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Use of Supplementary Irrigation for Improvement of Growth and Yield of Sorghum [*Sorghum bicolor* (L.) Monech] in North Darfur State*

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Abstract: A field experiment was conducted in two consecutive seasons (2006 and 2007) in Al-Fashir University Farm in North Darfur State to investigate the impact of supplementary irrigation at three available water depletion levels (AWDL); namely, 25%, 50% and 75% on growth and yield of two sorghum varieties (Wad Ahmed and Tabat) grown on a fine loamy, mixed isohyperthermic Typic Haplocambid. The experimental design was a split-plot design with four replicates. Irrigation treatments were designated the main plots and varieties the subplots. In both seasons, Wad Ahmed variety was significantly better than Tabat in germination percentage, plant height, leaf area index and number of heads. For the two seasons, the mean plant height, leave area index and number of heads ranged from 147.0 to 173.5 cm, 3.3 to 7.4 and 77 to 158, respectively. In the two successive seasons, the mean dry matter yield was 11.2 and 12.8 ton/ha for Wad Ahmed and 7.9 and 9.9 ton/ha for Tabat. In both seasons, the mean thousand grain weight and grain yield ranged from 26.0 to 29.59 g and from 6.2 to 9.4 ton/ha. Wad Ahmed gave significantly (P = 0.05) greater yield than Tabat in the first season, but the difference was not significant in the second season. Furthermore, in most cases, application of water at 25% AWDL gave better growth and yield than at 50% or 75%. However, the impact of AWDL was not significant because of the random variation of occurrence and quantity of rainfall. The Experiment showed that supplementary irrigation, using harvested water, offers a great potential for improving crop production in North Darfur State.

Key words: Water harvesting; supplementary irrigation; sorghum; Darfur

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INTRODUCTION

Al-Fashir lies in an arid region, which is characterized by low and erratic rainfall with dry spells that occur at any stage of crop development causing water stress and consequent reduction in yield. When a prolonged drought period occurs during a critical stage, crop yield may be markedly reduced or even completely lost. Supplementary irrigation is the appropriate solution for alleviating plant water stress and substantially increasing crop yield.

The State is traversed by many small water courses ((“khors”), some of which drain in big water courses (“wadis”), e.g. Wadi El-Ku. Although traditional farmers practice some runoff agriculture using various traditional water harvesting techniques, e.g. terraces (“truse”), the large water resources rendered available by these water courses are not efficiently utilized. Thus, there is great potential for increasing agricultural production and improving the livelihood of the local community through efficient use of these water resources. A viable strategy in this direction is to promote supplementary irrigation to offset the adverse impact of the dry spells and promote sustainable crop production. This requires intensification of research on *inter alia*, rain-water harvesting, soil and water management and conservation, supplementary irrigation and fertilizer application (Lal 1991). Maximizing water productivity is the prime objective in dry farming systems.

To our knowledge, there is lack of experimental research on the impact of supplementary irrigation on crop growth and yield in Darfur. The present research was undertaken to investigate the impact of supplementary irrigation and its scheduling on yield and water use efficiency of two sorghum [*Sorghum bicolor* (L.) Monech] varieties; namely, Wad Ahmed and Tabat in Al-Fashir.

MATERIALS AND METHODS

A field experiment was conducted during July-November in two consecutive seasons (2006 and 2007) in the Experimental Farm of Al-Fashir (Lat. 13°38′N, Long. 25°20′E, Altitude 730 m) University to investigate the impact of supplementary irrigation at three available water depletion levels (AWDL); namely, 25%, 50% and 75% on growth and yield of two sorghum (*Sorghum bicolor* L.) varieties (Wad Ahmed and Tabat), grown on a sandy clay loam soil. The two varieties were chosen because they are relatively drought resistant, high yielding, tolerant to heat stress and preferred by the local community. The experimental design was a split-plot with irrigation treatments designated the main plots (6 x 7 m) and sorghum variety the subplots (3 x 7 m); each treatment was replicated four times. The main plots were arranged at random in each replicate block. The main plots were 2 m apart to minimize lateral water movement. Water was obtained from Wadi El-Ku and stored in a large calibrated concrete tank.

