# Early Sowing and Irrigation - Differential Response of Barley and Oat

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**Research Highlight: Yield increase of 110% over the non-irrigated control was obtained by early sowing of barley at end of Oct followed by 30 mm irrigation, but the later maturing oat had no significant response. Water use efficiency of early irrigation, which was >3 times higher than that of late irrigation (at heading), was much higher on barley (75 kg/ha/mm) than oat (18 kg/ha/mm) especially in the dry 2007/08.**

## Introduction

Sowing date has a large effect on crop yields under rain-fed conditions. In West Asia and North Africa (WANA), yield tends to decrease if sown late as the growing period will be shortened and the crop will be exposed to late season heat and water shortage. In contrast, early sowing tends to give higher seed yield as early emergence always lead to earlier flowering and maturity allowing an escape from terminal heat and drought.

However, since rains may come late in some years, earlier sowing does not always lead to earlier seedling emergence. Irrigation immediately after early sowing is a possible way to ensure early germination. The idea of applying a small amount of supplemental irrigation to initiate early emergence after early sowing emerged 3-4 decades ago. Recently, three field and/or simulation studies on the technique were conducted on wheat, but inconsistent results have been reported. On the contrary, the technique gave significant higher seed and straw yields in our study on barley.

Barley cropping and sheep husbandry are traditionally the two most important agricultural activities in arid and semi-arid areas of WANA, including the northern Bekaa Valley of Lebanon. In North Africa, oat is a popular forage crop second to barley, and oat has started getting attention in West Asia.

The objective of the study was to test whether early sowing followed immediately with a small amount of irrigation to ensure earlier emergence will increase oat seed yield significantly as barley does.

## Materials and methods

Site information:

Experiment conducted at the Agricultural Research and Educational Centre (33°56' N, 36°05' E, 995 m a.s.l.) in the semi-arid central Bekaa Valley, Lebanon. The long-term (51 years) annual precipitation of the site is 519 mm, 58% of which falls in December, January, and February.

Experiment details:

➢Irrigation treatments - control (without irrigation), only early irrigation (EI), and only late irrigation (LI). The LI treatment received irrigation (100 mm on 15 April 2008; 60 mm on 24 April 2009) when barley was heading. Irrigation was applied by sprinklers.

➢Design - Strip-plot design with 4 replicates conducted for 2 years (2007/08 and 2008/09).

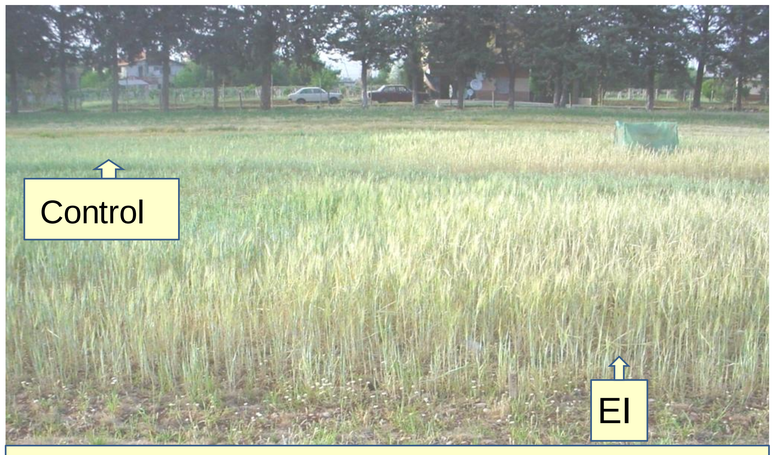
➢Sowing and plot size - Seeds were sown early (Oct 25 in 2007/08; Nov 12 in 2008/09). A 30-mm irrigation was given to appropriate plots within a week after sowing, which was carried out by a small-plot planter using a 30cm inter-row spacing. Plot size was 8m x 3m. Barley (variety Rihane) and oat (variety name unknown; grown at AREC since 1950s) were sown at a rate of 100 kg/ha.

