RIDGE TILLAGE RESEARCH IN WESTERN KANSAS

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INTRODUCTION

Many producers of irrigated continuous corn in the Central Plains utilize multiple tillage operations prior to planting for seedbed preparation. These tillage operations require extensive amounts of labor, machinery, and fuel while increasing water loss by evaporation. A ridge tillage system that eliminates seedbed tillage could reduce input costs, increase soil water retention, and improve profitability. This research was initiated to evaluate the effect of ridge tillage under various irrigation practices on crop yield, off-season precipitation capture, water use efficiency, and production economics for furrow irrigated continuous corn in western Kansas.

PROCEDURES

Corn was grown in a continuous corn rotation under conventional and ridge tillage. Conventional tillage consisted of stalk shredding and discing in the fall followed by spring discing and furrowing prior to planting. With ridge tillage, the only operation between harvest and planting was shredding stalks. Tillage (two cultivations) during the growing season was the same for both systems. A study from 1992 to 1994 evaluated four in-season irrigation levels with two hybrids differing in maturity (medium and long season). The irrigation levels were approximately 0, 40, 70, and 100% of estimated irrigation demand (EID) which was calculated as estimated evapotranspiration less growing season precipitation. Each tillage by irrigation plot was planted to a medium maturity hybrid (ICI 8599) and a full season hybrid (Pioneer 3162). Seeding rates were based upon irrigation treatment and hybrid to account for differences in estimated yield potential.

An earlier study from 1988 to 1991 evaluated tillage and preplant irrigation. Preplant irrigation (4.5 inches) was applied about 2 to 4 weeks prior to planting and compared to without preplant irrigation for both tillage systems. In-season irrigations were applied uniformly to all plots when needed.

For both studies, plots were machine harvested and grain yields adjusted to 15.5% moisture. Soil water content was determined near plant emergence and after harvest. An economic analysis was performed based on actual grain yields, average corn prices, and estimated production costs. Land and machinery ownership costs (depreciation and interest) were not included as they are highly variable among producers. Therefore, estimated returns represent returns to land, machinery, and management.

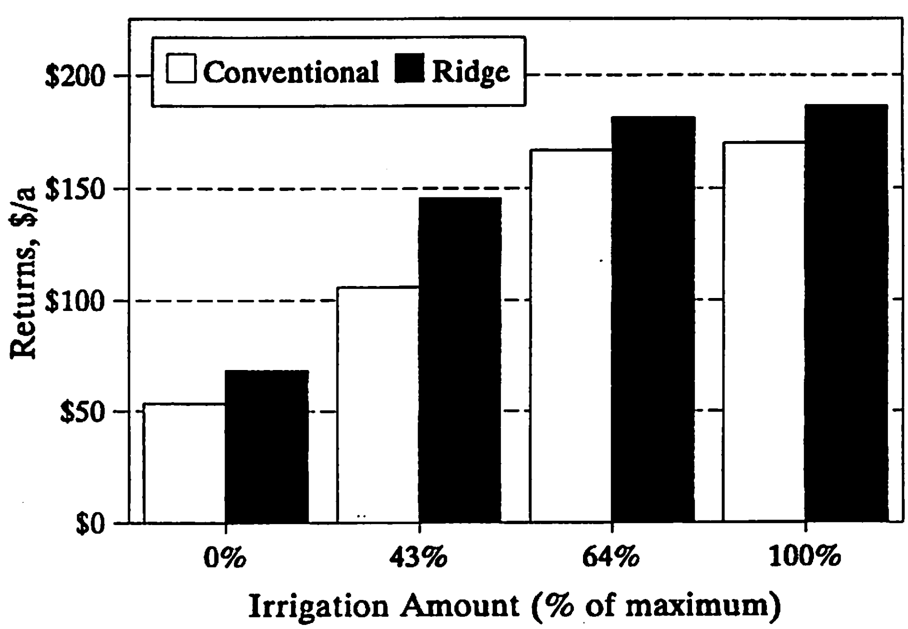

Figure 1. Returns to land, machinery, and management for conventional and ridge tillage versus irrigation amount (three year average).

RESULTS AND DISCUSSION

In-season Irrigation by Hybrid Maturity Study

Grain yields (3 year average) were higher for ridge than conventional tillage with very limited irrigation (40% EID) and similar for both tillage systems with higher levels of irrigation (Table 1). Net returns were greater for ridge than conventional tillage at all irrigation levels because of reduced tillage costs with ridge-till (Fig. 1).

