# EFFECTS OF STRAW MULCH AND IRRIGATION RATE ON SOIL LOSS AND RUNOFF

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**Summary**

A Nyssa slit loam soil was bedded for potatoes. Furrow irrigation for 11 hours at four gallons per minute on a 2.5 percent slope resulted in 17.7 tons of soil lost per acre. Soil loss was reduced to 2.8 tons per acre by the use of 790 lbs/acre of wheat straw mulch. At two gallons per minute, straw reduced soil losses from 3.4 to 0.02 tons per acre. Erosion control benefits from mulch continued to a lesser extent during the second irrigation. Wheat straw mulch increased water intake and decreased runoff. Water intake was not related to the irrigation inflow rate.

## Introduction

Furrow Irrigation on moderate slopes can lead to high rates of soil loss and low efficiency of water use. Where water intake is limited, crop yield and quality can be adversely affected. Application of small quantities of straw mulch is a possible practical means to decrease erosion and increase water infiltration. Robert Berg (1984) showed that small quantities of straw could increase water infiltration and decrease soil loss in furrow-irrigated crops near Kimberly. Berg's studies were done on straw applied uniformly by hand into the furrows. Miller and Aarstad (1983) showed that at Prosser, Washington, most of the measured soil loss occurring under furrow irrigation could be controlled by relatively small quantities of hand-applied straw (between 360 and 1,080 lbs of straw per acre). Although the costs of wheat straw mulch are low, the labor costs to apply the mulch can be considerable. The use of a tractor-drawn multiple-row straw spreader used in this experiment makes the mulch a more feasible alternative.

## Materials and Methods

An experiment was designed to measure the effects of straw mulch and irrigation rate on runoff, water intake, and soil erosion. The soil used was a Nyssa silt loam with average slope of 2.5 percent at the Malheur Experiment Station. The soil is a typical bench soil planted to a wide variety of row crops.

More than 40 beds for potatoes were prepared with three feet between the furrows. Operations In preparing the land were repeated so there would be no difference In tractor traffic between wheel rows and non-wheel rows. Forty furrows 250 feet long were used for the experiment. Each replicate of each treatment was installed in five parallel furrows.

The land was bedded as if a potato crop were going to be planted. No crop was planted. The first irrigation was made on August 6 and 7 and the second Irrigation was made on August 20 and 21. The first Irrigation dates were chosen for the conven- ience of making erosion and water measurements.

The treatments were 1) strawed furrows, two gallons per minute irrigation, 2) non-strawed furrows, two gallons per minute irrigation, 3) strawed furrows, four gallons per minute irrigation and 4) non-strawed furrows, four gallons per minute irrigation. Furrows were strawed using Hobson's Baled Mulch Applicator. This machine spread 790 lbs/acre(5.4 lbs/100 ft. of furrow) of baled wheat straw simultaneously down the length of five furrows. The straw distribution was not completely uniform. Most of the straw fell into the furrow. Loose soil in the bedded ground tended to hold the straw in place before the first irrigation.

Furrow irrigation was controlled by adjusting the outlets of gated pipe. Powlus flumes were used to measure water inflow and outflow throughout the duration of the experiment. Soil erosion was calculated by collecting runoff water and allowing collected sediment to settle in lmhoff cones.

## Results and Discussion

Differences among the treatments were clearly evident from the beginning of the first irrigation. At approximately four gallons per minute the water reached the end of the non-strawed 250-foot furrow In 40 minutes; the strawed furrow took 89 minutes. At approximately two gallons per minute, the water took 108 minutes in the non-strawed furrows and 175 minutes In the strawed furrows.

Sediment differences in the outflowing water were obvious from subjective evaluation. During the first irrigation, water coming from the strawed furrows appeared as clear as the water entering the furrow at the top of the field regardless of irrigation rate. During the second Irrigation, only the strawed furrow at two gallons per minute had clear water at the lower end of the field.

1. Water Inflow

Water inflows were maintained close to the two- and four-gallon per minute rates desired (Table 1). Analysis of the outflow volumes, water intake, and irrigation rate effects on erosion were based on actual rates of inflow into the furrows at the top of the field.

2. Water Outflow

Water outflow volume was closely related to the rate of inflow (Tables 1 and 2). Outflow volumes showed highly significant decreases with straw mulch.