A typical soil profile was dug at the experimental site, described and classified according to USDA-SCS system as fine loamy, mixed isohyperthermic Typic Haplocambid (Soil Survey Staff 1975).Soil samples and clods were collected from each horizon for analysis. Selected soil physical and chemical properties were determined using standard procedures(Page *et al.*1982; Campell *et al.* 1986)and presented in Table 1.

Crop evapotranspiration (ETcrop) was estimated by the following relationship: ET crop = k ETr, where k is the crop coefficient (k) estimated using an FAO method (Doorenbos and Pruitt 1984), and ETr is a reference evapotranspiration estimated by a modified Jensen-Haise method, which was found appropriate under arid conditions (Mustafa *et al*. 1989). A long-term (1961-1990) meteorological data and the rainfall data collected during the two seasons are reported in Table 2.

Sorghum was sown at a seed rate of 2 kg/fed (1 fed = 0.42 ha) with a spacing of 75 cm between rows and 50 cm between plants. The sowing dates were 19 July 2006 and 15 July 2007 in the two successive seasons. After germination, two rows from each subplot were chosen at random and the germination percentage was determined. Thereafter, the plants were thinned to 3 plants per hole followed by transplanting of missed holes.

Table 1. Selected physical and chemical properties of a typical soil profile

	Physical properties						
Depth (cm)	Sand (%)	Silt (%)	Clay (%)	BD (g/cc)	FC (%)	PWP (%)	AW (%)
0-10	54.2	11.0	34.8	1.7	30.6	16.3	14.4
10-20	52.9	11.2	35.9	1.7	27.7	14.9	12.8
20-50	51.2	11.1	37.7	1.7	26.6	14.2	12.4
50-80	40.7	12.4	46.9	1.7	36.5	19.7	16.8
80-100	68.1	8.8	23.1	1.7	31.2	16.9	14.3

			Chemical properties			
Depth (cm)	pH	ECe (dS/m)	SAR $(mmole+/l)^{1/2}$	$CaCO_3$ (%)	Nitrogen (%)	Phosphorus (mg/l)
0-10	7.7	0.7	2.9	0.6	0.04	4.52
10-20	7.8	0.6	2.2	0.8	0.03	4.46
20-50	7.6	1.0	9.3	0.6	0.02	4.22
50-80	7.3	1.3	10.0	0.4	0.02	3.60
80-100	7.2	2.6	11.7	0.2	0.02	3.70

BD = bulk density, FC = gravimetric field capacity, PWP = gravimetric permanent wilting point, AW = gravimetric available water, ECe = electrical conductivity of the soil saturation extract at 25 C, SAR = sodium adsorption ratio.

Table 2. Mean seasonal (2006 and 2007) and long-term (1961-1990) meteorological data (1961- 1990) for Al-Fashir Station

Month	Rainfall		Long-term data (1961-1990)				
	2006	2007	Rainfall	ETr (mm/d)	T (°C)	RH (%)	WS (m/sec)
January	0	0	TR	5.7	19.7	24	4
February	0	0	TR	6.7	21.7	21	5
March	0	0	0.3	7.8	25.6	18	5
April	0	0	1.9	8.7	28.1	18	6
May	5.0	7.0	7.0	9.2	30.1	22	5
June	7.5	5.5	14.5	8.3	30.7	33	5
July	70.5	38.4	59.1	7.5	29.0	52	5
August	126.9	201.9	87.0	7.5	27.9	61	4
September	52.1	22.4	35.5	7.6	27.5	46	4
October	0	0	7.1	7.7	27.5	30	4
November	0	0	TR	6.6	23.2	27	4
December	0	0	0	5.6	20.2	26	5
Total	262.0	275.2	212.4				

