The Effect of Different Seeding Rates and Supplemental Irrigation on Clipping and Productivity of Two Barley Cultivars in Muwaqqar

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Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Agricultural Resources and Environment

Faculty of Graduate Studies

University of Jordan

August 1998

بسم الله الرحمن الرحيم

" أولم يرَ الذين كفروا أن السمٰوات والأرض كانتا رتقاً

ففتقنٰهما، وجعلنا من الماء كل شيءٍ حيٍ، أفلا يؤمنون "

سورة الأنبياء (٣٠)

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DEDICATION

To All Honest and Hardworking People

With

Best Wishes.

ACKNOWLEDGEMENT

Great thanks for God for helping me in everything.

I would like to express my deep thanks and appreciation to my advisor Dr. Omar Kafawin and co-advisor Dr. Ibrahim Ghawi for their supervision, encouragement, support, guidance and interest in this study.

Thanks are extended to members of My Examination committee, Dr. Hani Saoub, Dr. Butros Hattar and Dr. Abdel Nabi Fardous for their valuable thoughts and advices in writing this thesis, also for their support and help.I am grateful to the National Center for Agriculture Research and Technology Transfer (NCARRT) represented by Dr. Awni Taimeh for the scholarship provided for this research and to the Jordan Arid Zone Productivity Project (JAZPP) represented by Dr. Butros Hattar for providing the funds and facilities to conduct this work.

Also, special thanks are due to Dr. Hani Saoub for his advice and help and for Muwaqar Agricultural Research Station staff for their help in this study. Also thanks for everyone helped in the performance of this study.

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ABSTRACT

The Effect of Different Seeding Rates and Supplemental Irrigation on Clipping and Productivity of Two Barley Cultivars in Muwaqqar.

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This experiment was conducted in the Muwaqar Agricultural Research Station during 1996 / 97 growing season to study the effect of three seeding rates and three levels of supplemental irrigation on forage and grain production of two barley cultivars (ACSAD 176 and RUM). Supplemental irrigation was applied at germination, tillering and booting stages.

A single clipping at the tillering stage produced the highest fresh and dry matter weights for both ACSAD 176 and Rum cultivars with the highest water level. While ACSAD 176 under the highest water level gave the highest plant height, biological yield, and total biological yield. Plant height, fresh yield, dry yield, biological yield, and total biological yield

increased with the increase in both seeding rate and supplemental irrigation.

Grain yield after clipping declined for all treatments. The cultivar ACSAD 176 significantly out yielded Rum in forage production, while the interaction between the cultivar Rum, seeding rate (100 kg / ha) and the highest supplemental irrigation (141.7 mm) increased grain yield significantly fboth treatments with and without clipping.

1. INTRODUCTION

About 81% of the total land area of Jordan receives less than 200 mm rainfall (7.27 million hectare) and it is called Badia region (Department of Agricultural Statistic, 1994). In Jordan, barley is grown for grain production in relatively low rainfall areas. In dry and insufficient rainfall years, barley is used for grazing. Although the crop is mainly consumed as grains, considerable use is made of barley at the green stage (tiller stage) and at the maturity stage when rainfall is insufficient to ensure an economic grain harvest. Barley production in Jordan is considered relatively low and does not satisfy Jordan's needs. Jordan imports annually 253859 ton of barley to meet the increasing demand of barley as feed for animals (Statistical yearbook 1986-1994). The average area planted with barley is about 43000 ha and produces 31681 tons of grain. Average barley grain productivity from 1984 - 1995 was 737 kg / ha (Statistical yearbook, 1984 – 1995).

Increasing barley production could increase animal production as it is usually used in animal feeding. Due to the erratic and low rainfall, supplemental irrigation is a potential solution to increase barley production. Supplemental irrigation is addition of irrigation water to a certain crop in addition to the rainfall amount during the growing season distributed according to the plant needs in order to give the plant its water requirements to increase and sustain productivity per unit area.

In Muwaqar, via rainfall water harvesting behind dams, supplemental irrigation could be practiced. Because limited work has been done in Jordan to investigate the effect of plant density and supplemental irrigation on barley production, this research was conducted with the following objectives:

1. To determine the optimum seeding rate for forage and grain production of two barley cultivars: ACSAD 176, and RUM.
2. To determine the response of the two barley cultivars and seeding rates to the supplemental irrigation.

2. LITERATURE REVIEW

Many factors such as varieties, seeding rate, climatic factors, and fertility status of soil affect yield of barley. Dry regions are characterized by drought and heat stresses conditions for cereal crop production. Barley tolerates these conditions (drought and heat stresses). Under such stresses yield of barley is much higher than that of wheat, oat, and rye (Chapman and Carter, 1976). Higher grain yield and biomass yield of barley was achieved in a shorter duration than triticale, bread wheat, durum wheat, and oat. In addition, barley and triticale are faster than wheat and oat in developing a greater leaf area and dry mass (Lopez-Castaneda and Richards, 1994). Barley has a shorter life cycle than wheat and it is often grown where other cereal crops are not grown because of environmental factors (Mekni and Kourieh, 1984). Grazed barley (green material and grain) is a major portion of the diet of sheep and goat in Jordan, Tunisia, Algeria and Syria (Anderson, 1985). Barley can be used in different farming systems as grain crop, grazing crop or hay crop (A. Hadjichristodoulou, personal communication). A review of literature of the different effects of some factors affecting wheat, barley, and some cereal crops will be discussed.