➢Fertilization and weed control - Nitrogen was applied twice by broadcasting: 20 kg N/ha as ammonium sulfate after sowing, and 40 kg N/ha as ammonium nitrate in early spring. Broadleaf weeds were controlled by spraying 2,4-D.

➢Traits measured - Dates of seedling emergence, heading, and maturity, plant height near maturity, seed and shoot yields, harvest index and supplemental irrigation water use efficiency ($WUE_{SI}$) defined as grain yield increase over the non-irrigated control per unit of irrigation water applied.

Data analysis:

The analysis of variance program in the GenStat package (Version 6.1) was used to perform the statistical analysis. For combined analysis over years, the option of general analysis of variance was used.




A view of the 2007-08 experiment (Apr 23, 2008)

## Results and discussion

*Weather and seedling emergence*

The annual precipitation was 151 mm lower than the long-term average in 2007/08 but 76 mm higher in 2008/09. In 2007/08, the minimum monthly temperatures were above the long-term average in all the months except January, February, and May, but minimum monthly temperatures in 2008/09 were lower than or close to the average.

In 2007/08, relative to the EI treatment, seedling emergence took place 30 days later in the control and in LI. In contrast, date of seedling emergence under the three treatments was the same in 2008-09.

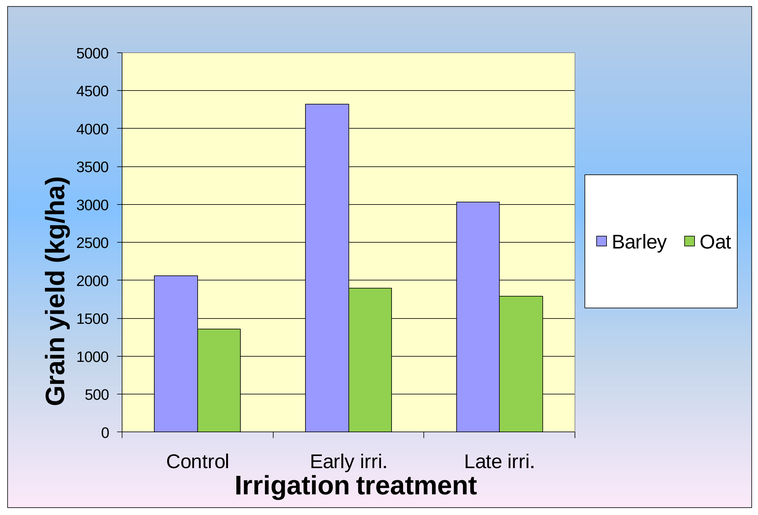



Fig. 1. Grain yield response of barley versus oat to irrigation. (LSD in kg/ha = 782; = 392 for same irrigation treatment; =789 for same crop)

*Yields and harvest index*

Since the two years were so different, year effects were highly significant for all the traits measured except days to heading. Interaction effects involving year were also mostly significant. Since the objective was not to study year effects, we will concentrate on irrigation treatments, crops, and their interaction except when discussing $WUE_{SI}$.

Crop by irrigation interaction, crop, and irrigation were significant for grain and shoot yield and harvest index. Barley grain yield was higher after EI than LI, which in turn was higher than the control, but there was no significant response to irrigation in oat (Fig. 1). On average, barley yielded (3140 kg/ha) nearly twice the amount of grain than oat (1680 kg/ha), and irrigation gave higher yield (82% by EI and 41% by LI) than the control (1710 kg/ha). Similar responses by the two crops to irrigations were obtained in shoot yield and harvest index (Table 1).

*Other agronomic traits*

Crop by irrigation interaction, crop, and irrigation were also significant for days to heading and maturity. Relative to the control and LI, barley headed 15 days earlier under EI, but oat panicles emerged only 3-4 days earlier (Table 1).

