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Interactive Effect of Chicken Manure with Nitrogen Fertilizer and Watering Regimes on Yield and its Components of Bread Wheat

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Abstract: A field experiment was conducted for two consecutive seasons during 2010/2011 and 2011/2012 on the Demonstration Farm of the Faulty of Agriculture, University of Kassala at New Halfa. The objectives of study were to investigate the interactive effects of watering regime, nitrogen and organic manure on yield of wheat (*Triticum aestivum* L). The watering regime treatments were irrigation every 7, 14 and 21 days, and the nitrogen fertilizer levels were zero, 43, 86 kgN ha^{-1} without or with 4 tons of chicken manure ha^{-1}. Irrespective to fertilizer application, grain yield was substantially reduced under prolonged watering interval, relative to frequent watering interval by 29.3%. While application of organic manure, high N level solely or together significantly increased grain yield, relative to their control treatments by 37.6%, 56.1% and 117%, respectively. Under frequent irrigation, addition of organic manure with high N level significantly increased grain yield by more than 120% relative to control treatment. However, the increase in grain yield was associated with significant increases in yield components (number of tillers m^{-2}, number of grains $spike^{-1}$ and 1000-grain weight). Also, the results showed that application of high N level and organic manure had positive effect on harvest index.
Keywords: wheat , water stress, Nitrogen chick manure, yield

INTRODUCTION

Wheat (*Triticum aestivum* L.), is a winter annual grain grass of the family graminae, generally common to temperate zones grassland Prairies and Savannas[1]. According to Hanchinal *et al.* [2] wheat is the most important crop and ranks first among world food crops, measured either by cultivated area or by production. During the three production seasons (2010-2013), the average world wheat areas were about 224.7 million hectares producing 689.1 million metric tons with average yields estimated at 3.08 tons per hectare[3]. Wheat attained its premier position by virtue of its unique protein (gluten) which is responsible for bread making properties of wheat flour. It is highly nutritious cereal food stuff and its amino acid yield per hectare exceeds that of animal products [4, 5]. After irrigation, nitrogenous fertilizer is the second most important input for wheat crop growth and development [6]. Wheat production in Sudan is restricted by soil deficiencies in moisture and plant nutrients (especially nitrogen). Consequently adequate levels of irrigation and nitrogen (N) fertilizer are needed [7]. As wheat is an irrigated crop, its production is frequently exposed to water deficits at any stage of the crop development. Different studies have shown that prolonged watering interval decreased grains yield per unit area in wheat [8-10]. On the other hand, application of organic manure has become an important tool used to increase crop yields and grain quality in intensive agricultural systems[11]. The importance of N fertilization in increasing wheat production has been well documented by many workers[12-13], but still it is difficult to determine the quantities to apply under water stress condition Thus combined application of organic manure and nitrogen fertilizer can increase crop productivity through improving the chemical, physical and biological properties and nutrient status of the soil. These factors interrelate providing an important insight to the study of their interaction on wheat production. Keeping these in view, an experiment was planned to study the interactive effect of water stress, application of organic manure with nitrogen levels on yield and yield components of wheat.

MATERIALS AND METHODS

The proposed study was conducted on the Demonstration Farm of the Faulty of Agriculture, University of Kassala at New Halfa, Sudan (Latitude 15° 19′ N. Longitude 35° 36′E and Altitude 45 m asl). The experiment was arranged in strip-split-plot design with three replications. Strip blocks were allotted for the chicken manure treatments and the main plots were allotted for watering treatments and the subplots for nitrogen treatments. Seeds were sown manually at a rate of 120 kg/ha, in three lines 15 cm apart, on the second week of November in both seasons.

Chicken manure was obtained from Dairy Farm at the Faculty of Agriculture, University of Kassala. The chemical composition of the manure was determined for two seasons using Matrix spinking technique[14]. The watering regime treatments were irrigation every 7, 14 and 21 days (W1,W2 and W3) and the nitrogen fertilizer levels were zero,43, 86 kgN ha^{-1} (N0, N1 ad N2) without (-M) or with(+M) 4 tons of chicken manure ha^{-1}. Irrespective to fertilizer application, grain yield was substantially reduced under prolonged watering interval.