Under dryland conditions, the grain and dry matter yields of barley cultivars grazed at tillering stage were reduced compared to no grazing, while grain yield increased under irrigation or high rainfall (Hadjichristodoulou, 1991).

Craig *et al.* (1994) reported that different barley cultivars responded differently in dry matter yield and grain yield.

Erchedat (1991) at Smakia, in south Jordan, found that the biological yield of Tadmor, and SLB-6-38 barley cultivars were 856, and 850 kg / ha, respectively and were significantly higher than Rum (425 kg / ha). He also found no significant differences in biological yield (without clipping) between forage barley cultivars: WAD hasa and Rihani. Also, the cultivar WAD hasa had significant differences in the fresh yield (3910 kg / ha) and dry matter yield (891.8 kg / ha). He also found that the grain yield of cultivar SLB-6-38 in Smakia was 1599 kg / ha. In Madaba the grain yield of WAD hasa and SLB-6-38 cultivars were 748, and 675 kg / ha respectively. Grain yield of SLB-6-38 cultivar outyielded significantly the other cultivars (344 kg / ha) while, cultivar Rum gave the lowest yield (178.1 kg / ha). The reason of yield reduction was due to the drought stresses.

2.1.2. Without Clipping:

Simmons *et al.* (1982) indicated that barley grain yields of both low and high tillering genotypes were as high or higher than those of intermediate tillering cultivars. Anderson (1985) found that maximum barley yield was dependent on the uses of the improved variety.

Abu-Shriha (1989) in a green house pot experiment indicated that the reduction in soil water content resulted in a progressive decline in plant height, grain yield, and straw yield of barley. He showed that ACSAD 176 was the most droughts tolerant compared to the local selection cultivar.

Fardous *et al.* (1995c) in a study conducted at Ramtha Agricultural Research Station reported that different cultivars showed different effects in yield. Barley cultivars: Deir-Alla 106 and Rum outyielded significantly the cultivars: ACSAD 176, and Harmal in grain yield production. While cultivar Rum, ACSAD 176, and Harmal outyielded the cultivar Deir-Alla 106 in biological yield. Rum and Deir-Alla 106 were significantly higher than Harmal, and ACSAD 176 with respect to 1000 seed weight.

2.2. Seeding Rate

2.2.1. With Clipping:

Anderson (1985) reported that the seeding rates required to reach maximum yield in grazed treatments were approximately double those required in ungrazed plots (50 - 100 kg / ha). He also indicated that the highest barley dry matter and grain yields after grazing were obtained from seeding rates ranging from 30 to 120 kg / ha depending on variety and season. He reported that increases or decreases in grain yield after grazing

Yau (1987) reported that the barley under supplementary irrigation produced significantly higher grain yield than triticale with and without stimulated grazing.

2.3.2 Without Clipping:

Abu-Shriha (1989) in a field experiment at Muwaqare Agricultural Research Station indicated that maximum yield of barley could be obtained by continuous irrigation through the growing season compared to supplemental irrigation. He showed that water stress during booting stage was the most sensitive to moisture stress and resulted in reduction of grain yield, biological yield, plant height, and 1000 seed weight. Also the termination of irrigation water at both booting and heading stages reduced yield.

The effect of supplemental irrigation is dependent on wheat cultivars. Also, the grain yield increased with the use of supplemental irrigation (Bouzerzour and Oudina, 1990).

Jarrar (1993) in a study at Mushaqqar Agricultural Research Station showed that wheat grain yield increased slightly due to the lowest amount of supplemental irrigation (69.2 mm) which produced 4.35 ton / ha as compared to the rainfed treatments which produced 3.38 ton / ha. He found that the biological yield, 1000 seed weight, plant height, and water use efficiency were significantly higher than the rainfed treatments.

Fardous *et al.* (1995a) in a study conducted at Khaldia Agricultural Research Station on barley cultivar ACSAD 176 irrigated with five different levels of saline and non-saline water using advanced surface irrigation, found no significant differences in yield between saline and non-saline water in irrigation, while there were significant differences in the yield when different amounts of water were used. Plant height increased with the increase of water amounts especially at the first growth stage of the crop (germination until heading). They showed that the yield was decreased per unit area when non-saline water was used because threshold point of barley is greater than that of the saline water and higher nitrogen content of the saline water.

Fardous *et al.* (1995b) in a study conducted at Ramtha Agricultural Research Station found that the biological yield and grain yield of barley irrigated with 110, 82.5, and 55 mm supplemental irrigation outyielded significantly the treatments with 0, and 27.5 mm irrigation. They reported no significant differences in the 1000 seed weight through the different water levels.

Fardous *et al.* (1995c) in a study conducted at Ramtha Agricultural Research Station during two year crop rotation found that the barley cultivar ACSAD 176 outyielded the other cultivars significantly with 68.59 mm of supplemental irrigation except the cultivars Harmal, Deir-Alla 106 and Rum. Rum cultivar had higher significant differences with the water levels 51.14 and 68.59 mm when compared to the other cultivars except Deir-Alla 106 with the water levels of 42.12, 51.14, and 68.59 mm. Supplemental irrigation treatment (51.14, and 68.59 mm) was significantly higher than other treatments (21.35, and 42.12 mm) in the grain yield and biological yield. Also, the 1000 seed weight had significant differences at water levels 51.14, and 68.59 mm.