3. Water Intake

Averaged over water inflow rates and irrigations, straw ulch increased water intake by 250 gallons per furrow per irrigation during the first 7 hours and 10 minutes, and by 460 gallons over the entire 11 hours. Increased water intake from straw as greatest during the first irrigation (Table 1). On average, the use of straw increased the amount of total water intake by 20 percent (Tables 1 and 2).

Water intake over time is extremely important for crop growth and water management. The strawed treatment at four gallons per minute was not as effective at promoting water intake during the second Irrigations as during the first irrigation (Table 1, Figures 1 and 2).

Water intake was not Influenced by irrigation rate (Table 2), suggesting that water intake was severely limited by water infiltration rates in this soil.

4. Sediment Yield

Soil loss at a rate of 18 tons per acre per irrigation occurred with water application rates of four gallons per minute per furrow. At four gallons per minute, 790 lbs/acre of straw mulch reduced soil loss to less than 3 tons per acre on the first irrigation, but soil loss rose to 8 1/2 tons per acre on the second irrigation. The soil loss on the second irrigation was exaggerated on the mulched treatment because the mulch had stimulated high water intake during the first irrigation. The soil retained a large reserve of moisture from the first irrigation that slowed intake, increased outflow, and increased soil loss from strawed furrows during the second irrigation.

At two gallons per minute, soil loss from strawed furrows averaged less than 0.2 tons per acre per irrigation over 11 hours. The non-strawed furrows lost more than 3.3 tons of soil per acre per irrigation. The soil loss over time was least during the initial part of both irrigations (Figures 3 and 4).

**Literature Cited**

Berg, R. D. 1984. Straw residue to control furrow erosion on sloping, irrigated cropland. Journal of Soil and Water Conservation 39(1): 58-60.

Miller, D. E. and J. S. Aarstad. 1983. Residue Management to reduce furrow erosion. Journal of Soil and Water Conservation 38(4):366-370.

Table 1. The effects of straw mulch (790 lbs/acre) and irrigation rate on water intake, water loss, and soil erosion loss on land bedded for potatoes. Measurements were made during two successive furrow irrigations. The soil was a Nyssa silt loam with 2.5 percent slope. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1985

| Strawed or No Straw | Planned Inflow Rate gpm | Average Inflow Rate gpm | Average Percent Slope % | Total Water Inflow Per Furrow gallons | Total Water Outflow Per Furrow gallons | Total Water Intake Per Furrow gallons | Percent Intake Per Furrow % | Average Sediment Yield tons/acre | Total Water Inflow Per Furrow gallons | Total Water Outflow Per Furrow gallons | Total Water Intake Per Furrow gallong | Percent Intake Per Furrow % | Average Sediment Yield tons/acre |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| First Irrigation | | | | | | | | | | | | | |
| Strawed | 2 | 2.16 | 2.49 | 940 | 100 | 840 | 90 | 0.02 | 1510 | 430 | 1080 | 72 | 0.02 |
| Non-Strawed | 2 | 2.18 | 2.48 | 950 | 320 | 630 | 66 | 0.64 | 1530 | 730 | 800 | 52 | 3.37 |
| Strawed | 4 | 4.41 | 2.50 | 1860 | 750 | 1100 | 60 | 1.81 | 3070 | 1060 | 2010 | 66 | 2.78 |
| Non-Strawed | 4 | 3.89 | 2.43 | 1660 | 1090 | 570 | 34 | 11.50 | 2800 | 1940 | 860 | 31 | 17.74 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Second Irrigation | | | | | | | | | | | | |
| Strawed | 2 | 1.78 | 2.49 | 780 | 300 | 480 | 61 | 0.15 | 1160 | 480 | 690 | 59 | 0.17 |
| Non-Strawed | 2 | 1.74 | 2.48 | 780 | 460 | 320 | 41 | 2.66 | 1140 | 710 | 430 | 38 | 3.46 |
| Strawed | 4 | 4.15 | 2.50 | 1770 | 1270 | 500 | 28 | 4.95 | 2720 | 1930 | 780 | 29 | 8.47 |
| Non-Strawed | 4 | 4.23 | 2.43 | 1800 | 1380 | 420 | 23 | 15.99 | 2770 | 2180 | 590 | 21 | 19.51 |

Statistical relationships are listed in Table 2.

