LUECKE, JOHN L., ALLAN W. CATTANACH, ALAN G. DEXTER, Department of Plant Sciences, North Dakota State University and the University of Minnesota, Fargo, ND 58105.-Fertilizer effect on sugarbeet.

INTRODUCTION:

This research was conducted to investigate problems experienced by some sugarbeet growers in eastern Montana. Fields had unexplained sugarbeet injury and stand loss resulting in poor sugarbeet populations, stunting and significant yield loss. Fields with severe damage were replanted and some of the same problems persisted. Several production practices were common to the affected fields. For example, affected fields were treated with Ro-Neet at 2 to 3 pounds active ingredient per acre. Ro-Neet was impregnated onto dry urea or ammonium nitrate fertilizer and was broadcast applied to provide 160 to over 200 pounds nitrogen per acre. Affected fields were ridged after herbicide and fertilizer application in the fall. The ridges remained until spring when fields were deridged and sugarbeet was planted. Three questions were considered: 1) Did the combination of Ro-Neet and dry fertilizer cause unexpected injury or death of sugarbeet? 2) Did the fall ridging operation concentrate damaging levels of fertilizer and/or herbicide around the sugarbeet seed and seedling? 3) Did high soil temperatures following early fall fertilizer application cause increased sugarbeet injury the next spring?

Experiments were established to: 1) determine the effect of Ro-Neet and high rates of dry nitrogen fertilizer on sugarbeet population and yield and 2) evaluate the effect of cool and hot soil temperatures immediately after herbicide and fertilizer application on sugarbeet seeded in the soil the next spring.

MATERIALS AND METHODS:

Two greenhouse experiments were conducted using soil collected from Montana with pH 8.0, 2.5% organic matter, 35 lb/A of nitrogen, 25 lb/A of phosphorus, and 1110 lb/A of potassium. The experiments had four replicates and were repeated. Herbicide and fertilizer were incorporated into the soil with a rotating drum soil mixer. Two inches of untreated soil was placed in the bottom of each greenhouse pot and saturated with water before 3 inches of treated soil was placed on top. Soil was exposed to different soil temperatures for 30 days after application of herbicide and fertilizer using a refrigerated cooler set at 40F, a greenhouse where temperatures varied from 70F to 108F, and a heated drying chamber set at 120F. After 30 days of storage, pots were moved to a freezer set at 0F for seven days to simulate a winter freeze. Eight sugarbeet seeds per pot were seeded 0.5 inches deep one day after pots were removed from the freezer. Sugarbeet injury was evaluated visually by estimating reduction in sugarbeet fresh weight as compared to the untreated check two weeks after planting when sugarbeet was in the two-leaf stage. Sugarbeet plants in each pot were counted at the four-leaf stage.

The first greenhouse experiment was to evaluate sugarbeet injury from Ro-Neet at 2 and

4 lb ai/A, urea fertilizer at 200 and 400 lb/A of nitrogen, and soil temperatures of 40F and 70 to 108F following herbicide and fertilizer application. 'Seedex Monohikari' sugarbeet was seeded one day after pots were removed from the freezer.

The second greenhouse experiment evaluated sugarbeet injury and stand loss from urea and ammonium nitrate fertilizer applied at 200 and 400 lb/A of nitrogen and soil temperatures of 40F, 70 to 90F, and 120F following fertilizer application. 'Van de Have Puressa II' sugarbeet was seeded one day after pots were removed from the freezer.

A field experiment was designed to determine if time of fertilizer application or high rates of urea or ammonium nitrate fertilizer affect sugarbeet yield and population. The experiment had a randomized complete block design with four replicates and was repeated. Soil was a silty clay with a pH of 7.2 and 5.1% organic matter. A soil test of the plot area determined the recommended rate of fertilizer to apply for a sugarbeet crop. The fertilizer rates used in this study were half (0.5X) the recommended rate, the recommended rate (1X), twice (2X) the recommended rate, and three times (3X) the recommended rate of nitrogen fertilizer. The recommended rate was the amount of nitrogen needed to bring soil test plus added nitrogen to 130 lb/A. Actual nitrogen added to the soil was 50, 100, 200, and 300 lb/A in 1993 and 35, 70, 140, and 210 lb/A in 1994. Fertilizer was applied early in the fall (September 4, 1992 and August 30, 1993), late in the fall (October 20, 1992 and October 25, 1993), and in the spring (April 23, 1993 and May 9, 1994). The application times were chosen to expose the fertilizer treated soil to different soil temperatures before planting. Fall applied fertilizer was incorporated with a rototiller set 2 inches deep. Spring fertilizer was incorporated with a field cultivator plus rolling baskets set 2 inches deep. 'Van der Have 66110' and 'Maribo 875' sugarbeet was seeded 1.25 inches deep in 22 inch rows April 23, 1993 and May 9, 1994 respectively. Sugarbeet in the 4- to 6-leaf stage was hand thinned to a population of 130 plants per 100 feet of row. Sugarbeet was maintained weed free throughout the growing season with row-crop cultivation and hand weeding. Sugarbeet plants from the center two rows of six row plots were counted and machine harvested September 21, 1993 and September 28, 1994. Root quality was analyzed at the American Crystal Sugar Quality Lab, East Grand Forks, MN.