McDonald *et al.* (1984) reported that the total dry matter yield and grain yield of wheat were increased with more frequent irrigations when they were used three water potentials (water when morning leaf water potential = - 0.4 ± 0.1, - 0.8 ± 0.1 MPa and not watered).

A'ra'r (1985) showed that increasing the agricultural productivity needs good land management, appropriate crop rotations, and supplemental irrigation to provide the crop with one or two irrigations at the time of moisture deficient in rainfall areas. He attributed the effect of supplemental irrigation to:

(a) Homogenous planting growth.

(b) Sowing more plant number per the unit area.

(c) Better fertilizer use efficiency.

(d) Using improved varieties produced for irrigation planting.

(e) Excluded the risk of water deficiency at the critical growth stages of the crop.

He found that the first 100 - 150 mm of rain or irrigation didn't produce seeds, and every 1 mm after that produced 14 - 16 kg grain / ha.

Gorashi (1988) found significant differences in the grain yield and 1000 seed weight of wheat when nine irrigations were used. The highest grain yield was obtained when irrigation terminated before the last irrigation and the lowest grain yield was obtained when irrigation terminated before the last three irrigations.

Patel and Upadhyay (1993) showed that wheat yield increased significantly with the increase in the amount of water applied. Al-Salti and Nafa' (1993) found that irrigation treatments caused significant increases in grain yield, biological yield, and plant height of barley and all the treatments outyielded the control in Ramtha region.

AL-Zuriqi *et al.* (1995) in a study conducteat Wad Alyabis Agricultural Research Station reported that the biological yield, grain yield of wheat, plant height, and 1000 seed weight were increased with the increase in supplemental irrigation until 222.5 mm (rainfall + 52.5 mm supplemental irrigation).

From economic point of view, Mazid *et al.* (1984) showed that the calculated grazing threshold of barley in western Syria was 321 kg / ha grain yield, in which the crop would be more profitably grazed than harvest.

Singh *et al.* (1979) found that in normal rainfall years, the grain and straw yield of wheat increased with the increase of the number of irrigations. The use of water by wheat increased with the increase in number of irrigations, while the water use efficiency was decreased with the increase in number of irrigations. Sepaskhah (1978) found that straw yield was not influenced by irrigation treatments at the reproductive stages. He suggested that higher water efficiency and grain yield of barley was obtained by one irrigation at the flowering stage, while McDonald *et al.* (1984) found that the yield of the wheat increased with more frequent irrigations. Nachit (1984) showed that grain yield of triticale with partial irrigation (30 mm to initiate germination) increased by early planting (one month before normal planting) and decreased by late planting (one month after normal planting) as compared to normal planting date (mid-October).

Nofal (1996) showed that the barley cultivars: ACSAD 176 and Rum had significantly the highest grain water use efficiency, while the cultivar Rihani had the highest biological water use efficiency.

3. MATERIALS AND METHODS

3.1. Location

The experiment was carried out during 1996 / 1997 growing season at the University of Jordan Agricultural Research Station at Muwaqar. The site is 50 km southeast of Amman (Latitude of 36 0'5', N, Longitude of 31 4'9', E and Altitude of 760 m above sea level. The climate is typical Mediterranean arid with wet winter and dry summer. Rainfall varies from 80 to 200 mm with annual mean of 150 mm falling mostly during January and February. Mean maximum and minimum temperatures during January (coldest month) are 13 and 3°C, respectively. Mean relative humidity for January is 70 %. The wind is active in the area because of its open topography. Mean sunshine is 9 hours / day, while mean annual incident solar radiation is 550 langleys / day. The soil is fine silty, mixed, thermic, Typic calciorthid (Taimeh, 1989). Generally this location characterized by weak vegetative cover, soil surface of high silt content, strong surface crust, low organic matter and weak aggregate stability.

The amount of rainfall was 139.5 mm in which 81.5 mm fell after the planting date. Rainfall distribution during the winter season is presented in Table 1.

Table 1: Monthly rainfall for 1996/97 growing season at the Agricultural Research Station at Muwaqar*.

Month	Days			Total /month
	1 - 10	11 – 20	21 – 30	
Oct. 1996	00.0	00.0	00.0	00.0
Nov.	00.0	17.0	30.0	47.0
Dec.	03.0	08.0	00.0	11.0
Jan. 1997	00.0	16.5	26.5	43.0
Feb.	00.0	00.0	28.0	28.0
Mar.	03.5	06.0	01.0	10.5
Apr.	00.0	00.0	00.0	00.0
May	00.0	00.0	00.0	00.0
Total / season				139.5

*Source: Muwaqar Res. Station, Faculty of Agriculture, Univ. of Jordan.

3.2. Experimental Design

Experimental design layout is shown in Figure 1. Two factor factorial in split block in RCBD arrangement design was used. Number of replications was three. The blocks represent the irrigation treatments, which consisted of three water levels:

- Low (W 1): 25 mm water was applied at germination stage.
- Medium (W 2): 75 mm water was applied at three stages: at germination stage (25 mm), tiller stage (25 mm) and boot stage (25 mm).

