

SHORT NOTE

Effects of different amounts of water and irrigation intervals on growth and grain yield of wheat (*Triticum aestivum* L) under New Hamdab conditions

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Determination of crop water requirement is one of the key parameters for precise irrigation scheduling, especially in regions with limited water resources, such as northern Sudan. Wheat is the main cereal crop and source of food and income to the majority of the inhabitants. Normally, wheat is irrigated by surface methods of which furrow, border and basin are most common. Sprinkler irrigation is also practiced, especially when water supply is limited or the topography or the soils are not suitable to surface irrigation (FAO, 2002).

In New Hamdab Scheme wheat, is considered as the main crop in the winter season despite using expensive irrigation water. Hence, there is a need for an efficient and economical water use without affecting yield. The planning of cropped area and sowing dates depend on crop water requirement (CWR), water availability and canal capacities. The operation of irrigation network also depends on water demand, which is a function of areas of crops and CWR (Adam, 2005). In dry land producing areas, water is the first factor to control growth. In the Northern State of Sudan, wheat was found to require about 640 mm of water to produce 4 t/ha of grain (Ageeb, 1993). Ageeb *et al.*, (1995) reported that daily water consumption for wheat varied from 3.5 mm (4200 m³/ha) to 8.0 mm (9600 m³/ha). The causes of this variability could be related to the prevailing weather, the stage of crop development and vegetative vigor.

Water requirement (consumptive use) and crop water productivity (CWP) of crops are two important factors that should be considered when assessing the feasibility of growing crops in any region (Hashim *et al.*, 2012). The low water productivity was due to the shortage of water and it could be improved further by meeting the full crop demand of irrigation water. Ageeb (1993) stated that irrigation water and irrigation practices are factors which have always limited wheat productivity. Fadul and Mustafa (2011) investigated three irrigation frequencies: 7, 14, and 21 days, and recommended that wheat should be irrigated weekly. Also, El Hwary and Yagoub (2011) reported that irrigation every 7 and 10 days gave the highest protein content, grain, straw yield and field water use efficiency.

This study was carried out in two seasons 2008/09 and 2009/10 in New Hamdab Agricultural Scheme in Northern Sudan to study the effect of different amounts of water and irrigation intervals on growth and grain yield of wheat (*Triticum aestivum* L). The area is located in the desert plain and confined between longitude 31° '06 and 31° '13 E and latitude 17° '55 and 17° '58 N. This experiment was conducted in (24cm×24cm) pots. The pots were filled with soil which is classified as Typic, Haplocmbids, fine loamy, mixed, hyperthermic and was correlated to Kelly soil series. Generally, this soil is not saline, non sodic and characterized by low chemical fertility and light texture.

The main objectives of this study were to determine the optimum water application depth and timing for wheat yield and water productivity under New Hamdab conditions. The treatments are combinations of three amounts of irrigation water (5,6 and 7 mm of water /day) and three irrigation intervals (7,10 and 14 days) and designated as follows:W1=5mm/day for interval of 7days, W2=6mm/day for interval of 7days, W3=7mm/day for interval of 7days, W4=5mm/day for interval of 10 days, W5=6mm/day for interval of 10 days, W6=7mm/day for interval of 10 days, W7=

5mm/day for interval of 14 days, W8=6mm/day for interval of 14 days and W9= 7mm/day for interval of 14days. The treatments were arranged in a complete randomized block design with four replicates.

Seeds of wheat (Wadi Elniel cultivar) were sown at the rate of 143 kg /ha on the second half of November in pots. Irrigation water was measured and applied carefully for each treatment. Triple superphosphate at the rate of 43 P₂O₅kg/ha and 10 ton farm yard manure were broadcast before sowing. Nitrogen in form of urea was applied at the rate of 86 N kg/ha in a split dose at 21 days after sowing and after one month later. Data collected consisted of plant height (cm), spikelet per spike, number of seed per head, 1000- seed weight (g), grain yield (kg/ha), straw yield (kg/ha) and biological yield (kg/ha). Water productivity (kg/m³) was calculated using the formula.

WP (kg/m³) = Grain yield (kg/ha)/ total water applied (m³/ha).....(1)

Data were analyzed using standard analysis of variance procedure and means were separated according to Duncan's Multiple Range Test.

