	1.30	19.97	6.50
Latmay		150	19.63	0.94	164.99	35.73	51.86	1.25	60.22	24.92
Earmay	2-0		37.96	2.45	25.30	8.86	21.81	1.54	97.69	34.35
Earmay	2-2		33.56	3.20	1.98	0.24	20.88	1.30	16.58	3.40

Earmay	4-0		40.12	2.36	24.23	9.55	19.62	1.75	170.60	42.53
Earmay	4-2		37.88	3.09	2.96	0.54	19.94	2.09	13.94	5.85
Earmay	6-0		38.83	2.60	10.78	3.11	18.09	0.72	37.27	8.01
Earmay	6-2		37.26	2.01	10.15	6.13	20.42	1.91	38.40	19.61
Latmay	2-0		23.18	1.18	176.54	53.80	52.72	1.76	81.46	30.86
Latmay	2-2		21.67	1.71	157.38	38.19	53.08	1.79	67.38	40.17
Latmay	4-0		20.75	1.75	60.44	26.57	51.20	1.57	19.00	11.31
Latmay	4-2		20.58	1.17	97.35	34.23	51.88	2.82	9.75	3.61
Latmay	6-0		19.28	1.07	58.39	24.08	49.19	1.23	19.22	9.36
Latmay	6-2		20.59	2.09	97.04	48.39	53.98	1.24	21.67	12.82
Earmay	2-0	50	36.45	2.38	30.13	7.77	23.68	3.79	157.81	69.03
earmay	2-0	100	42.37	4.89	4.17	0.22	19.48	2.45	31.13	15.90
earmay	2-0	150	35.57	6.37	40.00	26.66	22.28	1.60	104.13	72.58
earmay	2-2	50	33.65	7.53	1.38	0.31	21.00	4.19	12.75	5.05
earmay	2-2	100	35.88	4.94	1.88	0.36	21.25	0.89	15.19	2.36
earmay	2-2	150	31.15	5.26	2.69	0.36	20.40	0.35	21.81	9.00
earmay	4-0	50	36.60	5.13	32.31	28.28	20.33	4.34	48.50	36.19
earmay	4-0	100	38.85	2.90	12.00	6.80	18.60	3.19	255.00	38.51
earmay	4-0	150	44.90	3.79	28.38	8.94	19.93	2.04	208.31	96.35
earmay	4-2	50	34.73	7.67	3.63	1.55	16.48	2.25	12.81	6.12
earmay	4-2	100	35.58	4.37	2.94	0.41	18.10	2.48	2.56	0.43
earmay	4-2	150	43.33	3.45	2.31	0.58	25.25	4.72	26.44	15.60
earmay	6-0	0	41.55	2.88	1.81	0.66	17.20	2.10	9.25	2.68
earmay	6-0	50	35.53	6.58	14.31	6.36	19.35	1.32	31.25	16.79
earmay	6-0	100	38.43	6.53	10.31	5.00	18.48	0.79	59.75	16.27
earmay	6-0	150	39.80	5.91	16.69	9.20	17.33	1.61	48.81	15.61
earmay	6-2	50	37.20	1.91	4.31	2.12	22.28	3.33	2.75	0.49
earmay	6-2	100	37.48	4.48	5.44	3.53	20.20	2.82	21.81	10.78
earmay	6-2	150	37.10	4.55	20.69	18.47	18.78	4.37	90.63	51.84
latmay	2-0	50	25.65	1.49	69.69	28.09	57.90	2.28	72.31	46.74
latmay	2-0	100	22.38	2.46	218.88	100.27	48.43	2.72	19.25	9.93
latmay	2-0	150	21.53	1.96	241.06	123.32	51.83	2.47	152.81	71.94
latmay	2-2	50	24.88	0.31	140.31	61.13	52.78	5.30	44.56	25.35
latmay	2-2	100	18.48	3.48	135.00	25.62	50.78	1.67	30.38	15.75
latmay	2-2	150	21.65	3.62	196.81	104.23	55.68	0.57	127.19	122.61
latmay	4-0	50	21.83	2.56	128.63	71.60	49.28	2.16	37.50	33.84
latmay	4-0	100	21.23	3.17	29.88	15.29	50.85	3.26	16.13	8.02
latmay	4-0	150	19.20	3.96	22.81	8.48	53.48	2.95	3.38	0.83
latmay	4-2	50	21.48	2.34	18.13	8.76	50.63	3.62	9.75	6.06
latmay	4-2	100	21.28	2.70	159.94	89.26	58.45	4.94	6.94	2.73
latmay	4-2	150	19.00	1.03	114.00	36.78	46.58	5.04	12.56	9.69
