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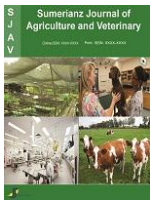

Original Article Open Access

Physiological Response to Combined Application of Nitrogen Fertilizer and Chicken Manure on Grain Yield of Wheat (*Triticum Aestivum* L.) At Halfa Elgadida Sudan

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Abstract

This study was conducted at the Demonstration Farm of Fuculty of Agriculture, Kassala University during 2010/2011 and 2011/ 2012 seasons in the Halfah Elgadidah, Sudan. Randomized complete plot design (as split trail) with four replications was used in this study. The treatments were three levels of N (N0, N1 andN2) corresponding to N fertilizer rates of zero, 43, 86 kg N/ha. Also, organic manure treatments are -M and +M corresponding to zero and 4 tons of chicken manure/ha. The main objective of this study is to investigate the effects of combined application of N and chicken manure on physiological traits and grain yield in wheat. The obtained results showed that, the treatments which received high dose of nitrogen fertilizer or chicken manure solely or mixed together, resulted in high dry matter production , higher values of LAI, leaf area duration, crop growth rate, net assimilation rate and grater grain yield. The positive strong correlations between these characters and grain yield indicated their unlimited contribution to final grain yield and may be key factors for wheat production in the study area.

Keywords: Wheat; Nitrogen; Chicken manure; Physiological parameters and yield.

1. Introduction

Wheat (*Triticum aestivum* L.) is the most important crop and ranks first among world food crops, measured either by cultivated area or by production Fertilizers are the most crucial components of the production package (soils of wheat growing areas are inherently deficient in N). The major soils in Sudan, where wheat is produced, are deficient in nitrogen, phosphorus and poor in organic matter [1]. Therefore, efficient nitrogen fertilization is crucial for economic wheat production [2]. 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[3, 4] also, they stated that, organic manures are a vital resource, not only for supplying plant nutrients, but also for replenishing organic matter content of most agricultural soils.

Plant growth analysis is considered to be a standard approach to study of plant growth and productivity[5].

Studies of growth pattern and its understanding not only tell us how plant accumulates dry matter, but also reveals the events which can make a plant more or less productive singly or in population [6]. In a crop the growth parameters like optimum LAI and CGR at flowering have been identified as the major determinants of yield [7]. A combination of these growth parameters explain different yields better than any individual growth variable [8]. The effect of addition of nitrogen and chicken manure on net assimilation rate, crop growth rate, leaf area duration and relative growth rate in wheat were studied by earlier researchers [9-11]. They reported that application of nitrogen and organic manure significantly increased these physiological traits in wheat plant.

Wheat production in Sudan is restricted by soil deficiencies in plant nutrients (especially nitrogen). Consequently adequate levels of nitrogen (N) fertilizer are needed. Because of increasing mineral fertilizer costs and negative environmental impacts of these fertilizers, the interest in biological nitrogen fixation is increasing within the scope of sustainable agriculture (without significant yield losses. Also, extensive use of chemical fertilizers has been inflicting adverse effect on the environment causing pollution and damaging beneficial soil flora and fauna, causing erosion and lower crop quality [12]. 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. This would further emphasize the need to use organic manures alone or in conjunction with chemical fertilizers in soil fertility maintenance for sustainable crop production. These factors interrelate providing an important insight to the study of their interaction on physiological parameters in wheat production. Therefore, the objectives of this study are to investigate the responses of physiological parameters and grain yield to combined application of nitrogen and chicken manure in Wheat.

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2. Matreials and Methods

A field experiment was conducted for two consecutive seasons (2010/011 and 2011/012) in the Demonstration Farm of the Faculty of Agriculture and Natural Resources, University of Kassala, New Halfa, Sudan. A wheat cultivar; Nebta was used in this study. The experiment was designed to study the effect of three levels of nitrogen fertilizer with or without organic manure (Chicken manure) on the performance of wheat plants. The three nitrogen fertilizer levels are designated as 0N, 1N and 2N, corresponding to nitrogen fertilizer rates of zero, 43, 86 kg N/ha, respectively. The organic manure treatments are designated as -M and +M corresponding to zero and 4 tons of chicken manure/ha, respectively. The experiment was arranged in Randomized Complete Blocks Design as split-plot trail with three replications in both seasons. The main plots were allotted for chicken manure treatments and the subplots for nitrogen treatments.

2.1. Characters Studied

Leaf area index (LAI): was calculated using the formula suggested by Sestak, *et al.* [13]. LAI = LA (cm^2) / Land area (cm^2)

Leaf area per plant was computed according to Gomez [14] method as follows: Leaf area (LA) = L × W × K

Where: L ≡ maximum leaf length (cm), W ≡ maximum leaf width (cm) and

K ≡ Adjustment factor (0.8)

Shoot dry weight (g plant^{-1}): The dry weight of ten plant is subsequently determined using a precision balance.