Table 2. Obeserved variations in water loss, water intake, and soil loss had highly significant relationships to the average water inflow rate, whether or not the furrow was strawed, or whether the observation was during the first or second irrigation. To interpret the equations the average inflow rate per furrow in gallons per minute is represented as "Inflow" and the percent slope is represented as "Slope." Bother "Inflow" and "Slope" are continuous varibles. The variable "Irrigation" takes on the values 0 or 1 depending on whether it is the first or second irrigation. The variable "Strawed" takes on a value of 1 when strawed and a value of 0 otherwised. Malheur Experiment Station, Ontario, Oregon, 1985.

| | |
|---|---|
| 1. Total Outflow Volume to 7:10 hours (gallons/furrow) = | 204 + 53.7 (Inflow)$^2$ + 204 (Irrigation) - 299 (strawed) ns $R^2$ = .96 |
| 2. Total Water Intake to 7:10 hours (gallons/furrow) = | 665 ns - 355 (Irrigation) + 251 (strawed) ns $R^2$ = .69 |
| 3. Percent Water Intake to 7:10 hours (%) = | 74 - 1.92 (Inflow)$^2$ - 25.4 (Irrigation) + 20.3 (strawed) ns $R^2$ = .81 |
| 4. Percent Water Loss at 7:10 hours (%) = | 20 + 12.5 (Inflow)$^2$ + 20.1 (Irrigation) - 13.8 (strawed) ns $R^2$ = .97 |
| 5. Ln (Sediment Yield to 7:10 hours) (Ln(tons/acre)) = | -10.2 + 1.37 (Inflow)$^2$ + 1.63 (Irrigation) - 3.06 (strawed) + 2.74 (slope) $R^2$ = .90 |

Figure 1. Percent water intake over time during the first irrigation in strawed and non-strawed furrows at two irrigation rates. Water intake was measured on a Nyssa silt loam with 2.5 percent slope. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1985.

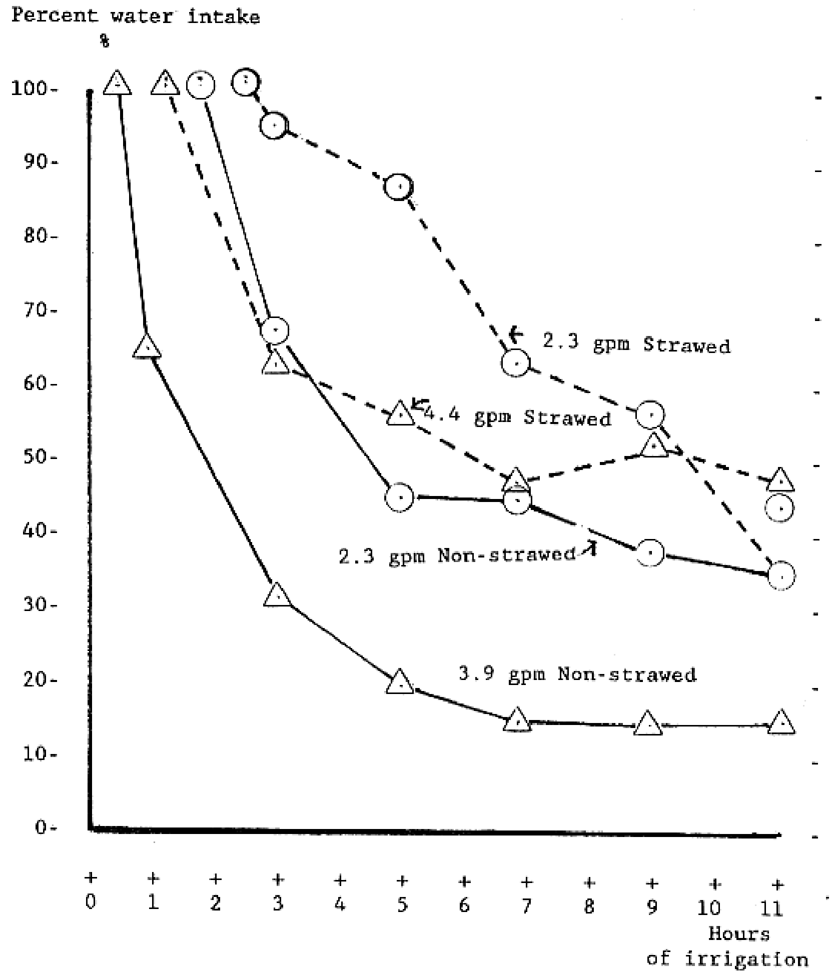



Figure 2. Percent water intake over time during the second irrigation in strawed and non-strawed furrows at two irrigation rates. Water intake was measrued on a Nyssa silt loam soil with 2.5 percent slope. Malheur Experiment Station, Ontario, Oregon, 1985