latmay	6-0	0	17.33	1.13	9.25	2.74	51.08	1.66	19.88	16.88
latmay	6-0	50	21.70	3.66	6.94	2.56	47.88	4.00	3.81	1.47
latmay	6-0	100	19.58	1.78	60.50	30.06	49.03	2.17	41.94	34.41
latmay	6-0	150	18.50	1.35	156.88	75.88	48.78	2.19	11.25	2.64
latmay	6-2	50	24.18	5.15	15.94	7.14	51.60	2.54	5.69	2.42
latmay	6-2	100	19.68	3.69	16.81	5.49	55.50	1.49	5.19	3.29

latmay	6-2	150	17.93	0.94	258.38	112.51	54.85	2.27	54.13	35.54

Table 15. Agronomic traits of canola grown on clay loam in 2002										
Seeding	Nitrogen	Nitrogen	plants m^{-2}		Straw Ha^{-1}		Seed kg Ha^{-1}		Harvest index	
Date	placement	rate	mean	SE	mean	SE	Mean	SE	mean	SE
		0	32.71	2.39	2376	187	1157	94	49.16	2.63
		50	30.95	1.77	2528	90	1160	62	45.66	1.90
		100	26.86	1.41	2514	87	1096	57	43.55	1.82
		150	25.52	1.79	2514	101	979	53	38.30	1.71
	2-0		28.78	2.84	2409	123	1045	98	42.14	3.14
	2-2		23.82	2.23	2358	119	939	86	37.92	2.85
	4-0		22.22	2.05	2276	93	879	64	38.02	2.57
	4-2		26.67	2.28	2655	134	1115	82	41.98	2.25
	6-0		33.59	1.65	2698	137	1247	65	47.69	1.71
	6-2		31.28	2.11	2610	111	1220	53	47.88	2.19
	2-0	50	35.63	6.05	2224	166	1069	200	45.54	6.08
	2-0	100	26.67	2.39	2258	132	1071	143	46.37	4.47
	2-0	150	24.06	5.20	2745	285	997	175	35.04	5.10
	2-2	50	28.33	4.53	2484	169	1098	176	43.35	5.82
	2-2	100	24.79	2.23	2532	123	1042	101	40.90	3.15
	2-2	150	18.33	4.00	2058	275	677	130	29.50	4.52
	4-0	50	22.71	3.16	2309	101	1053	106	45.72	4.07
	4-0	100	21.35	3.79	2166	230	714	122	31.61	5.45
	4-0	150	22.60	4.10	2353	140	870	78	36.72	2.01
	4-2	50	28.96	4.70	2433	182	1209	150	48.76	3.94
	4-2	100	27.40	3.10	2990	259	1198	142	40.19	3.23
	4-2	150	23.65	4.16	2542	230	940	129	37.00	3.67
	6-0	0	32.71	2.39	2376	187	1157	94	49.16	2.63
	6-0	50	34.58	2.02	3096	340	1367	182	44.24	4.08
	6-0	100	34.69	4.45	2710	282	1282	141	50.68	2.97
	6-0	150	32.40	4.26	2609	250	1186	92	47.05	3.87
	6-2	50	35.52	3.78	2625	200	1164	86	46.32	4.89
	6-2	100	26.25	3.41	2428	104	1292	104	52.82	2.96
	6-2	150	32.08	3.41	2778	251	1203	89	44.49	3.06
earmay			32.34	1.31	2628	54	1257	35	48.64	1.33
latmay			23.74	1.14	2394	85	902	46	36.90	1.25
earmay		0	32.29	1.29	2382	247	1253	130	52.71	1.67
earmay		50	36.94	2.41	2573	83	1422	53	55.63	1.65
earmay		100	30.56	2.05	2609	91	1240	64	48.42	2.55
earmay		150	29.51	2.51	2744	112	1111	59	41.17	2.09
latmay		0	33.13	4.98	2369	320	1061	133	45.60	4.59
latmay		50	24.97	1.98	2484	161	898	83	35.68	1.86
latmay		100	23.16	1.65	2419	149	940	86	38.24	2.13
latmay		150	21.53	2.33	2285	155	846	82	35.43	2.62
earmay	2-0		36.11	3.93	2710	124	1355	89	50.84	3.72
earmay	2-2		27.50	2.99	2678	75	1243	84	46.53	3.10
earmay	4-0		25.83	2.98	2466	81	1011	88	41.57	3.80
earmay	4-2		28.61	3.25	2904	149	1265	102	44.64	3.91