Both greenhouse experiments and the field experiment were repeated. The data presented in the results and discussion are combined over the two runs.

RESULTS AND DISCUSSION:

All treatments in the first greenhouse experiment except Ro-Neet at 2 lb/A caused greater sugarbeet injury in soil stored at 70-108F than at 40F (Table 1). Urea applied alone caused more sugarbeet injury than Ro-Neet applied alone. Sugarbeet injury from Ro-Neet and urea in combination was similar to the sum of sugarbeet injury when they were applied separately. This suggests that the effect was additive and no unexpected interaction occurred when Ro-Neet and urea were applied together. Sugarbeet injury over 50% occurred in soil treated with urea at 200 or 400 lb/A and stored at 70 to 108F regardless of the presence or absence of Ro-Neet.

Table 1. Ro-Neet and urea at two soil storage temperatures in the greenhouse.

	Sugarbeet Injury	
	Soil Storage Temperature (F)	
Treatment (rate)	40	70-108
lb N or lb ai/A	---------- % injury ----------	
Ro-Neet (2)	3	6
Ro-Neet (4)	5	16
Urea (200)	24	54
Urea (400)	73	98
Ro-Neet (2) + Urea (200)	21	53
Ro-Neet (4) + Urea (200)	26	69
Ro-Neet (4) + Urea (400)	85	97
LSD (5%) = 8		

In the second greenhouse experiment, sugarbeet grown in soil with no applied fertilizer was not injured regardless of soil storage temperature (Table 2). However, sugarbeet stand in soil with no applied fertilizer increased from 6.4 plants per pot following 40F storage temperature to 7.6 plants per pot following the 120F storage temperature. Soil treated with urea or ammonium nitrate at 200 lb/A of nitrogen gave sugarbeet injury similar to untreated soil when soil storage temperature was 40F or 70 to 90F. Soil treated with urea at 200 lb/A of nitrogen and stored at 120F gave greater sugarbeet injury than soil with ammonium nitrate at 200 lb/A of nitrogen and stored at 120F. Soil treated with urea at 400 lb/A of nitrogen caused less sugarbeet injury at 70 to 90F soil storage than at 40F soil storage. All fertilizer treatments caused greater sugarbeet injury at 120F than at 70 to 90F soil storage temperatures. Soil treated with urea at 400 lb/A of nitrogen per acre caused greater sugarbeet injury than soil with urea at 200 lb/A of nitrogen for all soil storage temperatures. Soil treated with ammonium nitrate at 400 lb/A of nitrogen caused greater sugarbeet injury than soil with ammonium nitrate at 200 lb/A of nitrogen for all soil storage temperatures.

Sugarbeet stand was less when soil storage temperature was 120F compared to 40F or 70 to 90F, except soil treated with ammonium nitrate at 200 lb/A of nitrogen had similar sugarbeet stands across all storage temperatures (Table 2). Soil treated with urea applied at 400 lb/A of nitrogen and stored at 120F gave nearly 100% sugarbeet stand loss. In a

commercial field, urea fertilizer at a high rate in the fall plus ridging the soil following fertilizer application, and a high soil temperature in the fall could result in significant sugarbeet injury. Even without high soil temperatures, reduced stands may be expected if urea fertilizer becomes concentrated around the sugarbeet seed. Ridging in the fall would contribute to high levels of nitrogen in the seed zone if nitrogen leaches out of the ridge and is deposited just below the ridge.

Table 2. Fertilizers at three storage temperatures in the greenhouse.

	Sugarbeet Injury			Sugarbeet Stand		
	Soil Storage Temp. (F)			Soil Storage Temp. (F)		
Treatment (rate)	40	70-90	120	40	70-90	120
lb/NA						
No Fertilizer	4	1	1	6.4	6.9	7.6
Urea (200)	19	18	62	6.0	6.1	4.0
Urea (400)	70	39	97	3.6	4.6	0.2
Ammonium Nitrate (200)	15	3	32	5.7	6.5	6.4
Ammonium Nitrate (400)	36	27	53	5.8	5.5	4.4
	LSD (5%) = 20			LSD (5%) = 1.1		

Data in Table 3 are averaged over all fertilizer treatments. Sugarbeet injury decreased and sugarbeet stand increased when soil storage temperature increased from 40F to 70 to 90F. Fertilizer treated soil stored at 120F caused greater sugarbeet injury and less sugarbeet stand compared to storage at 40F or 70 to 90F.

Table 3. Soil storage temperature averaged over fertilizer treatments in the greenhouse.

Soil Storage Temperature (F)	Sugarbeet Injury	Sugarbeet Stand
	%	plts/pot
40	29	5.5
70-90	17	5.9
120	49	4.5
LSD (5%)	6	0.4

Data in Table 4 are averaged over the three soil storage temperatures and two fertilizer rates. Urea fertilizer gave greater sugarbeet injury and less sugarbeet stand compared to ammonium nitrate.

