WITHIN-ROW IRRIGATION SAVES WATER ON CROPLANDS

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(Accepted 19 September 1985)

ABSTRACT

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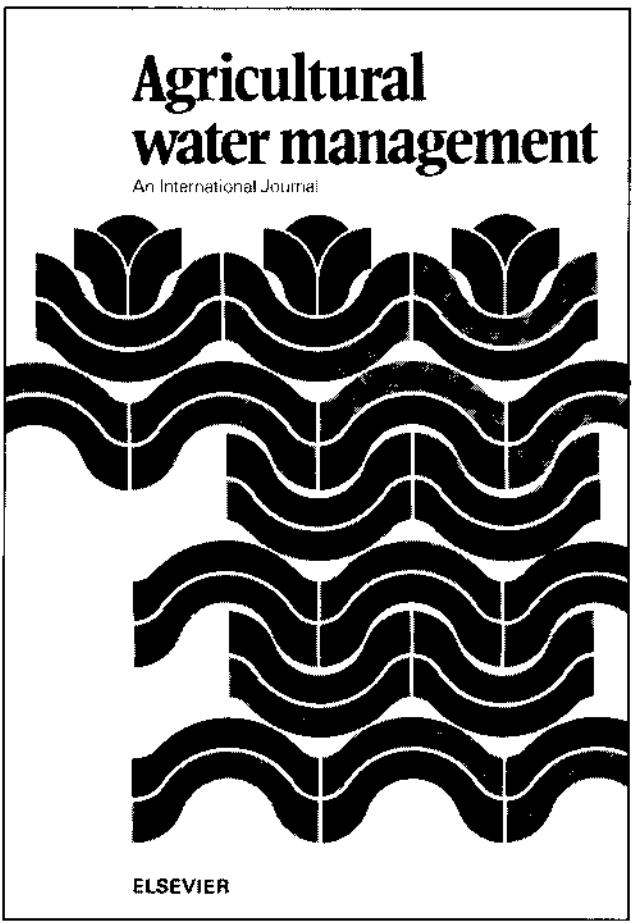

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Excessive water use and soil erosion from furrow irrigation are two of the most serious management problems on irrigated silt loam soils in southern Idaho, U.S.A. These problems are especially serious on croplands planted to dry beans. In conventional bean production, fields are irrigated before planting to wet the entire soil surface. It is not unusual for farmers to apply as much as 30 cm of water over the entire field during a single preplanting irrigation.

Results from this study showed that planting beans in the bottom of pre-irrigated furrows without soaking completely between the furrows reduced preplanting water application by 60%. The continuing within-row treatments reduced irrigation water use by 42% compared to conventional irrigation practices. Total bean yields on the preplanting, within-row treatments were not significantly different from the conventional treatments.

INTRODUCTION

Irrigation induced soil erosion from furrow irrigated cropland is a serious management problem on Portneuf silt loam soil (Durixerollic Calciorthid) in southern Idaho, U.S.A.

Irrigated crop land planted to dry field beans are highly susceptible to soil erosion. The conventional practice for bean production is to wet the entire field surface with a preplant irrigation. This irrigation occurs after seed preparation tillage operations when the soil is loose and highly erodable (Fig. 1). The large volume of water used in conventional irrigation practices often causes considerable within furrow soil erosion.

A 3-year study was conducted to evaluate the effects of controlled within-row irrigation on seasonal water use and dry bean yields. Preplanting irrigation and planting within the seed-row, and continuing within-row irrigation trials were tested on Portneuf silt loam soil.

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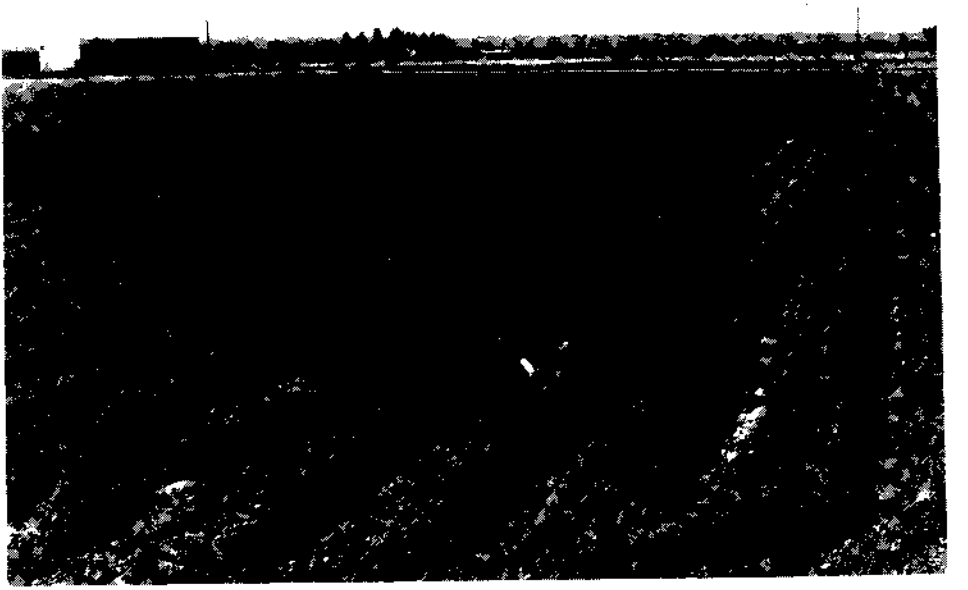

Fig. 1. Furrow irrigation after a conventional preplanting irrigation on a bean field.