- High (W 3): 141.7 mm water was applied at three stages: at germination stage (25 mm), tiller stage (58.33 mm) and boot stage (58.33 mm).

These amounts were chosen in addition to the average rainfall to gave the barley its requirements of water, which is 304 mm as reported by Shatanawi *et al.* (1987)

Twenty-five mm of water was applied at the sowing time for all treatments. It was applied on 23 December 1996 and 8 January 1997 in two equal applications (12.5 mm / application) because of the low infiltration rate and crust formation of the soil to ensure good germination. The application at tillering stage was on 24 and 26 of March 1997 for W2 and 24, 26 and 28 of March 1997 for W3. The application at booting stage was on 23 and 25 of April 1997 for W2 and 23, 25 and 27 of April 1997 for W3.

The sub-plot consisted of two factors: first was two six-row barley cultivars:

- ACSAD 176 (C1) - Rum (C2)

The second factor was the following three seeding rates:

- 50 kg / ha (S1)
- 100 kg / ha (S2)
- 150 kg / ha (S3)

Tested pure seeds were used.

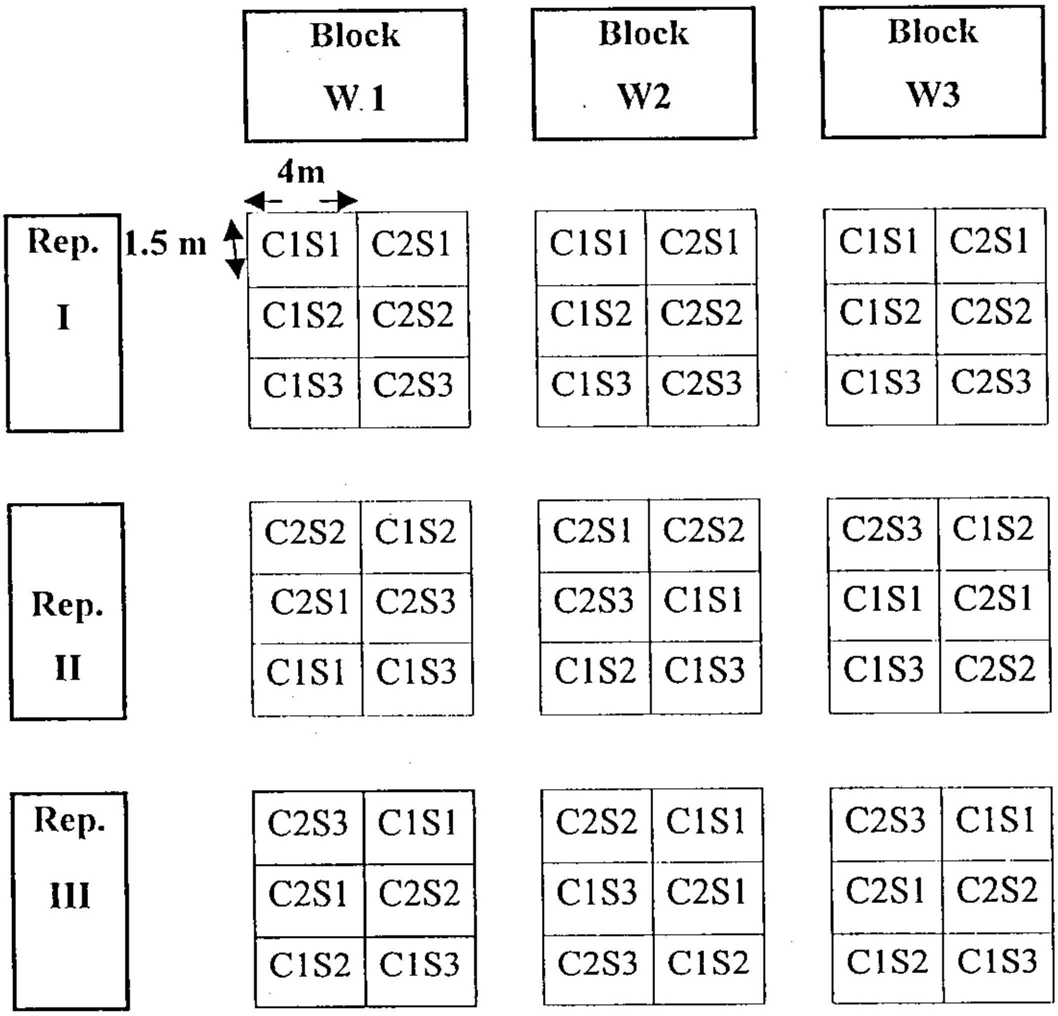

Figure 1: The experimental design for two barley cultivars, three seeding rates and three irrigation levels layout.

The six treatment combinations were distributed randomly to the plots in each block. These six treatments were:

C1S1 C2 S1

C1S2 C2 S2

C1S3 C2 S3

Table 2: Water level, total water, rainfall received, a mount of supplemental irrigation and stages of application.

Water Level	Total water received (mm)	Rainfall received (mm)	Supplemental irrigation (mm)	*Stage of application
W1	106.5	81.5	25	P
W2	156.5	81.5	75	P, T, B
W3	223.7	81.5	141.7	P, T, B

*P: Planting time. T: tillering stage. B: booting stage.