ETr = reference evapotranspiration, T = temperature, RH = relative humidity, WS = wind speed

Initially, each plot was irrigated to field capacity. A calendar water-budget method was adopted for scheduling irrigation. Accordingly, water lost by the crop, i.e. ETcrop was subtracted from the soil moisture content conserved in the top one metre soil depth, and the water gained by rainfall, monitored by a rain gauge, was added. A daily water balance account was made to monitor the available water depletion level (AWDL). Water in excess of field capacity was assumed to be lost by deep percolation, and water deficits were accumulated until the predetermined AWDL was reached. Then, a quantity of water equivalent to AWDL was delivered to the subplots, assigned to this AWDL, by a hose connected to the calibrated water tank.

An auger was used to collect soil samples from the following successive depths: 0-10, 10-20, 20-40, 40-60, 60-80, 80-100 cm. In both seasons the soil moisture content in each depth in the various subplots was determined at sowing and at harvest to calculate the crop consumptive water use (WU).

The crop was harvested on the 16^{th} and 12^{th} of November in the two successive seasons. At harvest, the mean height of 15 plants selected at random from each subplot was determined. Five random leaves were picked from five plants selected at random from each subplot. The average leaf length (L, cm) and width (W, cm) were measured, and the average leaf area (LA) was calculated by the following empirical relationship: LA = 0.747 x W x L (Marshall 1968). Leaf area index (LAI) was determined by the following equation:

LAI = (LA x NLp x NPs)/ AS

where NLp = the average number of leaves per plant, NPs = the average number of plants per subplot, and AS = area of subplot expressed in cm^2.

The heads of sorghum from each subplot were cut and left to dry for 30 days. The dry heads were weighed and threshed, and the 1000 grain weight and total grain yield were calculated. The straw was cut and its fresh and dry weights were recorded.

Crop water use (WU) was calculated by the following water balance equation applied to an experimental plot:

$$WU\,(mm) = I + P + \sum_{i=1}^{n} \left[Mb_i - Me_i \right) / 100 \big] \times BD_i \times D_i$$

where: I is the amount of added supplementary irrigation water (mm), P is the amount of precipitation water (mm), Mbi and Mei is the percentage gravimetric water content in the ith layer at the beginning and at the end of the season, respectively, BDi is the bulk density of the ith layer, (g gcm^{-3}), Di is the soil depth of the ith layer (cm), n is the number of layers.

The equation assumes that deep percolation below the sampled depth is zero and water depletion is predominantly from this depth. For experimental plots, surface runoff is absent.

The crop water use efficiency (WUE) was estimated by the following equation:

WUE = Yield/WU

RESULTS

In the first season, the total rainfall was 262 mm, which was above the normal mean rainfall for 1961-1990, which was 212.4 mm (Table 2). The rainfall started from the 4^{th} of May to 28^{th} of September with irregular distribution in time and space. The coefficient of variation of the monthly rainfall was 166.9%, indicative of irregular distribution of rainfall. Ninety-five percent of the rainfall occurred during July-August. The total amount of the rainfall used by the crop from 19^{th} of July (sowing date) to the 28^{th} of September (harvest date) was 203 mm, which is 77% of the total amount of the seasonal rainfall. The estimated ET crop ranged from 2.6 to 8.3 mm/ day. The crop was irrigated from the beginning of September till harvest. The total amount of rainfall used by the crop was 203 mm and the total amount of the irrigation water during the growing season was 689.7 mm. The amount of rainfall and added supplementary irrigation water constituted about 23% and 77% of the total water used, respectively (Abdalla 2008).