Plant height (cm) and Number of Spikelets per spike

The effects of irrigation treatments on plant height are shown in Table 1. There were highly significant differences ($P \leq 0.01$) among irrigation treatments. The results showed that W2 and W3 treatments produced the tallest plants in both seasons, whereas W5 produced the shortest plants in both seasons. In a similar study, it was reported that plant height increased with more frequent irrigation and decreased with less frequent irrigation (Elmonyeri *et al.*, 1982). These results were also in line with the findings of Shrief and Abd El-Mohsen (2015) who stated that plant height increased significantly with increasing amounts irrigation water

Table 1 shows highly significant differences ($P \leq 0.01$) in number of spikelets per spike among irrigation treatments. The largest number of spikelets per spike was shown by W2, W3, W5 and W6 in both seasons. These results support the findings of Akram (2011). In contrast, El Hwary and Yagoub, (2011) found that shorter and medium irrigation intervals (7 and 10 days) caused insignificant increase in number of spikelets per spike. The lowest number of spikelets per spike (11 and 11.3) was obtained by W7 in both seasons.

Number of seeds per head and 1000- seed weight (g)

There were highly significant differences ($p \leq 0.01$) in number of seeds per head among irrigation treatments (Table 1). The largest number of seeds per head was obtained by W3 and W6 for both seasons. These results support the findings of El Hwary and Yagoub, (2011) who reported that shorter and medium irrigation intervals (7 and 10 days) produced larger number of seeds per head. The lowest number of seeds per head was obtained by W7 in both seasons. Irrigation treatments had no significant effects on 1000- seed weight of wheat in both seasons (Table 1). The heaviest seeds (43 g) and (41g) were obtained by W3, in both seasons. These results support the findings of El Hwary and Yagoub, (2011) who reported that 1000-grain weight increased with short irrigation intervals.

Table 1. Effects of irrigation treatments on plant height, spike length, spikelet per spike and number of seeds per head of wheat grown during seasons 2008/9 and 2009/10.

Treatment s	Plant height (cm)		Spikelet per spike		Seeds per head		1000 seed wt	
	2008/09	2009/10	2008/09	2009/10	2008/09	2009/10	2008/09	2009/10
W1	32.1 b	32.8 b	14 a	15.0a	29 a	29.7c	39.7	39.4
W2	40.2 a	40.3 a	15 a	15.33a	32 a	32.3a	38.9	37.9
W3	40.7 a	40.6 a	15 a	15.7a	33 a	32.7a	43.0	41.3
W4	31.4 bc	31.0 c	13 b	12.7b	25 b	24.3d	38.4	38.2
W5	26.4 c	26.8 d	15 a	15.7a	30 a	31.0b	39.6	39.3
W6	30.1 bc	30.73 c	15 a	15.3a	33 a	33.3a	36.9	36.8
W7	31.3 bc	31.1 c	11 c	11.3c	17 c	16.0f	38.8	38.6
W8	30.7 bc	30.9 c	12 bc	11.7bc	21 c	20.0e	38.9	38.8
W9	30.7 bc	30.9 c	12 bc	11.7bc	21 c	20.7e	36.8	36.7
Sig. level	**	**	**	**	**	**	N.S	N.S
S.E±	0.81	0.22	0.20	0.36	0.73	0.44	0.12	0.31
C.V%	10	11.7	6	4.6	11	2.9	8	1.4

N.S = not significant and ** = Significant at $P \leq 0.01$

Means followed by the same letter (s) in a column are not significantly different according to Duncan's Multiple Range Test.

Grain yield (kg/ha)

Table (2) shows highly significant effects of irrigation treatments on yield and yield components of wheat. The highest grain yield (4804 and 4804 kg/ha) and (4811 and 4800 kg/ha) was obtained by W3 and W6 in the first and second seasons, respectively due to higher water application. Farah (1995) reported that yield increased with increasing irrigation water. This finding is also close to the values reported by Ageeb *et al.*, (1995) and Fadl and Baily (1984).

Straw yield (kg/ha) and biological yield (kg/ha)

Results showed that irrigation treatments had highly significant effects on the biological yield of wheat in both seasons (Table 2). The highest biological yield (1223.6 and 1223.8 kg/ha) was obtained by W3 in the first and second seasons, respectively. This was in conformity with the findings of El Hwary and Yagoub, (2011). The lowest biological yield (7257 and 7251 kg/ha) was obtained by W7 in the first and second seasons, respectively.