3.3. Land Preparation and Field Practices

Soil was plowed by chisel plow. Bordered basins of 1.5 m x 4 m were prepared. Six rows of 25 cm spacing was opened. Soil was fertilized before planting by 18 kg N and 46 kg P_2O_5 per hectare. The seeds were sown on 21 December 1996 manually into soil fallowed the previous winter. Emergence was completed 25 days after the first irrigation. Weeds were controlled by hands.

8. Soil samples were taken to study soil properties at 15 cm increments for 45 cm total depth (Page *et al.*, 1982) as follows:

- Before planting: EC (1 : 1) was measured by electrical conductivity bridge, pH (1 : 1) measured by pH meter, texture measured by the hydrometer, phosphorus measured by Olson method and soil moisture status by the gravimetric method.

- Soil moisture contents before and after each irrigation was measured for the plots that received supplemental irrigation (W2, W3). Plots W1 were measured every two weeks. Soil moisture was determined at harvest.

All soil moisture was determined gravimetrically (Black, *et al.* 1965).

The total amounts of water used by the crop were calculated by soil water depletion as the difference between each two readings of the soil water status from sowing time until harvest with the addition of the rainfall and irrigation water amounts for one replication.

3.7. STATISTICAL ANALYSIS

The analysis of variance and LSD mean separation correlation, and regression analysis were achieved using computer statistical program MSTAT-C (MSTAT-C Manual, 1989) according to Steel and Torrie (1980).

4. RESULTS AND DISCUSSION

4.1. Rainfall Distribution

Total rainfall at Muwaqar Research Station during the growing season was 139.5 mm distributed as shown in Table 1. The distribution was not even since high amounts fell during one or two days. While nothing or just little rain received in others.

4.2. Soil Properties

The soil is silty clay loam with obvious crust formation at surface due to its poor structural stability. Particle size and textural classes for three soil profile depths are shown in Table 3. Some physical and chemical properties of three soil depths are presented in Table 4.

Table 3: Particle size distribution and textural classes of the soil at the experimental site.

Depth (cm)	Sand (%)	Silt (%)	Clay (%)	Texture
0 – 15	22.5	50.0	27.5	silty clay loam
15 – 30	17.5	52.5	30.0	silty clay loam
30 – 45	15.0	55.0	30.0	silty clay loam

Table 4: Some physical and chemical properties of the soil at the Muwaqar experimental site.

Depth (cm)	P (ppm)	pH	EC (dS/m)
0-15	19.5	8.2	0.65
15-30	3.8	8.2	0.70
30-45	6.4	8.1	0.90

No significant interactions were noted for following treats. Therefor the main effects will be discussed on those traits:

4.3. Effects of Cultivars

The cultivar ACSAD 176 gave the highest plant height of the unclipped treatments at harvest (35.7 cm) compared to the cultivar Rum (32.9 cm). It is higher by 9 %.

Generally plant height was increased with the increase in seeding rate due to the competition for light (Kinara *et al.*, 1963).

4.4. Effects of Seeding Rates

The highest days needed for germination obtained from the lowest seeding rate (50 kg / ha), which germinated after 23.8 days when compared with the seeding rates 100 and 150 kg / ha which needed 22.8, 22.3 days respectively (LSD = 0.94 day). Which indicated that, the increase in seeding rate would increase germination % because of the increase in pushing power through the soil surface by increasing the seeding rate.

4.5. Effects of Water Levels

The average plant height of the unclipped treatment increased significantly with the increase in water level. They were 25.9, 34.2, and 42.8 cm for W1, W2, and W3 respectively (LSD = 1.9 cm). Because of the increase in both cell division and cell elongation.

The average 1000 seed weight of the unclipped treatment increased significantly with the increase in water level. They were 0, 29, and 32 g for W1, W2, and W3 respectively (LSD = 1.1 g). This might be due to the increase of the available water and nutrients for plant growth by the increase in the soil water content (A'ra'r, 1985). These results were in agreement with Al-Kayid (1996), Al-Zuriqi *et al.* (1995) Fardous *et al.* (1995c) Jarrar (1993) and Abu-Shriha (1989).

4.6. Interaction Effects

No significant differences in the three-way interaction between the cultivars, the seeding rates and the water levels in all treatments except the grain yield production for both clipping (Table 9) and unclipping (Table 10) treatments. However in two-way interaction of (cultivars X water levels) and (seeding rates X water levels) their significant differences for the following treats:

4.6.1. Plant Height

4.6.1.1. Plant Height at the Clipping Time

The cultivar ACSAD 176 under highest water level (W3) gave the highest plant height (37.7 cm) which is 19 % higher than that of the cultivar Rum (Table 5). The plant height of the cultivar Rum was significantly increased by 9 % and 34 % due to W2 and W3 respectively. Same trend was obtained for the cultivar ACSAD 176. These results are similar to those obtained by Al-Kayid (1996), Al-Zuriqi *et al.* (1995), Fardous *et al.* (1995a), Jarrar (1993), Al-Salti and Nafa' (1993) and Abu-Shriha (1989).

The tallest plants were obtained at the seeding rate (150 kg / ha) under W3 (38.8 cm) and the shortest plants were obtained at the seeding rate 50 kg / ha under W1 (22.7 cm) (Table 6). This increase of the plant height due to the seeding rate might be due to the competition for light (Kinra *et al.*, 1963). Also the increase in water level, increased plant growth and plant height due to the increase of the available water and nutrients in the soil solution (A'ra'r, 1985). Due to the effect of seeding rate (100 and 150 kg / ha) under the highest water level, the plant height increased by 5 % and 22 % respectively. Same trend was obtained under the medium water level (W2).