Corn yields were greater with the full season hybrid, especially at higher irrigation amounts (Table 1). This resulted in net returns with full irrigation being about $50/acre greater for the full season hybrid than for the medium season hybrid (Fig. 2). However, at lower irrigation levels or dryland, the medium season hybrid was more profitable than the full season hybrid.

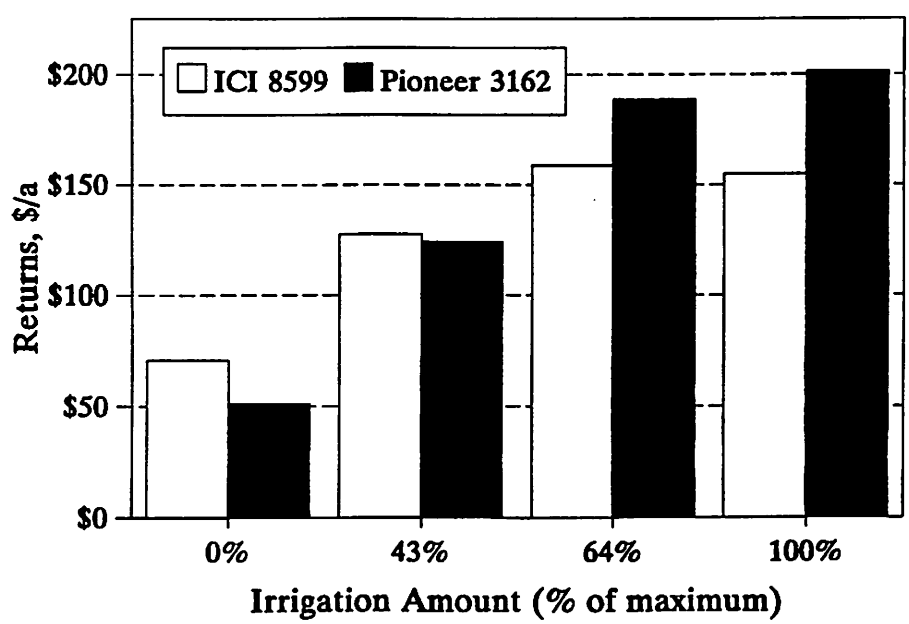

Figure 2. Returns to land, machinery, and management for medium and full season corn hybrids versus irrigation amounts (three year average).

Table 1. Tillage, irrigation, and hybrid effects on corn, Tribune, KS 1992-1994.

Tillage	Irr[¶]	Hybrid	Grain yield 1992	1993	1994	Mean
	% EID		bu/acre			
CONV	0	ICI 8599	117	83	48	82
		Pioneer 3162	130	55	19	68
	40	ICI 8599	152	108	88	116
		Pioneer 3162	165	120	74	120
	70	ICI 8599	170	144	143	152
		Pioneer 3162	188	166	137	164
	100	ICI 8599	178	145	160	161
		Pioneer 3162	181	161	181	174
RIDGE	0	ICI 8599	105	61	64	77
		Pioneer 3162	118	59	53	76
	40	ICI 8599	168	99	129	132
		Pioneer 3162	153	118	113	128
	70	ICI 8599	176	124	158	152
		Pioneer 3162	174	158	163	165
	100	ICI 8599	171	135	165	157
		Pioneer 3162	207	159	180	182
MEANS						
Tillage						
Conventional			160	123	106	130
Ridge			159	114	128	134
$LSD_{.05}$			6	6	7	4
Irrigation, %EID						
0			117	64	46	76
40			160	111	101	124
70			177	148	150	158
100			184	150	171	168
$LSD_{.05}$			9	9	10	6
Hybrid						
ICI 8599			155	112	119	129
Pioneer 3126			164	124	115	135
$LSD_{.05}$			7	6	6	4

[¶]Irrigation is approximate portion of estimated irrigation demand (EID), 100% was 9" in 1992, 15" in 1993, and 18" in 1994.

Table 2. Tillage, irrigation, and hybrid effects on soil water in Corn Water Study, Tribune, KS (Soil water harvest and wateruse is for 1992-1994, soil water planting and fallow data is for 1993-1994 only).