In the second season, the total rainfall was 275.2 mm, which was greater than the mean normal rainfall. The rainfall started on 9^{th} of May and ended on the 9^{th} of September. The amount of rainfall, used by the crop from 15^{th} of July to the 11^{th} of September was 249.6 mm, constituting about 90.5% of the seasonal rainfall. In the last 10 days of August, the amount of rainfall was 129.3 mm, which was about 64% of the August rain and 47% of the seasonal rainfall. The heavy rains resulted in flooding of the area for 14 days and reduced crop yield. The estimated ETcrop ranged from 2.6 to 8.3 mm/ day. The 25% and 50% depletion plots were irrigated at mid-September. The irrigation water used by the crop was 683.1 mm and the rainfall was 249.6 mm. The amount of the rainfall and supplementary irrigation water constituted about 27% and 73% of water used, respectively.

Germination percentage

Variety Wad Ahmed gave significantly higher mean germination percentage than variety Tabat in both seasons (Table 3). The available water depletion level had no significant impact on germination as expected, because it was not a factor at this stage. In general, the germination percentage was low even for Wad Ahmed. The mean germination percentage of Wad Ahmed was about 36% and 61% greater than that of Tabat in the two successive seasons.

Plant height

The mean plant height ranged from 147.0 to 159.3 cm in the first season and from 154.3 to 173.5 cm in the second season (Table 3). In both seasons, plant height was significantly (P = 0.05) affected by variety but not by AWDL. In both seasons, Wad Ahmed gave, on the average, a plant height, which was significantly (P = 0.05) 5.5% taller than that of Tabat. The interaction between AWDL and variety was not significant. Irrigation at 25% AWDL resulted in slightly taller plants than at 50% or 75% AWDL, but the effect was not significant. In general, the plants in the second season were taller than those in the first.

Leaf area index (LAI)

The mean LAI ranged from 3.3 to 5.8 in the first season and from 3.4 to 7.4 in the second season (Table 4). The impacts of treatments were qualitatively similar in both seasons. LAI was significantly (P = 0.05) affected by variety but not by AWDL. Wad Ahmed gave significantly (P = 0.05) higher LAI than Tabat. In the first season, the LAI of Wad Ahmed was 39% greater than that of Tabat, and in the second season it was 49%. In general, the plots irrigated at 25% AWDL gave broader leaves than those irrigated at higher AWDLs. However, the impact was not significant in both seasons.

Dry matter yield

The mean dry matter yield (DMY) ranged from 7.1 to 12.3 ton/ha in the first season and from 8.9 to 13.8 ton/ha in the second season (Table 4). The impact of variety on DMY was significant (P = 0.05) in both seasons. The DMY of Wad Ahmed was significantly (P = 0.05) 42% greater than that of Tabat variety in the first season and 28% in the second season.

The mean DMY at 25% AWDL was significantly (P = 0.05) higher than that 75% AWDL in the first season. At 25% AWDL, the mean yield was 9% and 16 % greater than that at 50 and 75% AWDL. The best treatment was Wad Ahmed irrigated at 25% AWD. The impact of AWDL was not significant in the second season.

Number of heads

The number of heads ranged from about 77 to 109 in the first season and from 77 to 158 in the second season (Table 5). In both seasons, the impact of variety on the mean number of heads was significant, but the impact of AWDL was not. The number of heads of Wad Ahmed was significantly (P = 0.05) 32% greater than that of Tabat in the first season, and 74% in the second season. In both seasons irrigating at 25% AWDL gave a higher number of heads than at higher AWDL but the impact was not significant. In general, the number of heads in the second season was greater than in the first season.

Thousand grain weight

The mean thousand grain weight ranged from 25.96 g to 26.68 g in the first season and from 25.31 to 29.46 g in the second season (Table 5). The impact of variety was significant in the second season only, whereas the AWDL level was not significant in both seasons. The overall mean thousand grain weight was 26.18 g in the first season. In the second season Tabat gave significantly (P = 0.05) 13% greater thousand grain weight than Wad Ahmed. In Both seasons, there was a trend for increase in thousand grain weight with increase in AWDL. In general, the thousand grain weight in the second season was slightly higher than that in the first season for Tabat.

