SHORT NOTE

Growth, forage and grain yields of barley as affected by irrigation regime and method of sowing in Sudan Gezira

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Barley (*Hordium vulgare*) is an important multipurpose crop used as feed for animals, malt and human food. Its importance lies in its ability to grow and produce in marginal environments, which are often characterized by drought, low temperature and salinity, (Maas and Hoffiman, 1997 and Baum *et al*.,2004). Barley is most commonly grown for cereal silage and can produce good yields of high quality feed if water is available. Compared to alfalfa, it grows during a short period and its water requirements are less. The full season water requirements of alfalfa are 900mm of water, one crop of barley silage may only require about 375mm of water for a 7.5 to 10 ton/ha yield. The three years average amount of the applied water for barley on 10 days interval was only 4525 m^3/ha, compared to other field crops, the average applied irrigation water for barley is low and water productivity is high even if irrigated every 10 days (Mahasin and Khair, 2014). Hand broadcasting is commonly used to sow wheat (84%) and barley (92%) while covering with mold-board is used to a lesser extent with wheat (48%) than with barley (68%).

An experiment was carried out by Khair *et al*. (2001) in Sudan, to evaluate the forage yielding potential and quality of a local variety of barley. The data indicated that, its forage yields were almost similar; its quality aspects were higher than that of Abu Sabeen. Barley has shown good potential for dry matter yield of good quality during the winter in the Gezira Research Station Farm (Khair *et al*.2007). Under the current intensive irrigated cropping system and during the winter in Sudan, studies in water relations of barley are highly needed. Moreover, the interaction of the irrigation regimes with other agronomic factors of barley can not be overlooked. In line with that, the objective of the current experiment was aimed to study the response of barley to irrigation regimes and different sowing methods.

An experiment was conducted during 2003-2006 cropping seasons at the Gezira Research Station Farm (GRSF, latitude 14^0 24′ N, longitude $33^0$31′ E and altitude 407masl) Wad Medani, Sudan. The experimental site was montnorillonitic cracking clay soil, with high clay content and low organic matter. The variety used was *Baladi type.* The experiment was conducted using a split plot design using three irrigation treatments as main plots designated as follows, irrigation every 10 days (W1), every 15 days (W2) and every 20 days (W3) and three sowing methods assigned for the subplot viz: sowing by machine on flat in lines 20 cm apart (F), manual drilling on 60 cm apart ridges (R) and manual broadcast followed by 80 cm ridging (B) replicated four times. Subplot size was 64 m^2 divided to forage yield, grain yield and plant sampling areas.

1P of phosphorus was applied at sowing in the form of triple super phosphate (96 kg/ha) and 2N of nitrogen with the second irrigation in the form of urea (192kg /ha). Manual weeding was carried out 2 times during the growing season. The forage harvested manually by hand 10 cm above the ground at the milk stage (75DAS). At physiological maturity stage (110 DAS) the area earmarked for grain yield was manually cut, left to dry in the field and threshed. For recording observations on various agronomical traits, five plants in each plot were selected at random and labeled to record the observations on plant height, number of grain per spike and 100 grains weight. Irrigation treatment was initiated 3 weeks from emergence after the well establishment of the crop. The quantity of irrigated water applied for each irrigation was measured using calibrated water flow meter. Data of the dry matter yields, grain yield and yield components were statistically analyzed for the split plot design by using CropStat 7.2 software.

The forage and grain yields, crop growth and the yield forming crop parameters for the various irrigation regimes are presented in Table 1. Mean quantity of the irrigation water was not affected significantly by the irrigation regimes and this is the behavior of Gezira cracking clay soil under irrigation (it takes what it needs) (Farbrother, 1996). However, the highest quantity of the irrigation water was consumed by treatment W1 that exceeded those of treatment W2 and W3 by 11% and 19%, respectively. The highest forage and grain yields were produced by W1 while W3 gave the lowest forage and grain yield and the W2 was in between (Table 1). The irrigation regime significantly affected plant height (cm), the W1 treatment had the tallest plants (Table 1).

Table 1. Effect of irrigation regime and sowing method on quantity of irrigation water, plant height, forage yield, grain yield and yield components and water productivity of forage and grain of barley (2003 – 2006 seasons).