At harvest, the two inner rows in each subplot were used for the determination of the yield components (spikes m^{-2}, number of grains per spike, 1000–grain weight and grain yield). Data on number of spikes m^{-2}, number of grains per spike, 1000–grain weight and grain yield were recorded by using standard procedures. Harvest index (HI) was calculated as the ratio of gain yield to the total above ground shoot biomass as follows: HI = (Grain yield)/ (Biological yield) x 100

RESULTS AND DISCUSSION

The results presented in table (1) showed that prolonged watering interval (W3) significantly reduced spikes m^{-2}, number of grains per spike, 1000-grain weight. In this respect, grain yield was substantially reduced under prolonged watering interval, relative to frequent watering interval (W1) by 29.3%. The reduction in yield under prolonged watering intervals was associated with significant decrease in all yield components. For example, the number of spikes m^{-2}, number of grains $spike^{-1}$ and 1000-grain weight were significantly decreased under water stress conditions. These results are agreements with those reported[15, 16]. They concluded that the reduction in number of spikes m^{-2} and number of grains $spike^{-1}$ under water stress condition could be attributed to the adverse effect of water stress on pollination process and flower retention. The reduction in grain weight $spike^{-1}$ fact under water deficit may be attributed to the lack of assimilate needed for grain filling. In addition, Sharma *et al.* [8] attributed the reduction in grain yield under water stress to reduction in LA and number of tillers m^{-2}.

Table 1: Effects of watering interval, organic manure and nitrogen level on grain yield and yield components of wheat during 2010/011 and 2011/012 seasons

	2010/2011				2011/2012			
treatments	No. of Spikes m^{-2}	No. of grains $Spike^{-1}$	1000-garin Weight (g)	Grain yield ton ha^{-1}	No. of Spikes m^{-2}	No. of grains $Spike^{-1}$	1000-garin Weight (g)	Grain yield ton ha^{-1}
-M	257.2	26.2	28.7	1.6	298.8	33.1	31.2	2.0
+M	279.4	43.2	32.8	2.8	326.8	40.2	33.9	3.0
$LSD_{0.05}$	8.6	2.5	1.5	0.4	25.4	1.9	0.8	0.3
W1	289.9	39.5	32.0	2.3	323.3	46.3	34.3	3.1
W2	269.5	32.1	30.2	2.1	311.6	33.3	32.0	2.3
W3	245.4	32.4	30.0	1.7	303.4	30.3	31.3	2.0
$LSD_{0.05}$	17.3	3.2	0.4	0.4	7.9	4.5	0.6	0.1
N0	250.5	32.5	29.8	1.8	292.5	35.4	32.0	2.2
N1	260.1	32.7	30.4	2.1	311.9	34.0	32.2	2.5
N2	294.3	38.6	31.9	2.6	333.8	40.5	33.4	2.8
$LSD_{0.05}$	20.6	1.0	1.0	0.1	14.8	4.0	0.7	0.2

The results presented in tables (1 and 2) also, showed that, addition of high nitrogen level and organic manure solely or mixed together significantly increased the mean number of spikes m^{-2}, number of grains per spike, 1000-grain weight and grain yield (ton ha^{-1}). However, application of organic manure, high N level solely or together significantly increased grain yield, relative to their control treatments by 37.6%, 56.1% and 117%, respectively. Likewise, under normal watering regime (W1), addition of organic manure significantly increased these yield components (Table 2) also, under frequent irrigation, addition of organic manure with high N level significantly increased grain yield by more than 120%. Grain yield enhancement resulted of application high N level could be mainly attributed to positive effects of nitrogen on yield components characters. In this respect, Ayoub *et al.*[17], Jan and Khan [18] reported that, at high N level, availability of nitrogen satisfied plant requirement for growth and development which enable plant to produce more number of grains $spike^{-1}$ and increasing individual grain weight which, in turn, positively increased grain yield. This may support the findings of this study where addition of high N level resulted in a significant increase of yield and its components. The positive effects of organic manure on increasing grain yield and yield components measured in this study could be attributed to improvement in soil physical and chemical conditions. These results are in accord with those results reported[19, 20]. Also, the positive effect due to application of high N level on number of grains $spike^{-1}$, 1000- grain weight and grain yield was exacerbating under frequent watering interval. These results are in accord with those results reported by Parameswaran *et al.* [21]. They attributed the increase in grain yield with application of high N dose under full irrigation to an increase in LA and number of grains $spike^{-1}$. Addition of organic manure together with high N level resulted in

greater grain yield and yield components as reported by many researchers[22, 23]. On the other hand, the results showed that addition of both N and organic manure fertilizers had the greater effect on HI (Table 3); this may be due to increase in 1000-grain weight in these treatments. Similar positive responses of harvest index of wheat plant to N fertilization, organic manure and their combination[24]. Also, Eyvazi *et al.* [23] observed significant increased in that trait due to addition of organic manure only or mixing with high N level.

