RESERVOIR TILLAGE FOR CENTER PIVOT IRRIGATION

By
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INTRODUCTION

Reservoir tillage is the process by which small holes or depressions are punched in the soil (usually between crop rows in the furrow) to prevent runoff of water from irrigation or rainfall. This is in contrast to basin tillage in which soil is dragged and periodically dumped in the furrow, creating small dams with basins in between. The advantage of the reservoir tillage system over basin tillage is that most of the surface storage created in the reservoir tillage process is below the original ground surface, and consequently is less subject to washing out than basin tillage where the dams are composed of loose soil that is easily eroded from intense water application.

The objectives of this study were to: 1) Compare reservoir tillage with basin tillage and conventional tillage in replicated plots (in commercial production under center pivot irrigation) of small grain, corn and potatoes; 2) Document the fate of water applied with a center pivot irrigation system on the above described tillage plots. This involved measurement and comparison of soil moisture and runoff for each plot; 3) Document the stand reduction caused by reservoir tillage in small grains, and to determine whether after-seeding could overcome this stand reduction.

Row Crops

Corn and potato plots were planted in the outer two spans of commercial center pivot irrigation systems. The corn plots were located at Chateau Ste. Michelle on sandy soil (circle 106) with an 8.5 percent slope and loamy sand (circle 420) with a 10 percent slope. The existing seeding was used for all plots (planted in the first week of May), and planting was done straight up and down the slopes. Tillage treatments included reservoir tillage with the Dammer Diker (manufactured by Ag. Engineering and Development Co., Richland, Washington) at lay-by time (June 1, 2); reservoir tillage with the Water-Saver (manufactured by the Milestone Corp., Blackfoot, Idaho) at lay-by time and a check with no tillage at lay-by time. Both sets of plots had four replications of each tillage treatment in a randomized complete block design.

Soil moisture was monitored throughout the season in circle 106 using a neutron probe to d depth of 3 feet in one foot increments. Replicated spot checks were also made with a gravimetric method in circle 420 to document soil moisture differences at various times during the growing season.

Runoff from single rows in each plot was measured periodically using fiberglass trapezoidal furrow flumes to obtain flow rate vs. time information or a runoff hydrograph. Several (from four to eight) flumes were operated at the same time as the center pivot lateral passed over the plots and flow measurements were made at one to two minute intervals.

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Yield measurements were made by picking the ears from 11.8 feet of row on August 28 in circle 106 and September 25 and October 29th in circle 420. Each plot received the standard irrigation scheduling program practiced on the commercial portion of each circle. Irrigation amounts for an individual irrigation were kept relatively constant at 0.220 inches/revolution in circle 106 and 0.280 inches/revolution in circle 420.

The procedures used in the potato plots at the K2H farm were essentially the same as those used on the corn plots, with the exception that a basin tillage treatment was added with a soil dragging type machine (manufactured by Ansley and Sons, Lockney, Texas). The soil at the K2H farm was sandy loam with a slope of seven percent and irrigations were normally 0.38 to 0.42 inches/revolution.

Yields were measured by digging 7.5 feet of row from each plot and weighing all tubers over two inches in diameter. Statistical analysis of the early yields on the potato plots was not possible because two of the replications were washed out early in the season by an irrigation system malfunction. A later harvest was done with all four replications on September 24, 1984, however. Plots were planted in a randomized complete block design with four replications of each tillage treatment.

Small Grains

A spring wheat trial similar to the row crop experiments described above was planted at the Childs ranch near Arlington, Oregon. The soil was a silt loam with a slope of 1.5 percent. Treatments were: 1) conventional tillage, 2) reservoir tillage alone after regular seeding and 3) reservoir tillage after regular seeding with an after-seeding in the areas disturbed by the tillage at the rate of approximately 40 lbs/acre. These plots were also planted in a randomized complete block design with four replications of each tillage treatment.

The after-seeding was accomplished using a unique system developed by the grower, Mr. David Childs. A drill box was mounted on the frame of the Dammer Diker, from which PVC tubes directed the seed to the disturbed area behind each “spider” or hole punching wheel on the machine. This seed falling onto the soil surface behind the tillage machine was germinated using several light water applications with the center pivot. Similar after-seeding has been done at other locations using aerial applications, but at considerably higher cost.

In order to determine the best after-seeding rate using reservoir tillage, another spring wheat experiment was planted at the University of Idaho Research and Extension Center (RECAB). The treatments in this experiment included reservoir tillage with the Water Saver, both with and without the ripping shank normally mounted in front of the tillage wheel. Other reservoir tillage treatments included the Dammer Diker without after-seeding and the Dammer Diker with 10, 20 and 40 lbs/acre after-seeding in the disturbed area, as well as a check with conventional tillage.

This experiment was designed specifically to test the effects of reservoir tillage on the stand of spring wheat. The experimental design was randomized, complete block with eight replications and irrigation was provided with a solid set hand line system.

RESULTS

Row Crops

The yield comparisons for the early harvest taken on August 29, 1984 from Chateau Ste. Michele in circle 106 and are given in Table 1. In this case, the Dammer Diker produced a 31 percent yield increase over the check tillage treatment, which was significant at ^{oc}=0.01 using the LSD comparison. From these yield data, it is obvious that water retention in the furrow on steep slopes translated into a substantial yield increase. The yields from circle 420 are shown in Table 2. Although not statistically different, there is a trend for a yield increase with both reservoir tillage treatments.

The gravimetric soil moisture comparisons taken on August 7, 1984 in the potato plots at the K2H farm are shown in Figure 7. All of the tillage treatments tested showed an increase in soil moisture in both the first and second foot as compared with the check, with the Milestone Water Saver showing the highest soil moisture in both cases.