earmay	6-0		36.88	2.36	2476	137	1321	67	53.91	1.51
earmay	6-2		37.57	2.62	2587	171	1329	71	52.58	2.80
latmay	2-0		21.46	2.94	2109	179	707	112	32.65	3.39
latmay	2-2		20.14	3.05	2038	186	635	84	29.31	3.29
latmay	4-0		18.61	2.50	2086	152	746	79	34.46	3.29
latmay	4-2		24.72	3.23	2407	205	966	117	39.32	2.15
latmay	6-0		30.31	2.08	2919	228	1169	111	41.05	2.05
latmay	6-2		25.00	2.14	2634	150	1110	67	43.18	2.88
earmay	2-0	50	47.08	6.53	2578	194	1550	127	60.06	1.63
earmay	2-0	100	27.92	3.97	2482	130	1282	176	51.54	6.82
earmay	2-0	150	33.33	6.81	3069	221	1232	144	40.91	6.44
earmay	2-2	50	33.33	6.43	2787	79	1513	118	54.71	5.81
earmay	2-2	100	26.04	2.46	2660	155	1245	116	47.07	4.48
earmay	2-2	150	23.13	5.70	2586	156	970	27	37.81	1.99
earmay	4-0	50	27.50	5.15	2406	78	1256	155	52.17	6.03
earmay	4-0	100	25.42	4.63	2569	235	847	135	34.37	7.25
earmay	4-0	150	24.58	6.95	2422	72	931	107	38.16	3.34
earmay	4-2	50	32.29	7.10	2544	291	1473	173	57.89	1.53
earmay	4-2	100	31.04	5.46	3066	262	1248	77	42.21	5.92
earmay	4-2	150	22.50	4.10	3100	160	1074	226	33.81	5.59
earmay	6-0	0	32.29	1.29	2382	247	1253	130	52.71	1.67
earmay	6-0	50	37.08	2.56	2790	327	1399	153	51.26	5.01
earmay	6-0	100	40.63	7.23	2361	312	1328	191	56.02	1.44
earmay	6-0	150	37.50	6.23	2372	258	1302	103	55.65	3.20
earmay	6-2	50	44.38	2.58	2334	109	1341	17	57.72	2.01
earmay	6-2	100	32.29	3.82	2515	133	1490	73	59.32	1.57
earmay	6-2	150	36.04	5.35	2912	483	1158	175	40.69	2.98
latmay	2-0	50	24.17	6.36	1870	82	588	125	31.03	5.44
latmay	2-0	100	25.42	3.13	2034	175	790	109	39.47	2.28
latmay	2-0	150	14.79	4.72	2422	510	763	293	29.17	7.54
latmay	2-2	50	23.33	6.13	2180	255	683	126	31.99	6.21
latmay	2-2	100	23.54	4.00	2403	188	838	81	34.74	0.93
latmay	2-2	150	13.54	5.20	1530	378	383	144	21.19	6.75
latmay	4-0	50	17.92	2.22	2213	187	849	26	39.27	3.64
latmay	4-0	100	17.29	5.87	1762	287	581	197	28.84	9.01
latmay	4-0	150	20.63	5.23	2284	289	809	122	35.28	2.53
latmay	4-2	50	25.63	6.73	2322	247	944	171	39.62	3.78
latmay	4-2	100	23.75	2.47	2914	491	1148	295	38.16	3.31
latmay	4-2	150	24.79	7.94	1984	119	805	119	40.19	5.00
latmay	6-0	0	33.13	4.98	2369	320	1061	133	45.60	4.59
latmay	6-0	50	32.08	2.90	3401	609	1335	361	37.23	4.47
latmay	6-0	100	28.75	4.10	3058	440	1221	253	43.57	3.67
latmay	6-0	150	27.29	5.35	2845	432	1071	142	38.44	3.22
latmay	6-2	50	26.67	2.78	2916	343	988	116	34.93	4.57
latmay	6-2	100	20.21	3.93	2340	165	1094	138	46.32	3.20
latmay	6-2	150	28.13	3.90	2644	219	1247	70	48.29	5.02

Table 16. Impact of seeding date and nitrogen rate and placement on ammonium levels in the seed row clay loam soil 2002										