Table 1. Differential responses of barley versus oat to irrigation.

| | Shoot yield (kg/ha) | | Harvest index (%) | | Plant height (cm) | |
|---|---|---|---|---|---|---|
| Treatment | Barley | Oat | Barley | Oat | Barley | Oat |
| Control | 6720 | 4730 | 21.6 | 20.6 | 60 | 58 |
| Early irr. | 11500 | 6720 | 36.4 | 21.9 | 79 | 65 |
| Late irr. | 8180 | 5420 | 28.2 | 23.6 | 59 | 63 |
| LSD (5%) | 1578; 1136 #; 1524 ## | | 3.66; 3.00; 3.54 | | 7.5; 7.1; 7.4 | |

| | Days to heading (from Mar 31) | | Days to maturity (from Apr 30) | |
|---|---|---|---|---|
| Treatment | Barley | Oat | Barley | Oat |
| Control | 18 | 21 | 26 | 37 |
| Early irr. | 3 | 17 | 20 | 35 |
| Late irr. | 18 | 20 | 32 | 42 |
| LSD (5%) | 1.4; 1.1; 1 .2 | | 1.9; 2.0; 1.9 | |

# for comparing means in same level of irrigation; ## for comparing means in same level of crop

EI also led to earlier maturity in barley than the control or LI. However, maturity under early irrigation was similar to that of the control in oat, though both were earlier than the late irrigation.

On average, days to heading were 9 days earlier in EI than the control and LI, and maturity was 3 days earlier under EI than the control, which was 6 days earlier than LI (Table 2). Barley was 6 days earlier than oat in heading, but 12 days earlier in maturity (Table 3)

Table 2. Mean effects of irrigation treatments on six different crop traits.

| Treatment | Grain yield (kg/ha) | Shoot yield (kg/ha) | Harvest index (%) | Plant height (cm) | Days to heading (fr Mar 31) | Days to maturity (fr Apr 30) |
|---|---|---|---|---|---|---|
| Control | 1710 | 5720 | 21.1 | 59 | 19 | 31 |
| Early irr. | 3110 | 9110 | 29.2 | 72 | 10 | 28 |
| Late irr. | 2410 | 6800 | 25.9 | 61 | 19 | 37 |
| LSD (5%) | 752 | 1387 | 3.07 | 5.9 | 1.2 | 1.3 |

Table 3. Mean difference between barley and oat on six different traits.

| Crop | Grain yield (kg/ha) | Shoot yield (kg/ha) | Harvest index (%) | Plant height (cm) | Days to heading (fr Mar 31) | Days to maturity (fr Apr 30) |
|---|---|---|---|---|---|---|
| Barley | 3140 | 8800 | 28.8 | 59 | 13 | 26 |
| Oat | 1680 | 5620 | 22.0 | 72 | 19 | 38 |
| LSD (5%) | 238 | 867 | 2.21 | 5.9 | 1.0 | 1.4 |

*Irrigation water use efficiency*

The $WUE_{SI}$ of barley in EI was very high (>64 kg/ha/mm) (Fig. 2) and it was much higher than that of oat especially in 2007/08. In each year, of EI was higher than that of LI, especially in 2007/08.

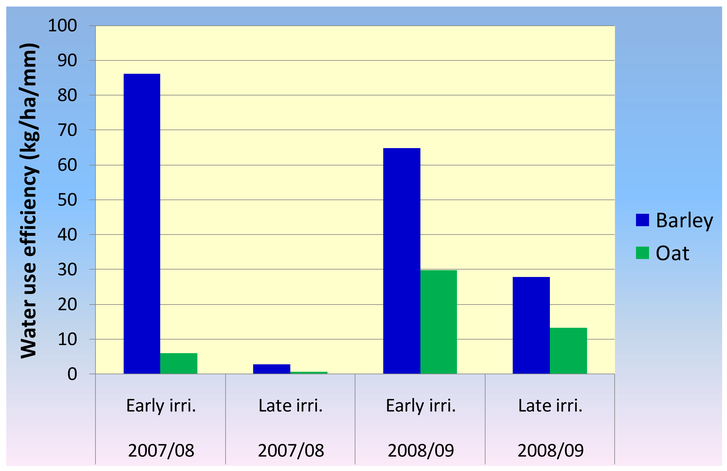



Fig. 2. Supplemental irrigation water use efficiency ($WUE_{SI}$) on barley versus oat under early or late irrigation in 2007/08 and 2008/09.

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