Grain yield

The mean grain yield ranged from 7.6 to 9.4 ton/ha in the first season and from 6.2 to 8.1 ton/ha in the second season (Table 6). In the first season, the impact of variety was significant, but the impact of AWDL was not. The mean grain yield of Wad Ahmed was significantly 14% greater than that of Tabat. The mean grain yield increased with decrease in AWDL level at which supplementary irrigation was applied but the effect was not significant. The impact of AWDL was significant in the second season but the impact of variety was not. In this season, the mean grain yield of plots irrigated at 25% AWDL was 22%, and 11% greater than those irrigated at 50% and 75% AWDL, respectively In general, the mean. grain yield was greater in the first season than in the second

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Water Use

The water use in the first season ranged from 963.7 to 1014.7 mm and the water use efficiency ranged from 7.7 to 9.3, and in the second season the range was 6.0-7.5. The water use efficiency when irrigating at 25% AWDL was higher for both seasons except for Tabat in the second season. In general, Wad Ahmed was more efficient than Tabat.

Table 3. Germination and plant height (cm) of sorghum as affected by variety and available water depletion at which supplementary irrigation water was applied during July-November in the two seasons 2006 and 2007

Variety	Available water depletion level (%)			Mean
	25	50	75	
	Germination % (Season 2006)			
Wad Ahmed	31.3	34.3	32.8	32.8 a
Tabat	23.5	26.8	22.3	24.2 b
Mean	27.4 a	30.6 a	27.6 a	
$LSD_{0.05}$ (D) = NS, $LSD_{0.05}$ (V) = 6.98, $LSD_{0.05}$ (D x V) = NS				
	Germination % (Season 2007)			
Wad Ahmed	44.3	27.5	40.5	37.4 a
Tabat	20.0	20.5	29.3	23.3 b
Mean	32.2 a	24.0 a	34.9 a	
$LSD_{0.05}$ (D) = NS, $LSD_{0.05}$ (V) = 14.2, $LSD_{0.05}$ (D x V) = NS				
	Plant height (Season 2006)			
Wad Ahmed	159.3	156.5	151.3	155.7 a
Tabat	150.3	147.0	145.3	147.5 b
Mean	154.8 a	151.8 a	148.3 a	
$LSD_{0.05}$ (D) = NS, $LSD_{0.05}$ (V) = 7.3, $LSD_{0.05}$ (D x V) = NS				
	Plant height (Season 2007)			
Wad Ahmed	173.5	162.0	169.8	168.4 a
Tabat	164.0	154.3	160.5	159.6 b
Mean	168.8 a	158.2 a	165.2 a	
$LSD_{0.05}$ (D) = NS, $LSD_{0.05}$ (V) = 7.5, $LSD_{0.05}$ (D x V) = NS				

Table 4. Leaf area index (LAI) and dry matter yield (DMY, ton/ha) of sorghum as affected by variety and available water depletion at which supplementary irrigation water was applied during July-November in the two seasons 2006 and 2007

Variety	Available water depletion level (%) 25	50	75	Mean
	LAI (Season 2006)			
Wad Ahmed	5.8	4.5	4.6	5.0 a
Tabat	4.0	3.3	3.4	3.6 b
Mean	4.9 a	3.9 a	4.0 a	
$LSD_{0.05}$ (D) = NS, $LSD_{0.05}$ (V) = 0.99, $LSD_{0.05}$ (D x V) = NS				
	LAI (Season 2007)			
Wad Ahmed	7.4	5.6	7.1	6.7 a
Tabat	5.1	3.4	4.9	4.5 b
Mean	6.3 a	4.5 a	6.0 a	
$LSD_{0.05}$ (D) = NS, $LSD_{0.05}$ (V) = 1.00, $LSD_{0.05}$ (D x V) = NS				
	DMY (Season 2006)			
Wad Ahmed	12.3	10.6	10.7	11.2 a
Tabat	8.4	8.3	7.1	7.9 b
Mean	10.4 a	9.5 a	8.9 b	
$LSD_{0.05}$ (D) = 1.4, $LSD_{0.05}$ (V) = 1.8, $LSD_{0.05}$ (D x V) = NS				
	DMY (Season 2007)			
Wad Ahmed	13.8	12.5	12.1	12.8 a
Tabat	12.3	8.7	8.9	10.0 b
Mean	13.1 a	10.6 a	10.5 a	
$LSD_{0.05}$ (D) = NS, $LSD_{0.05}$ (V) = 1.5, $LSD_{0.05}$ (D x V) = NS				