Seeding	Nitrogen	Nitrogen	% moisture 3das		NH4_ppm wet 3das		% moisture 3DAS		NH4_ppm wet 7das	
Date	placement	rate	mean	SE	mean	SE	mean	SE	mean	SE
			30.44	0.74	60.99	11.33	25.17	0.40	128.24	16.95
		0	29.62	3.83	4.68	1.78	26.48	2.41	5.39	1.59
		50	30.43	1.30	28.81	8.47	25.39	0.71	87.97	20.02
		100	30.19	1.37	85.65	24.22	24.44	0.75	116.88	24.01
		150	30.84	1.30	77.88	24.39	25.47	0.64	200.33	41.76
	2-0		30.34	2.15	87.39	24.27	25.11	0.99	115.84	25.54
	2-2		29.44	1.97	28.18	11.81	23.55	0.89	165.66	55.81
	4-0		31.18	1.83	71.89	39.70	25.66	1.01	99.19	27.72
	4-2		29.34	1.90	56.04	27.80	24.78	1.19	153.42	49.40
	6-0		31.00	1.63	64.23	30.02	26.52	0.88	109.21	40.94
	6-2		31.17	1.61	57.11	23.56	24.97	0.90	132.45	42.50
	2-0	50	30.60	3.34	32.42	28.33	24.44	1.57	107.25	55.37
	2-0	100	30.32	4.36	130.81	49.21	26.17	2.07	123.70	46.20
	2-0	150	30.10	3.91	98.94	43.17	24.72	1.63	116.58	34.75
	2-2	50	28.45	3.56	60.47	33.04	24.33	1.04	155.84	53.35
	2-2	100	28.17	4.06	16.35	7.01	21.78	2.19	54.39	28.32
	2-2	150	31.70	2.86	7.74	2.40	24.56	1.11	286.73	152.24
	4-0	50	31.69	3.47	5.45	2.03	27.01	1.76	10.24	3.35
	4-0	100	30.36	2.96	160.96	114.32	23.76	1.33	189.70	65.15
	4-0	150	31.49	3.44	49.25	24.99	26.22	2.09	97.62	31.90
	4-2	50	27.54	3.06	19.85	8.74	23.45	2.32	90.68	64.44
	4-2	100	30.14	3.47	48.36	23.06	25.15	1.78	81.12	37.87
	4-2	150	30.32	3.66	99.92	80.86	25.73	2.25	288.47	120.63
	6-0	0	29.62	3.83	4.68	1.78	26.48	2.41	5.39	1.59
	6-0	50	31.42	3.17	28.87	24.37	25.85	2.04	81.97	57.22
	6-0	100	32.91	3.22	74.49	47.73	27.41	1.20	94.44	56.25
	6-0	150	30.06	3.34	148.86	106.62	26.33	1.49	255.03	136.14
	6-2	50	32.89	3.08	25.83	9.39	27.26	1.51	81.85	34.92
	6-2	100	29.25	2.77	82.93	57.32	22.37	1.90	157.96	98.15
	6-2	150	31.38	2.71	62.57	43.12	25.28	0.63	157.54	80.03
Earmay			38.50	0.40	8.03	2.11	27.32	0.55	56.21	13.25
Latmay			22.39	0.58	113.94	20.92	23.03	0.47	200.26	29.03
Earmay		0	39.41	1.40	0.40	0.19	32.09	1.92	3.59	3.02
Earmay		50	37.97	0.90	3.58	1.77	27.23	1.00	13.81	5.81
Earmay		100	38.52	0.66	8.94	3.59	26.93	0.95	53.21	17.84
Earmay		150	38.85	0.56	12.84	5.24	26.99	0.98	110.38	35.14
Latmay		0	19.82	1.60	8.97	1.59	20.86	1.56	7.19	0.67
Latmay		50	22.89	1.05	54.05	15.33	23.54	0.87	162.13	33.57
Latmay		100	21.86	1.12	162.36	43.29	21.95	0.92	180.56	41.06
Latmay		150	22.83	0.98	142.91	45.12	23.96	0.71	290.27	72.04
Earmay	2-0		39.47	0.75	21.47	11.02	26.35	1.48	96.28	32.90
Earmay	2-2		38.10	0.73	4.87	3.27	26.01	0.96	28.42	9.63

Earmay	4-0		38.71	0.95	12.96	4.42	27.18	1.46	78.46	29.91
Earmay	4-2		37.26	1.58	6.86	2.84	27.40	1.71	86.48	57.51
Earmay	6-0		39.09	0.90	2.43	1.39	29.32	1.15	37.60	29.22
Earmay	6-2		38.17	0.73	1.44	1.05	26.99	1.32	16.24	11.13