Till.	Irr[¶]	Hybrid	Soil Water Plant	Soil Water Harv.	Wateruse Crop	Wateruse Eff.	Fallow Acc.	Fallow Eff
			in/profile		inch	lb/in	inch	%
CONV	0	ICI 8599	8.8	3.0	18.0	252	5.1	61
		Pioneer 3162	6.9	2.0	17.8	193	4.4	52
	0.43	ICI 8599	8.7	4.1	22.6	288	4.5	55
		Pioneer 3162	6.4	2.4	22.8	291	4.2	50
	0.64	ICI 8599	9.4	4.7	25.4	336	4.1	50
		Pioneer 3162	7.3	2.7	26.0	351	4.3	52
	1.0	ICI 8599	9.8	6.4	28.8	312	3.3	39
		Pioneer 3162	8.2	3.2	31.0	315	4.8	59
RIDGE	0	ICI 8599	9.7	3.7	18.0	239	5.5	66
		Pioneer 3162	8.9	2.4	18.8	223	5.8	72
	0.43	ICI 8599	10.2	5.2	22.7	324	4.9	59
		Pioneer 3162	9.3	2.8	24.5	293	6.6	81
	0.64	ICI 8599	10.3	5.4	25.4	335	4.5	55
		Pioneer 3162	10.1	4.2	26.6	347	5.5	69
	1.0	ICI 8599	11.0	7.7	28.6	308	3.6	44
		Pioneer 3162	10.3	4.7	31.1	329	5.3	65
MEANS								
Tillage								
Conv			8.2	3.6	24.1	292	4.3	52
Ridge			10.0	4.5	24.5	300	5.2	64
$LSD_{.05}$			1.3	0.3	0.9	10	1.5	17
Irrigation								
0			8.6	2.8	18.2	227	5.2	62
0.43			8.7	3.6	23.1	299	5.0	61
0.64			9.3	4.3	25.8	342	4.6	57
1.0			9.8	5.5	29.9	316	4.2	52
$LSD_{.05}$			0.7	0.5	0.5	14	0.7	8
Hybrid								
ICI 8599			9.7	5.0	23.7	299	4.4	54
Pioneer 3162			8.4	3.0	24.8	293	5.1	62
$LSD_{.05}$			0.5	0.2	0.3	10	0.5	6

[¶]Irrigation is fraction of estimated irrigation demand (average was 1.0 = 14", 0.65 =9", and 0.4 =6"). Fractions intended were (0.4, 0.7, 1.0). Growing season pcp. was 16.72" in 1992, 11.54" in 1993, and 8.35" in 1994. Fallow pcp. was 5.72" in 1992, 9.04" in 1993, and 6.82" in 1994.

Ridge tillage increased soil water at planting 1.8 inches over conventional tillage reflecting greater efficiency of over-winter (fallow) precipitation capture and storage (Table 2). Crop water use and water use efficiency were similar for both tillage systems.

Soil water at planting and harvest increased with increased irrigation amounts, but over-winter accumulation decreased (Table 2). Crop water use efficiency increased with the first two levels of irrigation and then declined with full irrigation.

Crop water use was greater with the full season hybrid than the medium season hybrid resulting in lower soil water at harvest. With drier soil at harvest, fallow accumulation was greater with the full season hybrid. Water use efficiency was similar for both hybrids.

Table 3. Effect of tillage and preplant irrigation on grain yield of corn. Tribune, KS, 1989-1991.

Tillage	Preplant Irrigation	Corn 1989	Corn 1990	Corn 1991	Corn Mean
		- - - - - bu/acre^{S} - - - - -			
Conventional	Yes	173	166	139	159
	No	169	164	153	162
Ridge	Yes	168	161	145	158
	No	176	164	148	163
<u>Means</u>					
Tillage					
Conventional		171	165	146	161
Ridge		172	163	147	160
$LSD_{0.05}$		5	4	6	3
Preplant irrigation					
Yes		170	164	142	159
No		172	164	151	162
$LSD_{0.05}$		5	4	6	3

Preplant Irrigation Study

Grain yield of corn averaged over three years was not affected by tillage practices or preplant irrigation (Table 3). Ridge tillage had lower input costs, so net returns were greater with ridge than conventional tillage (Fig. 3). Since yields were not increased by preplant irrigation in either tillage system, preplant irrigation was unnecessary and unprofitable.