Table 2: Interactive effects of watering interval and organic manure level on grain yield and yield components

		2010/2011				2011/2012			
treatments		No. of Spikes m^{-2}	No. of grains $Spike^{-1}$	1000-garin weight(g)	Grain yield ton ha^{-1}	No. of $Spikesm^{-2}$	No. of grains $Spike^{-1}$	1000-garin Weight(g)	Grain yield ton ha^{-1}
-M	W1	257.1	29.5	28.9	1.7	301.1	39.5	32.0	2.1
	W2	265.7	21.7	29.2	1.6	290.6	30.7	31.1	1.9
	W3	248.6	27.3	28.2	1.5	304.0	29.1	30.5	1.9
+M	W1	322.7	49.5	35.1	3.8	344.9	54.2	36.6	4.1
	W2	273.4	42.5	31.3	2.6	332.6	33.1	32.7	2.8
	W3	242.2	37.5	31.9	2.0	302.8	31.5	31.9	2.1
$LSD_{0.05}$MW		21.4	5.0	1.9	0.5	26.1	2.9	0.6	0.3
-M	N0	251.8	25.4	27.4	1.3	280.7	33.9	31.0	1.8
	N1	250.2	22.9	28.0	1.4	303.1	28.6	30.8	2.0
	N2	269.4	30.2	30.7	2.0	312.6	36.7	31.6	2.2
+M	N0	280.7	39.5	32.2	2.3	304.4	36.9	33.1	2.5
	N1	303.1	42.5	32.9	2.8	320.9	39.4	33.4	3.0
	N2	312.1	47.5	33.2	3.3	354.9	44.2	35.2	3.5
$LSD_{0.05}$MN		2.3	NS	1.5	0.1	NS	4.2	NS	0.3
W1	N0	254.3	35.3	29.6	2.0	290.4	43.7	32.6	2.5
	N1	286.9	36.6	31.2	2.7	323.3	40.8	32.9	3.2
	N2	328.4	46.7	35.3	3.6	356.3	54.6	37.2	3.7
W2	N0	264.1	28.8	30.4	1.9	292.4	32.4	32.0	2.0
	N1	258.1	30.5	30.4	1.9	305.2	33.4	32.1	2.4
	N2	286.4	37.0	29.9	2.5	337.1	34.0	32.0	2.6
W3	N0	233.0	33.4	29.5	1.6	294.8	30.3	31.5	1.9
	N1	235.2	31.1	30.4	1.7	307.4	27.8	31.5	2.0
	N2	267.9	32.8	30.6	1.9	307.9	32.9	30.9	2.2
$LSD_{0.05}$WN		NS	5.4	1.9	0.3	NS	5.2	2.1	0.2

Table 3: Interactive effects of watering interval, organic manure and nitrogen level on grain yield and yield components of wheat during 2010/011 and 2011/012 seasons

			2010/2011				2011/2012			
treatments			No. of Spikes m^{-2}	No. of grains $Spike^{-1}$	1000-garin weight(g)	Grain yield ton ha^{-1}	No. of Spikes m^{-2}	No. of grains $Spike^{-1}$	1000-garin Weight(g)	Grain yield ton ha^{-1}
W1	**-M**	**N0**	226.7	30.4	26.9	1.4	281.4	40.3	31.0	2.0
		N1	259.2	25.3	27.6	1.5	303.6	28.5	31.0	2.0
		N2	285.5	32.9	32.3	2.3	320.3	49.7	34.0	2.4
	+M	**N0**	282.0	40.1	32.3	2.7	299.4	47.0	34.3	3.0
		N1	314.7	47.9	34.9	4.0	342.9	52.9	35.0	4.4
		N2	371.4	60.5	38.2	4.8	392.3	59.6	40.6	4.9
W2	**-M**	**N0**	265.0	17.9	28.6	1.4	268.5	30.7	31.3	1.5
		N1	257.6	18.6	28.9	1.3	293.6	29.5	31.0	2.0
		N2	274.6	28.5	30.1	2.0	309.6	31.8	30.9	2.1
	+M	**N0**	263.8	39.6	32.3	2.4	316.2	34.1	32.7	2.5
		N1	258.7	42.4	31.8	2.4	316.9	37.3	32.2	2.6
		N2	298.3	45.6	29.8	2.9	364.6	27.8	33.1	3.1
W3	**-M**	**N0**	263.8	27.9	26.7	1.4	292.2	30.9	30.7	1.8
		N1	233.8	24.8	28.0	1.5	311.9	27.7	30.6	2.0
		N2	248.6	29.2	29.9	1.7	307.8	28.8	30.2	2.0
	+M	**N0**	202.3	38.8	32.3	1.8	297.4	29.8	32.3	2.0
		N1	236.5	37.3	32.0	2.0	302.9	27.8	32.3	2.0
		N2	287.8	36.4	31.4	2.1	308.2	37.0	31.1	2.4
$LSD_{0.05}$ MWN			NS	7.7	NS	0.4	NS	7.3	NS	0.5

CONCLUSION:

application of high level of N fertilizer (2N) together with organic manure (4tons/ha) can bridge the reduction in wheat yield caused by long watering intervals (14 – 21days) under New Halfa conditions, Eastern Sudan.

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