Piping failures of the dikes between the reservoirs or basins were evident in most of the potato plots at the U&I K2H farm at the time the runoff measurements were made. Because of the failure of many of the reservoirs and basins, it was not at first anticipated that yield data from these plots would be meaningful, but as the season progressed, some settling of the dikes in the furrows occurred, and a difference in plant health was noticed between the checks and the reservoir tillage treatments. The checks were suffering from “early dying” and the reservoir tillage treatments remained relatively healthy. For this reason, an early yield sample was obtained from two replications of each treatment on August 29, 1984 to determine if full season yield and grade data was worth obtaining. The results of this yield sample are shown in Table 3.

Although statistical comparisons are not available with only two replications, it is interesting to note that the highest yields were obtained from the Dammer Diker, which showed a 22 percent increase over the check. This yield difference is probably due to partial retarding of the runoff flow by the remains of the reservoirs, even though most of them had failed due to piping.

Table 4 shows the yield and quality data taken from all four replications on September 24, 1984. The total yields were not statistically different, but there was a strong trend for an increase with the reservoir tillage treatments. The yield of #1 and #2 potatoes, however, showed a 104 percent increase over the check with the highest reservoir tillage treatment, the Dammer Diker. The percent useable was also 71 percent higher than the check with this treatment. From these comparisons, reservoir tillage, and in particular the Dammer Diker, caused a significant improvement in the yield of useable potatoes over the standard practice.

Small Grains

Only stand and yield data were obtained for the small grain plots harvested early enough to be reported in this study. Table 5 shows the stand and yield data obtained in the spring wheat plots at the Childs ranch.

The stand counts taken on March 30, 1984, just after emergence (one to three leaf stage) indicate a severe stand reduction due to both reservoir tillage treatments when compared with the checks. The stand counts taken eight weeks later show that the after-seeding and tillering of the plants tended to reduce this stand difference, especially in the plots treated with after-seeding. The yields also indicate that, although there was a stand reduction in the reservoir tilled plots, the extra moisture trapped tended to produce yields equal to the checks. When the after-seeding was used, however, a 9.5 percent yield increase was obtained over the check treatment, even though considerably more lodging of the reservoir tilled plots was apparent.

The yield data from the stand density trial at RECAB are given in Table 4. Although most of the differences were not statistically significantly different, the highest yields were obtained with the Dammer Diker reservoir tillage treatment with after-seeding at the rate of 40 lbs/acre in the disturbed area.

CONCLUSIONS

The following conclusions were derived from the data collected in this study: 1) Substantial runoff or translocation occurs on steep slopes under center pivot irrigation without remedial tillage – even if the soil is very sandy and water applications are light; 2) This runoff can be effectively controlled using reservoir tillage and careful water management, resulting in substantial yield increases in both row crops and small grains; and 3) The stand reduction due to the use of reservoir tillage in small grains can be effectively offset by after-seeding at the rate of 40 lbs/acre in the disturbed areas.

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TABLES

Table 1. Early corn yield data, Chateau St. Michelle, circle 106, 8.5% slope, harvested August 28, 1984.

Treatment	Yield wet Tons/Acre
1. Check	6.69 b*
2. Milestone	7.67 ab
3. Dammer Diker	8.79 a
LSD's = 5%	1.39
1%	2.09

Table 2. Early corn yield data, Chateau St. Michelle, Circle 420, 10% slope, 1984.

Treatment	Yield (Kernel & Cob) Dry September 25	Tons/Acre Wet October 29
1. Dammer Diker	7.18 b*	10.17 a
2. Milestone	7.49 ab	10.17 a
3. Conventional	7.09 a	9.17 a
LSD's = 5%	1.05	
1%	0.46	

*Treatments with the same letter are not significantly different at P=0.95 using Duncan's MRT.

Table 3. Early potato yield data, U&I Corporation, K2H Farm, circle 420, 10% slope, 1984.

Treatment	Early Potato Yield August 29, 1984 Tons/acre
1. Check	15.18
2. Ansley	17.58
3. Milestone	18.07
4. Dammer Diker	18.47

Table 4. Early potato yield data, U & I Corporation K2H Farm, circle 320, 7% slope, 1984.

Treatments	Total Yield Tons/Acre	Yield #1, #2 Tons/Acre	% Useable
1. Check	14.27 a*	7.49 b	49 b
2. Ansley	18.07 a	15.30 a	84 a
3. Milestone	16.37 a	10.30 ab	64 ab
4. Dammer Diker	13.38 a	8.70 ab	64 ab
LSD's = 5%	7.99	6.29	24
10%	6.60	4.51	20

*Treatments with the same letter are not significantly different at P=0.95 using Duncan's MRT.

Table 5. Owens soft white spring wheat stand and yield data obtained at the Childs Ranch, 1984.

Treatment	Means (4 replications) Stand Counts (stems/yd^2)		Yield (lbs/acre)
	3/30	5/29	
1. Check	178	864	6252 b
2. Dammer Diker	98	674	6235 b
3. Dammer Diker + after-seeding	145	890	6852 a
LSD's = 5%	37	212	485

*Treatments with the same letter are not significantly different at P=0.95 using Duncan's MRT.

Table 6. Soft white spring wheat yield data from the stand vs. tillage reseeding trials at Aberdeen Research and Extension Center, 1984.

Treatment	Yield – lbs/acre
1. Milestone, No-rip	4316
2. Dammer Diker	4137
3. Check	4437
4. Milestone	3597
5. Dammer Diker + 10 lb/acre reseed	4137
6. Dammer Diker + 20 lb/acre	4377
7. Dammer Diker + 40 lb/acre	4796
LSD's = 5%	492
10%	408