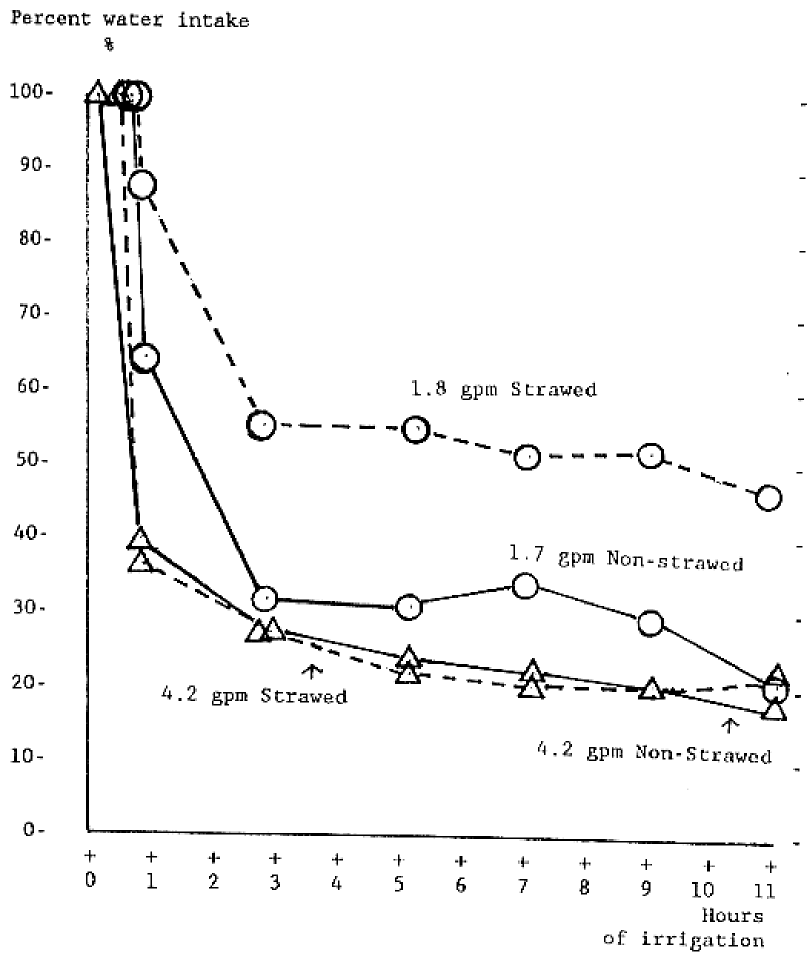



Figure 3. Cumulative soil loss over time during first irrigation. Soil losses were compared between strawed and non-strawed furrows at two irrigation rates. Soil loss was from a Nyssa silt loam with 2.5 percent slope. Malheur Experiment Station, Ontario, Oregon, 1985