Table 5. Number of heads and 1000-grain weight (g) of sorghum as affected by variety and available water depletion at which supplementary irrigation water was applied during July-November in the two seasons (2006 and 2007)

Variety	Available water depletion level (%) 25	50	75	Mean
	Number of heads (Season 2006)			
Wad Ahmed	109	100	101	103 a
Tabat	79	77	77	78 b
Mean	94 a	89 a	89 a	
$LSD_{0.05}$ (D) = NS, $LSD_{0.05}$ (V) = 7.9, $LSD_{0.05}$ (D x V) = NS				
	Number of heads (Season 2007)			
Wad Ahmed	158	150	122	143 a
Tabat	85	77	83	82 b
Mean	122 a	114 a	103 a	
$LSD_{0.05}$ (D) = NS, $LSD_{0.05}$ (V) = 15.8, $LSD_{0.05}$ (D x V) = NS				
	1000-grain weight (Season 2006)			
Wad Ahmed	25.96	25.98	26.34	26.09 a
Tabat	26.20	26.00	26.68	26.29 a
Mean	26.08 a	25.99 a	26.51 a	
$LSD_{0.05}$ (D) = NS, $LSD_{0.05}$ (V) = 0.9, $LSD_{0.05}$ (D x V) = NS				
	1000-grain weight (Season 2007)			
Wad Ahmed	25.31	26.07	25.9	25.76 a
Tabat	28.38	29.46	29.14	28.99 b
Mean	26.85 a	27.76 a	27.52 a	
$LSD_{0.05}$ (D) = NS, $LSD_{0.05}$ (V) = 1.1, $LSD_{0.05}$ (D x V) = NS				

Table 6. Sorghum grain yield (ton/ha) as affected by variety and available water depletion at which supplementary irrigation water was applied during July-November in the two seasons (2006 and 2007)

Variety	Available water depletion level (%) 25	50	75	Mean
	Season 2006			
Wad Ahmed	9.4	8.6	8.5	8.8 a
Tabat	7.8	7.6	7.6	7.7 b
Mean	8.6 a	8.1 a	8.1 a	
$LSD_{0.05}$ (D) = NS, $LSD_{0.05}$ (V) = 0.9, $LSD_{0.05}$ (D x V) = NS				
	Season 2007			
Wad Ahmed	7.4	6.5	7.1	7.0 a
Tabat	8.1	6.2	6.9	7.1 a
Mean	7.8 a	6.4 b	7.0 b	
$LSD_{0.05}$ (D) = 1.5, $LSD_{0.05}$ (V) = NS, $LSD_{0.05}$ (D x V) = NS				

DISCUSSION

The low germination percentage was attributed to the poor seed quality, presence of termites and possible dormancy. It was reported that seed stored for a long period after harvest, may not germinate even when placed under optimal germination conditions with respect to temperature, moisture, and aeration (Hall 2001). It was envisaged that the occurrence of a high temperature spell can damage all physiological processes and inhibits germination and emergence of seeds (Hall 1992). This poor germination was offset by transplanting and hence did not affect other growth and yield components.