STUDY METHODS

Three irrigation-planting treatments were applied for three seasons on four fields located at the University of Idaho Experiment Station, and the Snake River Conservation Research Center located at Kimberly, ID. The plots were arranged in a randomized block pattern with three treatments and three replications. The plots were 36.6 m long in the 1st and 3rd year, and 51.9 m long the 2nd year. All plots were four rows wide, each row 61 cm apart.

Irrigation water was applied by a multiset surface irrigation system, which permits the application of small quantities of water at controlled rates to short furrow segments (Rasmussen et al., 1973). Controlled irrigation reduces water loss and can improve uniformity of water applications. All the plots were located on fields having 0.5—1.0% slopes. Plots were treated with a pre-emergence herbicide for weed control. The unconventional irrigation and planting treatments consisted of irrigating in small furrows, and planting dry beans in the bottom of the furrows (Fig. 2).

Conventional irrigation treatment

Sufficient irrigation water was applied in standard furrows spaced 61 cm apart to wet the entire soil surface between furrows. After the field had

dried sufficiently, the beans were seeded into the moist soil between the furrows. Before bean emergence the field surface was lightly harrowed to control weeds. When the bean plants were 15—20 cm high the plots were cultivated, and irrigation furrows were re-formed between the rows. The bean plots were irrigated every 7—10 days for the remainder of the growing season.

Preplanting irrigation within-row treatment

A single pre-planting irrigation was applied in small furrows spaced the same as in the conventional irrigation treatment to sufficiently wet the soil 15—20 cm laterally, and 20—25 cm vertically into the upper soil profile. After 2—3 days for drying, beans were seeded directly into the moist furrow bottoms. Field plots were harrowed for weed control. When the plants were 15—20 cm high they were cultivated, and standard irrigation furrows were formed between the bean rows.

Sometimes a single within-row irrigation will not sustain the bean plants

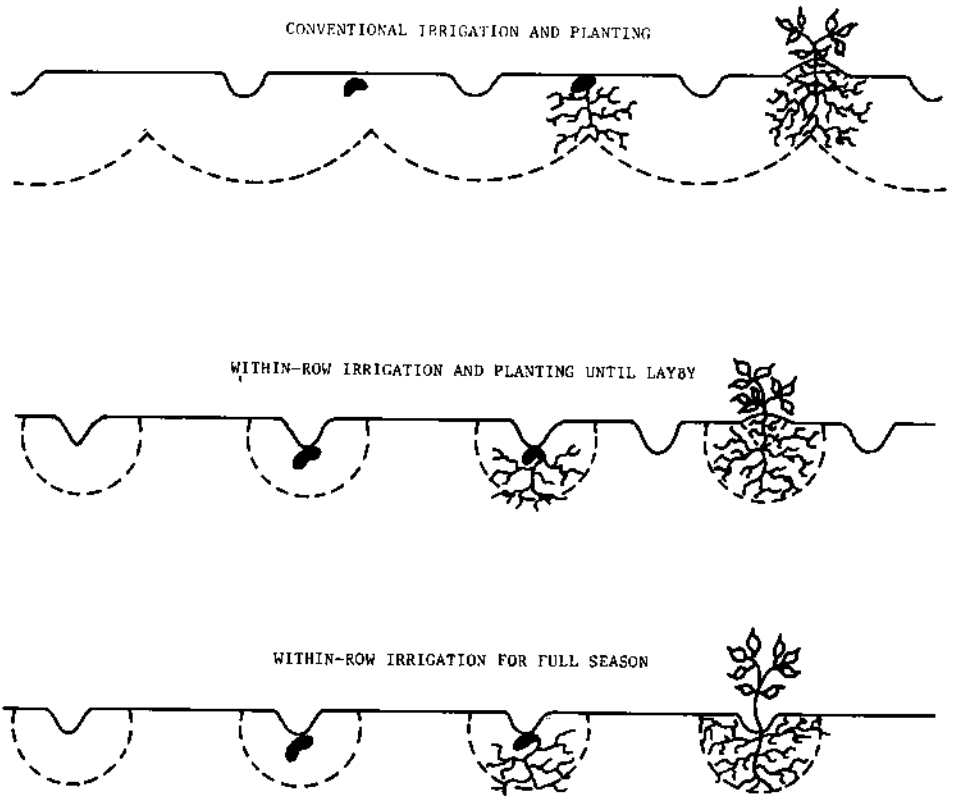

Fig. 2. Three irrigation treatments: conventional, within-row, and continuous within-row for full season.

until the final cultivation when furrows are formed between the rows. A practice that was successful in several tests was to irrigate the small bean plants within the rows with several light irrigations. Small quantities of water were applied to avoid washing out the bean plants. When the beans were 15—20 cm high they were cultivated, and furrows formed between the rows. Conventional irrigation practices were then continued for the remainder of the season for both practices.