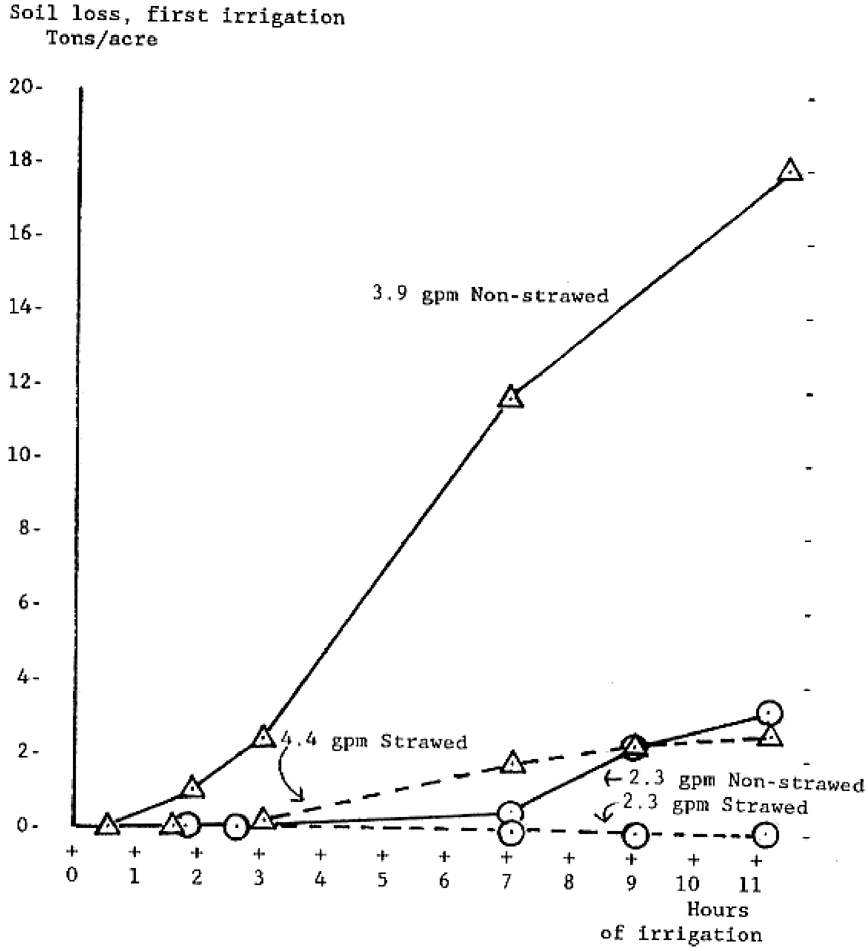
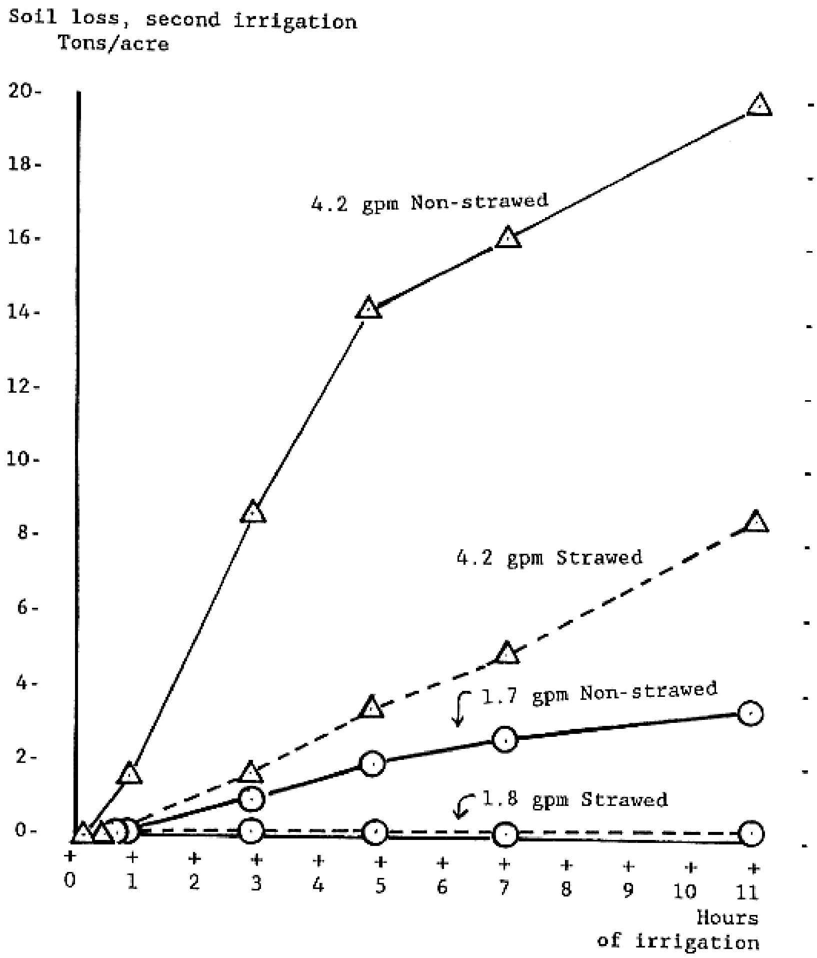



Figure 4. Cumulative soil loss over time during second irrigation. Soil losses were compared between strawed and non-strawed furrows at two irrigation rates. Soil loss was from a Nyssa silt loam with 2.5 percent slope. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1985.


Soil loss, second irrigation
Tons/acre
20-
18-
16-
14-
12-
10-
8-
6-
4-
2-
0-
4.2 gpm Non-strawed
4.2 gpm Strawed
1.7 gpm Non-strawed
1.8 gpm Strawed
0
1
2
3
4
5
6
7
8
9
10
11
Hours
of irrigation