	Parameter							
	Quantity of Water (m^3/ha)	Plant Height (cm)	Forage yield (t/ha)	Grain yield (t/ha)	No. of grain/ spike	1000 grain (g)	Forage water prod. (kg/m^3)	Grain water prod. (kg/m^3)
				Irrigation regime				
W1	4439	75	5.5	1.5	32	28	1.17	0.34
W2	4010	66	4.3	1.3	31	27	1.12	0.29
W3	3724	52	2.9	0.86	28	23	0.8	0.25
SE±	76.6	0.03	0.06	0.03	0.6	0.5	0.08	0.024
				Sowing method				
F	3970	63	4.1	1	29	26	1.06	0.26
R	3961	64	4.3	1.4	31	26	10.8	0.33
BR	4242	65	4.3	1.3	30	27	0.94	0.29
SE±	76.6	0.028	0.09	0.03	0.05	0.04	0.08	0.021

F: flat in lines 20 cm apart, R: manual drilling on 60 cm apart ridges and BR: manual broadcast followed by 80 cm ridging

The differences in grain yield among irrigation regimes were mainly a reflection from the variations in number of grain/spike and 100-grain weight (Table 1). Similar trend was observed in the water productivities (kg/m^3) for both forage and grain yields (Table 1).

Generally, for all parameters no significant differences were observed as affected by the sowing methods, the highest quantity of applied water was consumed by treatment BR compared with the other two treatments (Table 1). Treatments R and BR compared with treatment F produced the higher quantities of yields and yield components. Regarding the water productivities of both forage and grain yield the lowest values were obtained by treatment BR and this may be attributed to the higher quantity of irrigation water that consumed by treatment B (Table 1.).

The interaction effect of the irrigation regime with different sowing methods was depicted in Table 2. For the growth development "plant height and forage yield", the highest values were obtained by the interaction of the irrigation regime W1 with BR sowing method (Table 2). On the other hand, the treatment R with irrigation regime W1 outyielded the other two methods of sowing for the grain yield (Table 2). For instance, the lowest forage and grain yield was produced from the long irrigation interval (W3) X the sowing on flat (F).

Table 2. Interaction effect of sowing methods and irrigation regimes on plant height, forage and grain yield of barley.

Irrigation	Plant height (cm)			Forage yield (t /ha)			Grain yield (t /ha)		
regime	BR	R	F	BR	R	F	BR	R	F
W1	75	74	75	5.9	5.4	5.3	1.65	1.75	1.31
W2	68	66	64	4.2	4.5	4.3	1.34	1.37	1.06
W3	53	53	49	2.9	3	2.8	0.96	0.98	0.65
SE±	0.96			0.16			0.05		

F: flat in lines 20 cm apart, R: manual drilling on 60 cm apart ridges and BR: manual broadcast followed by 80 cm ridging

This research output recommended that the highest barley productivities in term of land or water productivity was obtained when irrigated every 10 days. Drilling on 60 cm apart ridges and broadcasting + ridging showed to be a common high yielding methods of sowing in terms of forage and grain yields compared with sowing on flat.

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تأثير فترات الري وطرائق الزراعة على نمو وإنتاجية علف وحبوب الشعير بولاية الجزيرة، السودان

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الخلاصة

اجريت هذه التجربة لثلاثة مواسم زراعية متتالية (2003/04, 2004/05, 2005/06) بمحطة بحوث الجزيرة، هيئة البحوث الزراعية بالسودان لدراسة تأثير فترات الري وطرائق الزراعة على نمو وإنتاجية علف وحبوب الشعير. المعاملات عبارة عن ثلاث فترات ري (10,15,20 يوماً) وثلاث طرائق زراعة (زراعة بالماكينة بدون تسريب في 20سم خطوط, زراعة بنثر الحبوب ثم التسريب 80سم عرض وزراعة يدوية على تسريب 60سم عرض). أجريت التجربة بتصميم القطع المنشقة بحيث توضع فترات الري في القطع الرئيسية وطرائق الزراعة في القطع الثانوية بأربع مكررات. أظهرت النتائج أن متوسط كمية مياه الري المضافة للشعير للثلاثة مواسم كانت **كالآتي**: 4439 m^3/ha, 3724 m^3/ha ,4010 m^3/ha للمعاملات W3,W2, W1 على التوالي. والفروق بين هذه المعاملات في كمية المياه المضافة معنوية. متوسط كمية المياه المضافة لطريقة الزراعة بالنثر ثم التسريب على 80سم (4242 m3/ha) أكثر من الزراعة على 20سم خطوط (3970 m^3/ha) والزراعة على 60 سم تسريب (3961 m^3/ha). تأثير معاملات الري خلال الثلاث سنوات على إنتاج المادة الجافة والحبوب للشعير تأثير إيجابي وفى الترتيب التنازلي الري كل 10, 15, 20 يوم. إنتاجية مياه الري للمادة الجافة لفترات الري أعلاها للري كل 10 يوم يليها الري 15 ثم الري كل 20 يوم. أعلى انتاج للحبوب للري كل 10 يوم بينما اعطى الري كل 20 يوم أقل انتاج. نوصى بالزراعة على 60 سم تسريب أو النثر ثم التسريب 80سم للحصول على أعلى إنتاجية من العلف الجاف والحبوب.