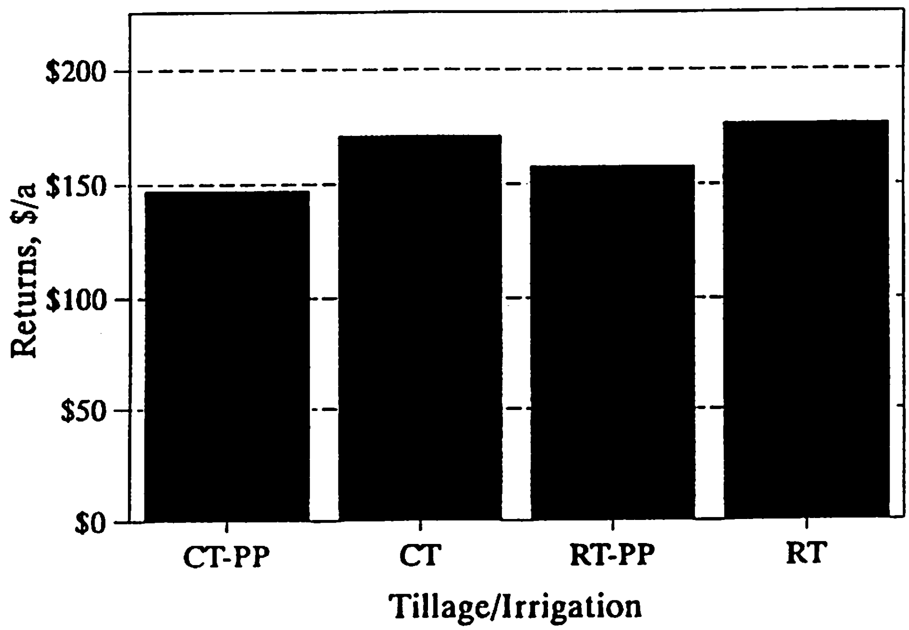

Figure 3. Returns to land, machinery, and management for conventional and ridge tillage with and without preplant (PP) irrigation (three year average).

Ridge tillage was more effective than conventional tillage in capturing over-winter precipitation (Table 4). Without preplant irrigation, fallow accumulation was over one inch greater with ridge than conventional tillage and fallow efficiency was increased from 16% with conventional to 37% for ridge tillage. Preplant irrigation increased soil water at planting by 2.8 in. for an apparent efficiency of about 60%. Preplant irrigation had little effect on soil water at planting in the surface foot but did increase soil water content at lower depths (Fig. 4). Crop water use was greater with preplant irrigation but, without increases in grain yield, water use efficiency was decreased.

Table 4. Available soil water, fallow accumulation, fallow efficiency, and water use in 8 foot profile as affected by tillage and preplant irrigation of corn, Tribune, KS, 1988-1991.

Tillage	Pre. Irr.	Soil water Plant	Soil water Harv.	Fallow acc.	Fallow eff.	Water use	WUE
		inch/8 ft profile			%	inch	lb/in
Conv	Yes	13.0	11.0	3.2	31	29.4	282
	No	10.4	10.9	0.8	16	27.0	312
Ridge	Yes	14.6	11.3	4.6	47	30.7	273
	No	11.7	11.2	2.0	37	28.0	312
	$LSD_{0.05}$	0.9	0.7	0.6	8	0.6	19
<u>Means</u>							
Tillage							
Conv.		11.7	10.9	2.0	23	28.2	297
Ridge		13.1	11.3	3.3	42	29.4	293
$LSD_{0.05}$		0.6	0.5	0.4	5	0.4	14
Preplant irr.							
Yes		13.8	11.2	3.9	39	30.1	278
No		11.0	11.0	1.4	26	27.5	312
$LSD_{0.05}$		0.6	0.5	0.4	5	0.4	14

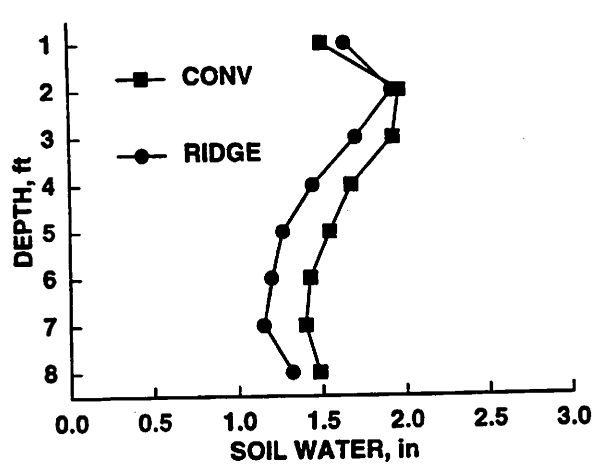

Figure 4. Available soil water for ridge tillage without preplant irrigation versus conventional tillage with preplant irrigation (three year average).

SUMMARY

Ridge tillage is a viable alternative to conventional tillage for irrigated continuous corn in western Kansas. Grain yields with ridge tillage were equal or greater than conventional tillage across two hybrid maturities and a range of irrigation levels. With reduced input costs with ridge tillage, economic returns were always greater for ridge than conventional tillage. Ridge tillage increased capture and storage of over-winter precipitation resulting in more soil water at planting. Preplant irrigation increased total soil water at planting, but not in the surface foot of soil. With adequate in-season irrigation, preplant irrigation did not increase grain yield.