The impact of treatments on plant height and LAI was reflected on the DMY. Wad Ahmed, which was more adapted to the environmental field conditions, gave significantly (P = 0.05) higher mean dry matter yield than Tabat. The increase was 42% in the first season and 28% in the second season. The mean DMY of Wad Ahmed was 11.2 and 12.8 ton/ha in the two successive seasons. Irrigating at the lowest AWDL improved the DMY, but the impact was significant in the first season only. Improvement of the DMY was attributed to alleviation of water stress, but the occurrence of rains after irrigation caused flooding and suppressed the beneficial impact of irrigation. The higher quantity and better distribution of rainfall and the overall favourable environmental conditions in the second season resulted in better DMY than the first season. However, this was not reflected in grain yield, which was higher in the first season. It is likely that the favourable environmental conditions promoted vegetative growth at the expense of reproductive growth.

The number of heads of Wad Ahmed was 32% and 74% greater than that of Tabat in the first and second season, respectively. However, the thousand grain weight of Tabat was not significantly different from that of Wad Ahmed in the first season, but it was 13% greater in the second season. This may be attributed to jassid attack, which is specific to Wad Ahmed. At the milk stage, Wad Ahmed was softer than Tabat. This explains why the grain yield of Wad Ahmed was greater than that of Tabat in the first season, but they were not significantly different in the second season. The greater grain weight of Tabat was offset by the higher number of heads of Wad Ahmed in the second season. The mean grain yield of Wad Ahmed in the second season was lower than that in the first season, because the crop was attacked by jassid, which did not attack Tabat.

The grain yield obtained in this experiment was on the average greater than that obtained under rain-fed and even irrigated farming systems (Ibrahim 1994; Omer and Alamin 1996; FAO 1996).

It is concluded that supplementary irrigation will help to put more land under cultivation, increase productivity and decrease the deficit of food in Darfur states leading to better utilization of the natural resources.

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استخدام الري التكميلي لتحسين نمو وإنتاجية الذرة الرفيعة بولاية شمال دارفور*

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موجز البحث: أجريت تجربة حقلية في موسمين متتاليين (2006و2007 م) في مزرعة جامعة الفاشر بولاية شمال دارفور لدراسة تأثير الري التكميلي عند مستويات استنفاد الماء الميسر تساوي 25% و 50% و75%، على نمو وإنتاجية صنفين من الذرة الرفيعة (ود أحمد و طابت) زرعتا في احدى سلاسل ترب الأريديسولز الطميية الناعمة. صممت التجربة على نمط القطع المنشقة بأربعة مكررات حيث وضعت معاملة الري في القطعة الرئيسية ووضع المحصول في الفرعية. في الموسمين تفوق ود أحمد معنويا على طابت في نسبة الإنبات وطول النبات ودليل مساحة الورقة وعدد السنابل حيث تراوح متوسط طول النبات بين 147.0 و 173.5 سم، ودليل مساحة الورقة بين 3.3 و7.4، وعدد السنابل بين 77 و 158. وكان انتاج العلف الجاف في الموسمين على التوالي 11.2 طن/هـ و12.8 طن/هـ لود أحمد و 7.9 و 9.9 طن/هـ لطابت. وفي الموسمين تروراح متوسط وزن الألف حبة بين 26.0 و29.5 جرام، وإنتاجية الحبوب بين 6.2 و 9.4 طن/هـ. وأعطى ود أحمد إنتاجية أعلى معنويا ($P = 0.05$) من طابت في الموسم الأول، ولكن لم يختلف الصنفان معنويا في الموسم الثاني. وفي معظم الحالات أعطي الري عند استنفاد 25% من الماء الميسر نموا و إنتاجية أفضل من الري عند استنفاد 50% أو 75% من الماء الميسر. ولكن لم يكن التأثير معنويا نتيجة للتباين العشوائي لهطول وكمية الأمطار. لقد أوضحت التجربة أن الري التكميلي المقنن باستخدامً حصاد المياه يتيح إمكانية هائلة لتحسين إنتاجية المحاصيل في شمال دارفور.

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