Applied water and water productivity (kg/m³)

Table 2 shows the effects of irrigation treatments on water productivity. There were highly significant differences ($P \leq 0.01$) among treatments in water productivity. The treatments W₁, W₂, W₃, W₄, W₅ and W₆ resulted in highest water productivity, while the treatments W₇, W₈ and W₉ resulted in the lowest. These results are agreement with those of Farah (1995) and Ahmed *et al.*, (2007) reported that wheat required 6083 - 6571 m³/ha and Ageeb (1993) who reported that, in the Northern State, wheat required about 6400 m³/ha. These results are also in agreement with those reported by Farah (1987) who stated that water use efficiency ranged from 0.38 to 0.68 kg/m³. Also, the results were higher than those obtained by Mohammed *et al.*, (2011) who reported that the average irrigation water productivity was 0.21 kg/m³ under center pivot irrigation system.

In general irrigation 7mm/day every 7 days interval and 7mm/day every 10 days intervals gave the highest plant height, spike length, spikelet per spike, number of seed per head, 1000-seed weight, grain yield, biological yield and straw yield. But for economics aspect irrigation 7mm every 10 days is recommended. Irrigation every 14 had low results in all parameters especially on yield, so it must be avoided under this semi-arid condition.

Table 2. Effects of irrigation treatments on water productivity (kg/m³) of wheat during seasons 2008/9 and 2009/10

Treatment s	Grain yield (kg/ha)		Straw yield (kg/ha)		Biological yield (kg/ha)		WP (kg/m ³)	
	2008/09	2009/10	2008/09	2009/10	2008/09	2009/10	2008/09	2009/10
W1	3535 bc	3531.7d	6146 bc	6141.7c	9681 cd	9679d	0.72 a	0.69a
W2	4224 ab	4221.7c	7035 ab	7031b	1125.8 ab	11251b	0.72 a	0.67a
W3	4804 a	4801.3a	7433 a	7428.7a	1223.6 a	12238a	0.70 a	0.70a
W4	3220 cd	3219e	5758 c	5751.7e	8987 def	8982f	0.64 a	0.69a
W5	4403 ab	4399.3b	5483 c	5480g	9436 cde	9433e	0.66 a	0.67a
W6	4804 a	4802.7a	5825 c	5822.3d	1069.1 bc	1068.5c	0.70 a	0.71a
W7	2083 e	2079.3h	5174 c	5170i	7257 g	7251i	0.42 b	0.41b
W8	2731cd e	2728.7f	5500 c	5494f	8231 efg	8226g	0.47 b	0.44b
W9	2562 de	2559g	5200 c	5194.7h	7761 gf	7755h	0.38 b	0.33bc
Sig. level	**	**	**	**	**	**	**	**
S.E±	0.14	1.07	1.66	1.10	2.08	2.52	0.018	0.02
C.V%	16	5	11	3	9	5	12	9.2

N.S = not significant and ** = Significant at $P \leq 0.01$

Means followed by the same letter (s) in a column are not significantly different according to Duncan's Multiple Range Test

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تأثير كمية مياه الري والفترة بين الريات على نمو وانتاجية القمح تحت ظروف منطقة الحامداب الجديدة ، الولاية الشمالية، السودان

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الخلاصة

حساب الاحتياج المائي يعتبر احد مفاتيح القياسات المهمة لجدولة الري خاصة في المناطق ذات مصادر المياه المحدودة. اجريت هذه الدراسة بالولاية الشمالية ، مشروع الحامداب الجديدة الزراعي في الفترة من 09/2008 الى 10/2009م. هدفت الدراسة الى معرفة تأثير كمية مياه الري والفترة بين الريات على النمو والانتاج ومكونات الانتاج وكفاءة استخدام المياه. تمت زراعة القمح صنف وادي النيل مع كميات ري مختلفة و هي 5 و 6 و 7 ملم/يوم و فترات ري 7 و 10 و 14 يوم. صممت التجربة بنظام القطاعات العشوائية الكاملة (RCBD) و بأربعة مكررات. تم أخذ طول النبات وعدد الحبوب في السنبل و وزن الالف حبة و انتاج الحبوب و الناتج الحيوي ومخلفات الانتاج. اوضحت النتائج ان هناك فروق معنوية عالية جدا على كل الصفات المدروسة ماعدا وزن الالف حبة. بصورة عامة الري 7ملم /يوم وكل 7 ايام والري 7 ملم/يوم وكل 10 ايام اعطيا اعلى قيم لكل الصفات المدروسة . الري كل 14 يوم اعطى اقل قيم لكل الصفات المدروسة خاصة انتاج الحبوب لذلك يجب تجنبه في المناطق الجافة.