Table 4. Fertilizer averaged over fertilizer rate and soil storage temperature in the greenhouse.

Fertilizer	Sugarbeet Injury	Sugarbeet Stand
	%	plts/pot
Urea	51	4.1
Ammonium Nitrate	28	5.7
LSD (5%)	5	0.3

Data in Tables 5, 6 and 7 are averaged over the 1992-1993 and 1993-1994 seasons. Sugarbeet treated with fertilizer at two or three times the recommended rate in the field experiment had lower harvest population, percent sucrose, and extractable sucrose compared to sugarbeet treated with fertilizer at the recommended rate (Table 5). Also, root yield tended to be less when fertilizer was applied at two or three times the recommended rate.

Table 5. Fertilizer rate averaged over fertilizer, time of application and two years in the field.

Fertilizer Rate	Sugarbeet Harvest Population	Root Yield	Sucrose	Extractable Sucrose
	plts/100 ft	ton/A	%	lb/A
0.5X	93	23.4	15.7	6434
1 X	93	24.1	15.7	6597
2 X	87	23.6	15.3	6206
3 X	83	23.1	15.0	5847
LSD (5%)	3	NS	0.2	243

Sugarbeet harvest population, root yield, percent sucrose, and extractable sucrose were similar with ammonium nitrate or urea in the field experiment (Table 6).

Table 6. Fertilizer averaged over fertilizer rate, time of application and two years in the field.

Fertilizer	Sugarbeet Harvest Population	Root Yield	Sucrose	Extractable Sucrose
	plts/100 ft	ton/A	%	lb/A
Urea	89	23.4	15.5	6274
Ammonium Nitrate	90	23.7	15.4	6269
LSD (5%)	NS	NS	NS	NS

Fertilizer application in early fall, late fall, or spring had no effect on sugarbeet harvest population, root yield, percent sucrose, or extractable sucrose in the field experiment (Table 7).

Table 7. Time of application averaged over fertilizer, fertilizer rate and two years in the field.

Time of Application	Sugarbeet Harvest Population	Root Yield	Sucrose	Extractable Sucrose
	plts/100 ft	ton/A	%	lb/A
Early Fall	89	23.3	15.3	6172
Late Fall	90	23.6	15.4	6269
Spring	89	23.7	15.5	6372
LSD (5%)	NS	NS	NS	NS

CONCLUSION:

Fall ridging of fields previously broadcast treated with herbicide and fertilizer will concentrate the herbicide and fertilizer in the ridge. Leaching of the herbicide or fertilizer may occur between ridging and planting causing a concentration of the chemicals in a zone just below the ridge. Sugarbeet seeded into this zone after spring deridging may be directly exposed to the concentrated chemicals. The results of this study indicate that Ro-Neet herbicide or nitrogen fertilizer at higher concentrations than recommended rates can cause sugarbeet injury, stand loss, and yield loss.

Urea alone caused more sugarbeet injury than Ro-Neet alone. No interaction was observed between Ro-Neet and urea fertilizer.

Soil temperatures of 120F or 40F after application of fertilizer increased sugarbeet injury and decreased sugarbeet stand compared to soil temperatures of 70 to 90F in the greenhouse. However, the attempt to duplicate variable soil temperatures by early fall, late fall and spring application of fertilizer in the field did not result in a significant effect on sugarbeet harvest population or sugarbeet yield.

Rate of fertilizer added to the soil affected sugarbeet injury, stand, population at harvest, and yield. Soil treated with urea fertilizer at 400 lb/A of nitrogen gave more sugarbeet injury and fewer sugarbeet plants per pot than soil treated with urea fertilizer at 200 lb/A of nitrogen at all soil storage temperatures in the greenhouse. Soil treated with ammonium nitrate at 400 lb/A of nitrogen gave more sugarbeet injury for all soil storage temperatures and fewer sugarbeet plants per pot at 120F soil storage temperature than soil treated with ammonium nitrate at 200 lb/A of nitrogen and stored at the same temperatures in the greenhouse. Nitrogen fertilizer applied at two or three times the recommended rate significantly reduced sugarbeet population, percent sucrose, and extractable sucrose and tended to reduce sugarbeet root yield compared to sugarbeet with the recommended or half the recommended amount of fertilizer in the field.

Urea fertilizer increased sugarbeet injury and decreased sugarbeet stand compared to ammonium nitrate in the greenhouse. Soil treated with ammonium nitrate at 400 lb/A of nitrogen caused less sugarbeet injury and had more sugarbeet plants per pot when stored at 40F or 120F than soil treated with urea fertilizer at 400 lb/A of nitrogen and stored at 40F or 120F in the greenhouse. Harvest population and yield parameters were similar for sugarbeet treated with urea and ammonium nitrate in the field. This difference in results between the field and greenhouse may be the result of the inablility to duplicate the desired soil temperatures following fertilizer application or the difference in soil types used in the greenhouse and field experiment. Further research is needed to investigate how sugarbeet grown in different soil types is affected by nitrogen fertilizer applied at recommended rates and then ridged.