2.2. Physiological Attributes

The following physiological parameters were computed from the predetermined dry weight and leaf area data.

Leaf area duration (dm^{2}days): Was worked out according to the formula of [15] as follows: LAD = $(A_2-A_1)(t_2- t_1)/ (\ln A_2 – \ln A_1)$

Where: A_1: Leaf area at sampling time t_1 , A_2: Leaf area at sampling time t_2

t_2, t_1: time intervals in days between two stages.

Net assimilation rate (gm^{-2} day^{-1}): (NAR) determined by using the equation described by Gardner, *et al.* [15]

$$NAR = \frac{(W2 - W1)(\ln A2 - \ln A1)}{(A2 - A1)(t2 - t1)}$$

Where; W_1, W_2 are dry weights at t_1 and t_2, A_1, A_2: total leaf area at t_1 and t_2

Relative growth rate (gg^{-1} week): (RGR) determined using the equation described by Gardner, *et al.* [15] as follows: $RGR = (\ln W_2 – \ln W_1)/ (t_2 - t_1)$

Where: W1, W2 are dry weights at t_1 and t_2

Crop growth rate (mgm^{-2} day^{-1}): (CGR) determined by using the equation described by Gardner, *et al.* [15] as follows: CGR = (W2 - W1) / (t2 - t1)

Where: W1, W2 are dry weights at t_1 and t_2

Grains weight (g plant^{-1}): Grains obtained from 10 randomly selected plants were weighed using sensitive balance to determine the average grain weight per plant.

Grains yield (Kg ha^{-1})

In each sub-plot, all plants grown in an area of 1.7 m^2 in the two central ridges were harvested, air-dried, weighed to determine the average yield per unit area.

Data were statistically analyzed according to the analysis of variance (ANOVA) for split plot trail using MSTAT-C computer software package [16]. Mean comparisons were worked out by Duncan's Multiple Range Test (DMRT) at 5% level of probability. Correlation analysis was determined by using SPSS computer software package version 16.

3. Results and Discussion

Nitrogen levels N1 and N2 increased the mean Shoot biomass (g plant^{-1}),

LAI, and all physiological parameters (LAD,RGR, CGR and NAR)relative to control (N0) in both seasons (Tables 1 2). Also, organic manure treatments had significant effects on aforementioned characters in the two seasons. In this regard, addition of organic manure significantly increased the mean NAR relative to control by 88.9% and 67.7% in first and second season respectively. Also, addition of organic manure significantly increased CGR across all nitrogen levels in the two seasons. Moreover, mixing of organic manure and N fertilizer (N2) resulted in a significantly greater LAD than both treatments when they added solely (Tables 1 2). Differences due to all treatments and their interactions on mean grains weight per plant were significant in both seasons. Differences due to all treatments and their interactions on mean grains yield were significant in both seasons(Tables 1 2). In this respect, addition of high nitrogen level and organic manure significantly increased the mean grains. However, mixing of organic manure with high N level increased the mean grains yield (Tables 1 2). On the other hand, grain yield was positively and significantly correlated with all studied traits in both seasons (Table 3).

In the present investigation, the treatments which received high dose of nitrogen fertilizer resulted in high dry matter production and higher values of LAI. Thus, the increase in these characters may be due to favorable effect of N on promoting vigorous plant growth. Similarly, addition of high N level resulted in significant increases in all of the physiological traits studied in this investigation. The positive correlations between these characters (LAI, shoot biomass, LAD, RGR and NAR) further explained the vigorous growth of the plants under these treatments. These

results are in agreement with those reported by many researchers [17, 18]. They concluded that, the increase in these characters under high level of nitrogen fertilization may be attributed to the role of nitrogen in activation of metabolic and photosynthetic processes. Similarly, [19] noticed that application of high N level greatly increased leaf area index by delaying senescence, sustain leaf photosynthesis and extend leaf area duration. Moreover, [20] concluded that nitrogen seemed to promote photosynthesis activity which resulted in more dry matter accumulation. The increase in growth and physiological characters due to the addition of chicken manure may be attributed to the fact that it supplies direct available nutrients (i.e., N) to the plants and improves of soil physical properties particularly in heavy clay soils, as reported by Harris [21]. The overall enhancement of growth under organic manure possibly might explain the increase in LAD, NAR and CGR observed in this study. Moreover, [22, 23] concluded that, application of nitrogen and organic manure hastened the dry matter accumulation which resulted in maximum CGR. This may support the findings of the present study where the addition of organic manure with high N level resulted in significant increase in aforementioned characters. [24] reported that, at high N level of nitrogen satisfied plant requirement for growth and development, which enabled plants to produce more number of spikelets, grains spike^{-1} and increased 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 grain yield. Moreover, [25] concluded that, application of organic manure with nitrogen increased grain yield by increasing dry matter production, LAD and NAR which resulted in maximum grain weight. This may support the findings of this study where addition of high N level with organic manure resulted in a significant increase of grain yield. This was further confirmed by correlation analyses where most of these traits were positively correlated with grain yield.