Preplanting, continuing within-row irrigation treatment

Preplanting irrigation and planting procedures were the same as within-row treatments. After bean emergence a light cultivation between the bean rows was applied. Care was taken to avoid moving soil into furrows. Plots were not harrowed on this treatment because of the continuing irrigations in the furrows where the beans had been seeded and were growing (Fig. 3). The only weed control was a pre-emergence herbicide. Light irrigations were applied directly into the bean furrows every 3—4 days for the remainder of the growing season.

Fig. 3. Continuous within-row irrigation of dry beans.

RESULTS AND CONCLUSIONS

During the first season, small red dry beans were planted in all plots. Total water applied was 173 cm in ten irrigations during the season on the conventional treatment compared to a low of 74 cm applied in 19 light irrigations on the continuing within-row irrigation treatment (Table 1). The preplanting, within-furrow irrigation treatment required 60% less water and 69% less irrigation time than the conventional preplanting irrigation (Table 1). The bean yields on all plots were low because of a late planting and an early killing frost. There were no significant differences in yield between treatments (Table 1).

TABLE 1

Effect of irrigation treatments on dry bean production

Treatment	Growing season (year)	Seasonal irrigations	Seasonal water applications (cm/ha)	Bean yield (kg/ha)
Conventional irrigation practices	1	10	173.0	1870
	2 a*	9	131.0	2998
	2	9	133.6	3423
	3	8	137.9	3694
Preplanting irrigation within plant row	1	10	160.5	1770
	2 a	11	124.8	2990
	2	9	129.2	3062
	3	8	112.9	3575
Preplanting irrigation continuing within-row	1	19	74.0	1967
	2 a	11	111.6	2845
	2	14	82.1	3191
	3	11	66.5	2964

*Treatments were conducted on two fields during the 2nd year. Small red dry beans were grown in field 2, and pinto 114 beans were grown in field 2 a.

The second season, treatments were applied on two fields planted to small red and Pinto 114 field beans. The seasonal water application was 131—133 cm with nine irrigations on the conventional plots compared to 82—112 cm on the continuing within-row irrigation plots with 11—14 light irrigations (Table 1). The preplanting, within-row treatment required 40% less irrigation water than the conventional irrigation (Table 1). The pinto bean yields were slightly less than those of the small red beans, but there were no significant yield differences among the three treatments.

The third season small red dry beans were planted in all plots. The single

preplanting, within-row irrigation required 74% less irrigation water than the conventional irrigation treatment (Table 2). The seasonal water application was 138 cm on the conventional treatments with eight irrigations, and 66.5 cm on the continuing within-row treatments with eleven light irrigations. The bean yields were significantly lower on the continuing within-row treatments than the conventional and preplant within-row treatments. This low yield only occurred during the third year, and we do not know why.

TABLE 2

Three-year preplanting irrigation treatments (single irrigation)

Treatment	Duration of irrigation (h)	Irrigation water applied (cm)
Conventional preplanting irrigation		
Year		
1	6.00	5.38
2	6.25	5.50
3	10.00	10.80
Mean	7.42	7.23
Preplanting irrigation within-furrow		
Year		
1	2.00	2.54
2	3.00	3.30
3	2.00	2.80
Mean	2.33	2.88

During the preplanting, within-row irrigation treatments, water was applied in the small preformed furrows for 1—2 h. Since only a small volume of soil in the seed bed was wetted, the average depth of water applied was 2.5—3.3 cm compared to 5.4—10.8 cm conventional preplanting irrigation treatments.

In the continuing within-row irrigations on long runs, silt depositions from furrow erosion caused some water damming and overflow after two or three in-row irrigations. On steeper slopes this may not be a problem. Within-row irrigation would reduce erosion by slowing the water velocity. A specially designed bean cutter would be needed to cut the beans within rows.

Light, frequent, within-row irrigations provided adequate water to the bean plants during the root development. Water quantity was reduced 60% during the preplanting, within-row irrigation compared to conventional irrigation. The within-row irrigation will reduce nitrogen leaching from the

soil, conserve water, and greatly reduce water runoff and soil erosion during the preplant irrigation, or until the final cultivation. At the final cultivation, plants are hilled, and new irrigation furrows are formed between the plant rows. During water short seasons or in areas where water is pumped and irrigation costs are high, the within-row irrigation technique would be very beneficial.

The results of this research show that these unconventional irrigation and planting treatments used in conjunction with the multiset surface irrigation system or a more recent automatic system called cablegation (Kemper et al., 1981) could produce equal stands of dry beans. This system could be applied to other furrow irrigated farm crops with similar water requirements. In undeveloped countries that have limited irrigation water and a shortage of agricultural land, the within-row irrigation practices could be very beneficial.

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