Latmay	2-0		21.22	1.89	153.30	39.40	23.87	1.27	135.41	39.68
Latmay	2-2		20.78	1.45	51.50	21.77	21.10	1.14	302.89	97.51
Latmay	4-0		23.64	1.64	130.81	77.07	24.15	1.32	119.92	47.34
Latmay	4-2		21.41	1.08	105.23	52.76	22.16	1.33	220.37	77.99
Latmay	6-0		22.91	1.21	126.02	56.69	23.72	0.93	180.81	73.42
Latmay	6-2		24.17	1.17	112.78	41.91	22.95	0.95	248.66	70.54
Earmay	2-0	50	38.29	1.61	1.36	0.75	24.68	2.19	28.88	24.27
Earmay	2-0	100	40.28	0.91	23.15	18.54	28.41	2.95	109.88	73.54
Earmay	2-0	150	39.82	1.45	39.91	27.25	25.95	2.87	150.08	58.05
Earmay	2-2	50	37.61	1.53	12.06	9.55	25.45	1.94	41.90	21.15
Earmay	2-2	100	38.14	1.61	0.51	0.18	25.80	2.30	19.37	10.12
Earmay	2-2	150	38.56	0.88	2.04	0.77	26.79	0.81	24.00	19.41
earmay	4-0	50	39.28	0.59	0.36	0.07	28.51	1.96	2.82	1.01
earmay	4-0	100	36.98	2.57	15.14	6.29	25.90	1.55	137.69	58.78
earmay	4-0	150	39.88	1.21	23.39	9.17	27.13	3.99	94.86	56.70
earmay	4-2	50	33.21	4.02	3.89	3.17	26.42	3.15	1.99	0.89
earmay	4-2	100	39.16	0.95	13.99	7.07	27.45	2.63	30.11	14.91
earmay	4-2	150	39.39	1.47	2.70	1.80	28.32	3.84	227.34	161.56
earmay	6-0	0	39.41	1.40	0.40	0.19	32.09	1.92	3.59	3.02
earmay	6-0	50	38.91	2.11	0.38	0.11	27.74	3.69	2.12	1.43
earmay	6-0	100	40.35	1.87	0.33	0.08	28.79	2.07	16.93	15.29
earmay	6-0	150	37.70	2.27	8.62	4.67	28.65	1.04	127.76	114.76
earmay	6-2	50	40.54	1.04	3.41	3.18	30.60	1.44	5.17	3.97
earmay	6-2	100	36.22	0.70	0.50	0.09	25.26	3.16	5.28	3.24
earmay	6-2	150	37.76	1.05	0.41	0.05	25.10	0.73	38.26	33.08
latmay	2-0	50	22.91	3.16	63.48	55.70	24.20	2.57	185.63	98.10
latmay	2-0	100	20.37	4.68	238.46	56.86	23.92	2.82	137.51	66.54
latmay	2-0	150	20.37	2.48	157.97	75.03	23.49	1.78	83.08	38.95
latmay	2-2	50	19.29	0.88	108.88	58.67	23.20	0.69	269.78	64.64
latmay	2-2	100	18.20	2.82	32.19	7.87	17.77	2.51	89.42	53.14
latmay	2-2	150	24.84	2.43	13.43	2.15	22.32	1.33	549.46	248.52
latmay	4-0	50	24.09	4.18	10.54	1.37	25.50	3.02	17.65	3.85
latmay	4-0	100	23.74	2.25	306.79	216.27	21.62	1.68	241.71	120.62
latmay	4-0	150	23.10	2.63	75.10	48.83	25.31	2.00	100.39	39.09
latmay	4-2	50	21.88	2.47	35.80	13.29	20.48	3.07	179.37	118.87
latmay	4-2	100	21.11	0.99	82.72	40.56	22.85	2.07	132.13	68.81
latmay	4-2	150	21.25	2.35	197.15	155.58	23.15	2.11	349.60	198.29
latmay	6-0	0	19.82	1.60	8.97	1.59	20.86	1.56	7.19	0.67
latmay	6-0	50	23.94	2.25	57.36	47.23	23.96	1.87	161.83	105.00
latmay	6-0	100	25.47	2.82	148.65	83.45	26.03	1.07	171.94	102.60
latmay	6-0	150	22.42	2.82	289.09	199.78	24.01	2.39	382.30	250.05
latmay	6-2	50	25.23	2.06	48.25	8.13	23.91	1.02	158.52	41.92
latmay	6-2	100	22.29	1.71	165.36	103.93	19.48	1.11	310.63	171.48

latmay	6-2	150	25.00	2.48	124.73	78.11	25.46	1.14	276.82	138.97