Table 5: Two-way interaction and significance between two barley cultivars and three water levels for plant heights (cm), fresh and dry weight (kg / ha), biological, and total biological yield (kg / ha) of the clipping.

Cultivar	Water level	Plant Height 1*	Fresh Yield	Dry Yield	Plant Height 2**	Biol. Yield	Total BY
Rum	W1	23.6 e#	2622 d	686 d	9.6 e	187 d	874 e
	W2	25.8 d	3821 c	923 c	22.0 d	1275 c	2198 d
	W3	31.7 b	7954 a	1454 a	26.6 b	1670 b	3125 b
ACSAD 176	W1	24.9 de	2507 d	625 d	9.5 e	179 d	804 e
	W2	28.7 c	5174 b	1214 b	23.7 c	1356 c	2569 c
	W3	37.7 a	8368 a	1547 a	31.9 a	2067 a	3615 a
LSD at 0.05		1.8	450.0	134	1.4	111	199

*Plant height 1: Plant height of the clipping at the clipping time.

** Plant height 2: Plant height of the clipping at the harvest time.

#Different letters with each column are significantly different.

4.6.1.2. Plant Height of the Clipping at the Harvest

The cultivar ACSAD 176 under the highest water level (W3) gave the highest plant height (31.9 cm) (Table 5). The cultivar ACSAD 176 was higher than the cultivar Rum by 8 % and 20 % due to W2 and W3 respectively.

The highest seeding rate (150 kg / ha) under the highest water level (W3) gave the highest plant height (30.2 cm). The seeding rate 100 kg / ha was higher by 5 % than the seeding rate 50 kg / ha, while no significant differences between seeding rates 100 and 150 kg / ha under the highest water level (W3). These results were low when compared to the unclipped treatments. These results were in agreement with Droushiotis (1984).

Table 6: Two-way interaction and significance between three seeding rates and three water levels for plant heights (cm), fresh and dry weight (kg / ha), biological, and total biological yield (kg / ha) of the clipping.

Seeding rate(kg / ha)	Water level	Plant height 1*	Fresh Yield	Dry Yield	Plant Height 2**	Biol. yield	Total BY
50	W1	22.7 e#	2425 e	612 f	12.2 e	217 d	830 e
	W2	26.2 d	3815 d	887 e	22.0 d	1194 c	2081 d
	W3	31.9 b	7216 b	1287 c	28.2 b	1813 a	3101 b
100	W1	25.0 de	2739 e	706 f	9.1 f	183 d	889 e
	W2	26.8 cd	4689 c	1111 d	22.5 cd	1312 bc	2424 c
	W3	33.4 b	7631 b	1452 b	29.5 ab	1866 a	3318 b
150	W1	25.0 de	2528 e	648 f	7.3 g	149 d	798 e
	W2	28.8 c	4987 c	1207 cd	24.1 c	1440 b	2647 c
	W3	38.8 a	9636 a	1763 a	30.2 a	1926 a	3690 a
LSD at 0.05		2.5	551	164	1.8	136	244

*Plant height 1: Plant height of the clipping at the clipping time.

** Plant height 2: Plant height of the clipping at the harvest time.

#Different letters with each column are significantly different.

4.6.1.3. Plant Height of the Treatments without Clipping

Plant height of the unclipped treatment increased significantly with the increase in water level. They were 25.9, 34.2 and 42.8 cm for W1, W2, and W3 respectively. This is due to the increase of water and nutrients availability in the soil solution with the increase in water level (A'ar'r, 1985). These results in agreement with Al-Kayid (1996), Al-Zuriqi *et al.* (1995), Fardous *et al.* (1995a), Al-Salti and Nafa' (1993), Jarrar (1993) and Abu-Shriha (1989), and disagreed with Peltonen and Jarvinen (1995) and Marshal *et al.* (1987).

4.6.2. Fresh Weight

The cultivar ACSAD 176 under highest water level (W3) gave the highest fresh weight (8368 kg / ha) (Table 5). Fresh weight was increased by 46 % and 203 % for the cultivar Rum and by 106 % and 234 % for the cultivar ACSAD 176 due to W2 and W3 respectively, because the increase in water level increased the soil nutrient and water availability (A'ra'r, 1985). This is true for all growth parameters such as dry yield, biological yield, and plant height. These results were in agreement with El-Husseiny *et al.* (1990).

The highest seeding rate (150 kg / ha) under the highest water level (W3) gave the highest fresh weight (9636 kg / ha) (Table 6). Fresh weight significantly increased by 6 % and 34 % due to seeding rates 100 and 150 kg / ha respectively. Increasing seeding rate has resulted in increasing plant growth through increasing plant number per unit area in the range that allowed optimum growth without competition between plants. These results were in agreement with Fukai *et al.* (1990) and Anderson (1985). This was true for all growth parameters such as dry yield, biological yield and plant height.

4.6.3. Dry Weight of the Clipping

The cultivars ACSAD 176 and Rum under the highest water level (W3) gave the highest dry weights (1547 and 1454 kg / ha respectively) (Table 5). The cultivar ACSAD 176 was 31 % and 6 % higher than the cultivar Rum due to W2 and W3.

