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Effect of Organic and Inorganic Fertilizers on Yield and Yield Components in Wheat (*T. aestivum and T. durum*) genotypes

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Amin Lotfi Jala-Abadi, S.A. Siadat, A.M. Bakhsandeh, G. Fathi and K.H. Alemi Saied; Effect of Organic and Inorganic Fertilizers on Yield and Yield Components in Wheat (*T. aestivum and T. durum*) genotypes

ABSTRACT

In order to Evaluation of different fertility systems and cultivars on wheat In Khuzestan conditions, a filed experiment was conducted Experimental field of Ramin Agriculture and Natural Resources University in Ahwaz, south-western of Iran, during 2008- 2009 growing season. Treatments were arranged as a split-plot experiment in a randomized complete block design with three replications. Fertilizer treatments at four system (inorganic1, inorganic2, chicken manure and chicken manure + biofetilizers) and six cultivars (Veenak, Chamran, Star, D-79-15, Karkheh and SP-50) were main plots and sub plot respectively. The result indicated that application organic manure and biofertilizer the grain yield, biological yield, harvest index ,1000-grain weight and chlorophyll content was increased, but at control, kernels per spike and grain protein content had the highest amount. The superiority of organic manure may be attributed to balanced and gradual release of plant nutrients and increased water holding capacity to support growth. The highest grain yield were in all fertility systems, in late maturing bread (star) and durum (SP50) wheat cultivars were long growth season and extensive root system. Generally, wheat yield and its component were increased, by application of animal manure and biofertilizer, as well as from application of inorganic nutrients.

Key words: Fertilizer, genotypes, wheat, yield and yield components.

Introduction

Cereals are an important crop throughout the world, because they constitute the main protein and energy supply in most countries [7]. Wheat is one of the major cereal crops with a unique protein, which is consumed by humans and is grown around the world in diverse environments. Average yield of wheat in Iran is low, which is due to substandard methods of cultivation, imbalanced nutrition, poor plant protection measures and lack of high yielding varieties. Crop management factors such as the application of fertilizers have effect on wheat yield and quality. Organic agriculture is one of the ways that can produce high quality crops and increase yield [13].

The continued use of chemical fertilizers causes health and environmental hazards such as ground and surface water pollution by nitrate leaching. So reducing the amount of nitrogen fertilizers applied to the field without a nitrogen deficiency will be the main challenge in field management. One of the possible options to reduce the use of chemical fertilizer could be using of organic matter. It is generally acknowledged that organic matter plays an important role in maintaining a high level of soil fertility. The positive influence of organic fertilizers on soil fertility, on crop yield and quality has been demonstrated in the works of many researchers

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[26,17,8,22]. Also, some studies showed that biofertilizers technologies are safer for plants and the environment than inorganic (chemical) products. Improper biofertilizers application can also contribute to surface and ground water pollution, may induce a plant nutrient deficiency or toxicity, or cause salt burn. [10,9]. Seed inoculation of wheat verities with biofertilizers showed a significantly increased yield and vegetative growth [15].

The benefits of bio-organic fertilizers for increasing wheat grain yield are not always easy to optimize because of N content and its subsequent release being difficult to predict. Increasing wheat yield by combined effect of bio-organic and organic and chemical fertilizers is a promising goal in wheat production for decreasing high doses of chemical fertilizer also, get more clean product with low undesirable high doses of heavy metals and other pollutants, these benefits reported by Radwan *et al*., [20], Abdel-Magid *et al*., [1], Fares, [11], Mikhaeel *et al*., [16] and Sushila *et al*., [23].

The present paper aims at finding the effect of bio-organic and organic manures and chemical fertilizers on yield and quality of six durum and bread wheat genotypes under Khuzestan condition.

Materials And Methods

Site description:

A filed experiment was conducted at Ramin Agriculture and Natural Resources University in Ahwaz, south – western of Iran, in the 2008- 2009 growing season. This University is located at 50 m above see level (31◦36' N, 48◦53'E). The result soil analysis is shown in Table 1.

Treatments and experimental design:

Treatments were arranged as a split – plot experiment in a randomized complete block design with three replications. Fertilizer treatments were in main plots and wheat genotypes were in sub – plots. Four type of organic and inorganic treatments were used, which were as following:

S1= inorganic1 (80 kg ha-1 N, 75kg ha-1 Superphosphate (15.5% P2O5) and 75 kg ha-1 potash)

S2= inorganic2 (control) (140 kg ha-1 N, 150kg ha-1 Superphosphate (15.5% P2O5) and 150 kg ha-1 potash)

S3= chicken manure (8 t/ha)

S4= chicken manure (8 t/ha) + Nitroxin* (1lit/ha) + