4. The Effect of Deep Ripping on Soil Physical Properties and Crop Production: 1991 Results

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(This project was supported by a grant from the Agriculture Development Fund)

INTRODUCTION

The feasibility of deep tillage under Saskatchewan conditions has been studied since 1986 in a number of field experiments (Grevers 1989). The purpose of this project is to determine the longevity of these improvements and to determine the economic feasibility of deep tillage of Solonetzic soils. This report involves the monitoring of soil conditions and crop production in the 4th and the 5th year following deep ripping at 3 locations in Saskatchewan .

MATERIALS AND METHODS

A total of 5 farm sites are included in the study. The Dale Eliason site is located NE of Glenside, the soil is classified as Tuxford Association and is under irrigation. The Chabot and Cragg sites are located near Arborfield and the soils are classified as Arborfield Assn. The Norrish and Warner sites are located east of Carrot River; the Norrish soil is classified as Tisdale Assn., and the Warner soil as Arborfield Assn. Further details of the sites and of the deep ripping and of the plot design are described in the 1989 Field Report (Grevers 1989).

Soil physical parameters that were measured include soil moisture content and soil bulk density; details of these measurements are shown in the 1989 Field Report (Grevers 1989). Soil water content measurements were taken monthly during the growing season. Soil density readings were taken prior to seeding (1 to 2 weeks).

Soil NO_3-nitrogen levels were determined from soil samples (0-15, 15-30, and 30-60 cm depth increments) taken in the spring of 1991 and having these analyzed by the

Saskatchewan Soil Testing Laboratory. A total of four replicates were taken in each tillage strip, these were bulked into one large sample which was used for the chemical analysis.

Crop yield was determined by taking square meter samples in a series of paired row samples, 8 pairs in each tillage strip. The crop samples were transported to the University of Saskatchewan, where the samples were dried, weighed, threshed and grain weights were taken. Crop water use (mm) was determined from the difference between the soil moisture content at seeding and at harvest, plus the growing season precipitation (using rain gauges installed in the field plots). Crop water-use efficiency was determined by dividing the grain yield by the total crop water use (kg/ha/cm).

RESULTS AND DISCUSSION

Soil Bulk Density

The soil bulk density in the deep tillage plots measured in the spring of 1991 is shown in Table 4.1. There were no significant differences ($P < 0.05$) in soil density, but there were some trends in the data. The density of the 10-30 and 30-50 cm depths in the deep ripped Solonetzic soils (Chabot, Cragg and Warner sites) appears to be lower than that in the control plots. Similar differences were not found at the Norrish site. This trend in density data suggest that some soil loosening of the B horizon was apparent 4 and 5 years after the initial deep ripping of the Solonetzic soils.

Soil-Water Depletion During The Growing Season

The disruption of the Bnt horizon in Solonetzic soils was expected to result in increased root proliferation and in better soil-water extraction with depth. Soil-water depletion by depth during the growing season in deep ripped and in the non-ripped Solonetzic and Chernozemic soils is shown in Table 4.2. There were only small differences in soil water depletion amongst the treatments. A trend was apparent for the Chabot and

Table 4.1 Soil bulk density values in the spring of 1991.

Site	Depth	Deep Ripped		Control	
	cm	---------- gm/cm^3----------			
Chabot	10-30	1.18	(0.16)	1.25	(0.13)
	30-50	1.27	(0.07)	1.35	(0.09)
	50-70	1.38	(0.10)	1.37	(0.06)
	70-90	1.36	(0.10)	1.37	(0.07)
	90-110	1.40	(0.09)	1.32	(0.05)
Cragg	10-30	ND		ND	
	30-50	1.26	(0.11)	1.32	(0.15)
	50-70	1.38	(0.06)	1.37	(0.08)
	70-90	1.36	(0.10)	1.31	(0.16)
	90-110	1.35	(0.08)	1.25	(0.06)
Norrish	10-30	1.41	(0.13)	1.34	(0.20)
	30-50	1.57	(0.05)	1.47	(0.09)
	50-70	1.50	(0.04)	1.48	(0.04)
	70-90	1.48	(0.03)	1.49	(0.05)
	90-110	1.51	(0.04)	1.48	(0.09)
Warner	10-30	ND		ND	
	30-50	1.47	(0.12)	1.58	(0.12)
	50-70	1.39	(0.17)	1.58	(0.09)
	70-90	1.43	(0.13)	1.53	(0.03)
	90-110	1.41	(0.12)	1.48	(0.07)

Values in brackets are standard deviations
None of the above data represent significant differences (P <0.0-5) between the treatments
No data was available for the Dale Eliason site

Table 4.2 Changes in soil-water content during the 1991 growing season.

Depth	May 30		July 9		August 1		May-August	
	Cntl	Rip	Cntl	Rip	Cntl	Rip	Cntl	Rip
	cm H_2O							
Chabot Site								
			P= 8.2		P= 3.6		P= 11.8	
0-10	3.2	3.2	4.3	4.0	3.4	3.4	-0.1 (0.1)	-0.2 (0.2)
10-30	9.2	9.5	8.6	8.8	6.3	5.4	2.9 (0.4)	3.8 (0.3)
30-50	9.5	9.1	8.9	8.7	6.5	5.9	3.0 (0.2)	3.2 (0.2)
50-70	8.8	8.9	8.6	8.7	6.3	6.1	2.5 (0.4)	2.8 (0.1)
70-90	8.5	8.5	8.5	8.4	7.0	6.9	1.5 (0.4)	1.5 (0.1)
Cragg Site								
			P= 9.3		P= 6.9		P= 16.2	
0-10	3.0	3.4	4.0	4.0	3.1	3.6	-0.2 (0.2)	-0.2 (0.2)
10-30	9.6	9.2	9.3	8.9	8.6	7.7	1.0 (0.4)	1.6 (0.5)
30-50	9.6	9.7	9.0	9.1	8.8	8.4	0.9 (0.3)	1.3 (0.2)
50-70	9.2	9.4	9.0	9.2	8.9	8.8	0.3 (0.1)	0.6 (0.1)
70-90	9.3	9.5	9.1	9.2	9.1	9.3	0.3 (0.1)	0.3 (0.1)
Norrish Site								
			P= 9.2		P= 2.2		P= 11.4	
0-10	2.3	2.4	4.3	4.6	2.4	2.7	0.0 (0.2)	0.2 (0.6)
10-30	8.1	7.7	7.6	7.5	6.0	5.6	2.2 (0.1)	2.1 (0.2
30-50	8.1	7.8	7.5	7.1	6.3	5.6	1.9 (0.2)	2.2 (0.1)
50-70	7.6	7.5	7.1	6.8	5.7	5.5	1.9 (0.2)	2.0 (0.2)
70-90	6.9	7.2	6.7	7.1	6.0	6.5	0.9 (0.3)	0.7 (0.1)
Warner Site								
			P= 9.8		P= 2.4		P= 12.2	
0-10	1.9	2.0	4.7	5.8	2.4	2.1	-0.5 (0.1)	0.0 (0.0)
10-30	8.6	6.1	8.6	7.3	7.7	5.3	0.9 (0.0)	0.8 (0.1)
30-50	8.8	7.0	8.5	8.1	8.4	6.5	0.3 (0.0)	0.5 (1.0)
50-70	9.3	7.7	8.7	8.4	8.9	7.5	0.4 (0.4)	0.3 (0.1)
70-90	9.5	7.9	9.0	8.6	9.2	8.0	0.2 (0.5)	-0.1 (0.3)

P = precipitation from the previous date to the date indicated in cm H_2O

Cragg sites, indicating slighter greater water depletion from the B horizon (10-30 cm depth) in the deep ripped plots.

Crop Production Following Deep Ripping.

Deep ripping increased crop yields at the Cragg, D. Eliason, Norrish and Warner sites, but there was no effect of deep ripping on crop yields at the Chabot site (Table 4.3). Deep ripping increased total dry matter production by values ranging from 9% to 40%, and grain production by values ranging from 9% to 32%. These yield increases due to deep ripping represent the 4th and 5th year crop yields after the initial deep ripping, indicating the longevity of the effect of deep ripping.

There were no significant (P <0.0-5) differences due to deep ripping on the spring soil NO_3-N levels, nor on the crop water-use efficiency.