The highest seeding rate (150 kg / ha) under the highest water level (W3) gave the highest dry weight (1763 kg / ha) (Table 6). Dry weight of the highest seeding rate (150 kg / ha) was higher than that of both seeding rates 50 and 100 kg / ha by 37 % and 21 % respectively. These results were in agreement with Anderson (1985).

While the highest water level (W3) was higher than the lowest (W1) and the medium (W2) water levels by 172 % and 46 % within the highest seeding rates. Same trend was obtained for both seeding rates 50 and 150 kg / ha. These results were in agreement with Al-Kayid (1996), Hadjichristodoulou (1991), El-Husseiny *et al.* (1990) and Anderson (1985).

respectively under the highest water level (W3) due to the increased in shoot numbers (Abu-Shriha, 1989 and Simmons *et al.*, 1982). Same trend was obtained under the water level W2.

Total biological yield increased with the increase in water level. These results were in agreement with McDonald *et al.* (1984). This increase was due to the increased in plant height (Fardous *et al.*, 1995a and Patel and Upadhyay, 1993) and increased of the number of tillers (Al-Kayid, 1996, Abu-Shriha, 1989 and Simmons *et al.*, 1982).

4.6.4.3. Biological Yield for the Treatments without Clipping

The cultivar ACSAD 176 under the highest water level (W3) gave the highest biological (1632 kg / ha) (Table 7). The cultivar ACSAD 176 produced higher biological yield than the cultivar Rum due to W2 and W3 by 6 % and 11 % respectively. This was due to increase in: plant height, tillers number (Al-kayid, 1996, Abu-Shriha, 1989 and Simmons *et al.*, 1982).

The highest seeding rates (150 kg / ha) under the highest water level (W3) produced the highest biological yield (1668 kg / ha) (Table 8). This could be due to the increase in soil water content and available nutrients (A'ra'r, 1985) which may increase plant height and tiller number. These results are in agreement with those obtained by Al-Kayid (1996), Al-Zuriqi *et al.* (1995), Fardous *et al.* (1995b), Fardous *et al.* (1995c), Al-Salti and

Nafa' (1993), Jarrar (1993), Bouzerzour and Odina (1990), Abu-Shriha (1989), and Singh *et al.* (1979).

Table 7: Two-way interaction and significance between two barley cultivars and three water levels for biological yield (kg / ha), and 1000 seed weight of the treatments with and without clipping.

Cultivar	Water level	Without Clipping	With Clipping	
		Biol. Yield	1000 Seed weight	Biol. yield
Rum	W1	746 d*	0 c	187 d
	W2	1015 c	26.7 b	1275 c
	W3	1464 b	29.4 a	1670 b
ACSAD 176	W1	647 d	00.0 c	179 d
	W2	1075 c	26.9 b	1356 c
	W3	1632 a	26.7 b	2067 a
LSD at 0.05		98	1.16	111

*Different letters with each column are significantly different.

Table 9: Three-way interaction and significance between two barley cultivars, three seeding rates, and three water levels for grain yield (kg / ha) after clipping.

Cultivar	Seeding Rate (kg/ ha)	Irrigation level		
		W1	W2	W3
Rum	50	0 g	139.7 de	208.8 b
	100	0 g	156.1 cd	230.8 a
	150	0 g	106.4 f	139.3 de
ACSAD 176	50	0 g	131.6 e	158.8 cd
	100	0 g	142.9 de	173.3 c
	150	0 g	97.2 f	149.1 de

LSD at 0.05 = 19.74 kg / ha. *Different letters are significantly different.

4.6.5.2. Grain Yield for the Treatments without Clipping

The cultivar Rum under the medium seeding rate (100 kg / ha) under the highest water level (W3) gave the highest grain yield (504.8 kg / ha) (Table 10).

Increasing water level from W2 to W3 for the cultivar Rum under the seeding rate of 100 kg / ha cause an increase in grain yield by 52 %. Same trend was obtained for both cultivars under all seeding rates used. This could be due to the increase in soil water content and available nutrients (A'ra'r, 1985) which may increase plant height and tiller number. These results are in agreement with those obtained by Al-Kayid (1996), Al-Zuriqi *et al.* (1995), Fardous *et al.* (1995b), Fardous *et al.* (1995c), Al-Salti and

Nafa' (1993), Jarrar (1993), Bouzerzour and Odina (1990), Abu-Shriha (1989), and Singh *et al.* (1979).

The seeding rate 100 kg / ha for the cultivar Rum under the highest water level (W3) was the highest in grain yield compared to 50 and 150 kg / ha by 34 % and 23 % respectively. These results were indicated that the seeding rate 100 kg / ha was optimum for grain yield without competition between plants.

Table 10: Three-way interaction and significance between two barley cultivars, three seeding rates, and three water levels for grain yield (kg / ha) of the treatments without clipping.

Cultivar	Seeding Rate (kg / ha)	Irrigation level		
		W1	W2	W3
Rum	50	0 i *	279.1 e	376.5 c
	100	0 i	332.8 d	504.8 a
	150	0 i	247.4 f	410.1 b
ACSAD 176	50	0 i	185.1 g	347.8 d
	100	0 i	191.1 g	378.2 c
	150	0 i	112.3 h	341.4 d

LSD at 0.050 = 19.71 kg. *Different letters are significantly different.