4. In Conclusion

Application of organic manure (4tons/ha) together with high N level, (2N) significantly increased grain yield. Which was associated with significant increases physiological parameters (CGR, NAR and LAD).The positive strong correlations between these characters and grain yield indicated their unlimited contribution to final grain yield and may be key factors for wheat production in the study area.

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Table-1. Responses of Physiological and grain yield to combined application of nitrogen and chicken manure in Wheat during 2010/2011 season

Treatments		Dry Weight(g)	LAI	LAD	RGR	CGR	NAR	Grain yield plant^{-1} (g)	Grain yield (T ha^{-1})
	+M	2.55	9.98	81.32	0.69	31.79	2.22	3.35	3.86
	-M	0.89	3.58	48.11	0.30	14.08	1.36	0.92	1.34
	$LSD_{0.05}$	0.29	0.95	4.53	0.06	3.11	0.37	0.38	0.28
	N0	1.69	4.64	60.80	0.37	18.73	1.89	1.39	2.00
	N1	1.21	6.42	61.41	0.37	21.58	1.22	1.97	2.32
	N2	2.27	9.29	71.93	0.57	28.48	2.25	3.07	3.48
	$LSD_{0.05}$	0.36	1.17	5.55	0.06	3.81	0.46	0.39	0.35
+M	N0	2.47	6.63	83.02	0.76	23.50	2.36	2.03	2.63
	N1	1.73	9.08	78.26	0.48	28.20	1.59	3.20	3.37
	N2	3.43	14.25	82.67	0.85	43.67	2.77	4.82	5.57
-M	N0	0.91	2.66	38.57	0.37	28.20	1.43	0.75	1.37
	N1	0.68	3.76	44.57	0.27	14.97	0.86	0.73	1.27
	N2	1.09	4.33	61.20	0.28	13.30	1.79	1.30	1.40
	$LSD_{0.05}$	0.5033	1.65	7.85	0.09	5.39	0.65	0.55	0.49

LAI: leaf area index ; LAD (days) : leaf area duration ; RGR(gg^{-1} week) : relative growth rate; CGR(mg m^{-2}day^{-1}) : Crop growth rate; NAR(gm^{-2}day^{-1}): net assimilation rate;

Table-2. Responses of Physiological and grain yield to combined application of nitrogen and chicken manure in Wheat during 2011/2012 season

Treatments		Dry Weight(g)	LAI	LAD	RGR	CGR	NAR	Grain yield plant^{-1} (g)	Grain yield (T ha^{-1})
	+M	3.70	8.04	81.68	0.47	32.87	2.64	3.86	4.12
	-M	1.56	5.73	49.21	0.32	18.03	1.56	1.34	2.17
	$LSD_{0.05}$	0.31	0.89	5.28	0.07	3.98	0.35	0.28	.540
	N0	2.18	5.65	52.05	0.31	19.28	2.05	2.00	2.52
	N1	2.21	7.08	67.67	0.40	25.83	1.97	2.31	3.23
	N2	3.50	7.93	76.62	0.47	31.23	2.33	3.48	3.69
	$LSD_{0.05}$	0.38	1.09	6.467	0.08	4.88	0.43	0.35	0.67
+M	N0	3.03	6.63	64.97	0.37	21.43	2.80	2.63	3.06
	N1	3.20	8.10	82.53	0.43	34.07	2.13	3.37	4.42
	N2	4.87	9.40	97.53	0.60	43.10	3.00	5.67	4.89
-M	N0	1.33	4.67	39.13	0.27	17.13	1.30	1.37	1.98
	N1	1.23	6.07	52.80	0.37	17.60	1.70	1.27	2.07
	N2	2.13	6.47	55.70	0.33	19.37	1.67	1.40	2.48
	$LSD_{0.05}$	0.54	1.55	9.15	0.11	6.90	0.61	0.49	0.94

Table-3. Combined correlation co-efficient between Physiological and grain yield charaters due to combined application of nitrogen and chicken manure in Wheat

correlation	NAR	CGR	RGR	DWT	LAD	LA	Yield plant
Yield plant	0.71**	0.93**	0.67**	0.88**	0.83**	0.82**	
Yield ha	0.63**	0.89**	0.61**	0.83**	0.83**	0.84**	0.90**