CONCLUSIONS

A total of five sites were included in the study; including four Solonetzic soils and one compacted Chernozemic soil. Deep ripping increased crop production on four of the soils. Deep ripping had no effect on crop production one of the Solonetzic soils. There were trends in soil bulk density, suggesting more porous B horizons in the deep ripped soils. It is possible that more porous B horizons facilitated greater soil-water depletion, which would explain the increased crop growth found in these soils.

REFERENCES

Grevers, M.C.J. 1989. The effect of Subsoiling on Crop Production in Saskatchewan. Pages 79-102. *In* (M.C.J. Grevers and J.L. Henry, Eds.) 1989 Field Research Report. Saskatchewan Institute of Pedology Report No. M95. University of Saskatchewan, Saskatoon, Sask.

Table 4.3 Spring soil moisture and nitrate-nitrogen, crop yield and water-use efficiency.

Farm	Year/crop	Tillage	Spring seeding		Yield		WUE
			SMC†	NO_3-N	Total	Grain	
			(cm)	(kg/ha)	(kg/ha)	(Bu/A)	(kg/ha/cm)
Chabot	1987 Peas	Control	46	47	5979	31.2	64
		Ripped	46	61	6977	28.6	52
	1988 Flax	Control	51	85	1910	9.8	28
		Ripped	48	102	1964	9.8	28
	1989 Smf	Control	40	140		Fallow	
		Ripped	38	162		Fallow	
	1990 Canola	Control	58	136	7392	45.2	120
		Ripped	60	135	6581	40.5	96
	1991 Wheat	Control	58	78	10340	60.5	164
		Ripped	57	57	10402	61.6	165
Cragg	1987 Wheat	Control	53	52	6249	41.8	68
		Ripped	52	27	5968	34.9*	54
	1988 Barley	Control	53	18	4319	23.8	73
		Ripped	53	16	5183	35.4*	102
	1989 Smf	Control	39	27		Fallow	
		Ripped	39	32		Fallow	
	1990 Durum	Control	53	81	9634	60.7	ND
		Ripped	55	101	10269	64.3	ND
	1991 Canola	Control	50	64	2520	13.3	40
		Ripped	51	69	3517*	17.5*	50
D. Eliason	1988 Lentils	Control	37	26	1564	11.2	ND
		Ripped	39	26	2089	17.0	ND
	1989 Durum	Control	33	30	7483	54.1	117
		Ripped	39	32	10868*	75.4*	169*
	1990 Durum	Control	33	83	8110	58.2	111
		Ripped	34	88	9573	65.6*	131*

SMC = soil moisture content, WUE = water use efficiency, ND = no data available
*, and **: means are significantly different at $P < 0.05$, and $P < 0.01$, respectively.
† cm H_2O to a depth of 130 cm

Table 4.3 Continued.

Farm	Year/crop	Tillage	Spring seeding		Yield		WUE
			SMC†	NO_3-N	Total	Grain	
			(cm)	(kg/ha)	(kg/ha)	(Bu/A)	(kg/ha/cm)
D. Eliason	1991 Durum	Control	ND	ND	9891	65.3	ND
		Ripped	ND	ND	10739	72.9*	ND
Norrish	1988 Canola	Control	49	52	5055	30.4	65
		Ripped	52	48	4616	25.9	56
	1989 Canola	Control	34	81	5118	25.7	87
		Ripped	35	147	5192	24.8	95
	1990 Barley	Control	43	29	8878	80.4	ND
		Ripped	42	25	9396	79.1	ND
	1991 Barley	Control	48	29	4272	42.1	108
		Ripped	47	26	5135*	50.3*	128
Warner	1988 Canola	Control	65	8	2683	12.8	88
		Ripped	65	30*	4228*	20.2*	132
	1989 Barley	Control	42	9	3014	25.8	ND
		Ripped	41	19	7713*	61.1**	ND
	1990 Canola	Control	50	15	2785	10.9	26
		Ripped	54	18	3138	15.0*	36
	1991 Barley	Control	56	48	6339	56.8	ND
		Ripped	53	68	7283*	61.8*	ND

SMC = soil moisture content, WUE = water use efficiency, ND = no data available
*, and **: means are significantly different at $P < 0.05$, and $P < 0.01$, respectively
† cm H_2O to a depth of 130 cm