Grain yield increased with the increase in seeding rate under Muwaqar conditions because of soil crust formation. With the increase of seeding rate the dynamic force of seedlings was increase to germinate and penetrate the crust layer, which increased plant growth and grain yield.

These results are in agreement with Jedal and Helm (1995), Blue *et al.* (1990), Fukai *et al.* (1990), Scurtu (1990), Marshal *et al.* (1987), Sharma and Smith (1987), Anderson (1985), Obeidat et al. (1984), Katchuda *et al.* (1982), Simmons *et al.* (1982) and Kinra *et al.* (1963). The rainfed treatments did not give grain yield. These results were in agreement with A'ra'r (1985).

4.6.6. One Thousand Seed Weight for Clipping

The cultivar Rum superior under the highest water level (W3) that gave the highest 1000 seed weight (29.4 g) compared to other treatments (W1 and W2) for both cultivars Rum and ACSAD 176 (Table 7).

4.6.7. Water Consumptive Use (ET)

Water consumptive use was not affected by seeding rate (Table 11). This was in agreement with Fukai *et al.* (1990). While water consumptive use increased with the increase in water level because of the increase in transpiration and metabolic activities in the plant. This was in agreement with Jarrar (1993) Singh *et al.* (1979).

Table 11: Water consumptive use of two barley cultivars as affected by three seeding rates and three water levels for one replicate.

Cultivar	Seeding rate (kg / ha)	Water level (mm)		
		W1	W2	W3
Rum	50	99.26	147.73	209.05
	100	101.34	149.50	210.07
	150	103.82	151.44	214.16
ACSAD 176	50	98.33	146.99	210.9
	100	100.23	149.39	212.63
	150	101.78	151.86	217.33

There was a significant, and positively correlation between water consumptive use and yield traits studied (biological yield of the clipped, biological yield of the unclipped, grain yield of the clipped and grain yield of the unclipped) (Table 12). The coefficient of determination quare (R^2) were 0.90, 0.80, 0.89 and 0.88 respectively. These results indicated that increasing the amount of water consumptive use increased the yield traits. Table 12 shows the linear regression equations.

5. CONCLUSIONS AND RECOMMANDATIONS

5.1 Conclusions

1. The maximum fresh and dry weights were obtained from both cultivars ACSAD 176 (8368 and 1547 kg / ha respectively) and Rum (7954 and 1454 kg / ha respectively) under the highest water level (W3). While the highest seeding rate (150 kg / ha) under the highest water level (W3) produced the maximum fresh and dry weight (9636 and 1763 kg / ha respectively).
2. The maximum grain yield was obtained from the cultivar Rum with the seeding rate of 100 kg / ha and W3 for both clipped (231 kg / ha) and unclipped treatments (505 kg / ha).
3. Increasing seeding rate increased forage production relatively more than grain production.
4. Fresh, dry, biological and total biological yield responded significantly to the increase in seeding rate with the use of supplemental irrigation.
5. The amount of supplemental irrigation showed significant effect on plant height, fresh weight, dry weight, biological and total biological yield, grain yield, harvest index and 1000 seed weight of the clipped and plant height, biological yield, grain yield, harvest index and 1000 seed weight of the unclipped treatments.

6. Supplemental irrigation (75 and 141.7 mm) increased and stabilized the yield of barley.

5.2. Recommendations

1. High seeding rate (150 kg / ha) of both cultivars is highly recommended for high forage yield and the seeding rate 100 kg / ha of the cultivar Rum for high grain yields with W3 (141.7 mm).
2. New studies needed on the dates of planting, dates and amounts of supplemental irrigation, application of nitrogen fertilizers after clipping time and the economics of yield in arid zone.

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ملخص

تأثير معدلات البذار والري التكميلي على حش وإنتاجية صنفين من الشعير في الموقر.

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أُجريت هذه التجربة في محطة الموقر الزراعية في الموسم الزراعي ١٩٩٦ / ١٩٩٧ بهدف دراسة تأثير ثلاثة معدلات من البذار وثلاثة مستويات من الري التكميلي على حش وإنتاجية صنفين من الشعير. أُضيفت كميات مياه الري التكميلي خلال مراحل الإنبات و الإشطاء والتبطين. تم إجراء حشة واحدة أثناء مرحلة الأشطاء.

تم الحصول على أعلى إنتاج من المادة الطازجة (الخضراء) والجافة لكلا الصنفين أكسلد ١٧٦ ورم عند إضافة أعلى مستوى من الري التكميلي. تفوق الصنف أكساد ١٧٦ عند إضافة أعلى مستوى من الري التكميلي معنوياً على الصنف رم في طول النبات والإنتاج البيولوجي. لقد وجد أن طول النبات، والإنتاج الأخضر، والإنتاج من المادة الجافة، و الإنتاج البيولوجي يزداد بزيادة معدل البذار والري التكميلي.

أما إنتاج الحب فقد تفوق الصنف رم بمعدل بذار ١٠٠ كغم / هكتار وبأعلى مستوى ري (١٤١,٧ ملم) على الصنف أكساد ١٧٦ لكلا المعا ملتين التي تم حشها والتي تركت بدون حش.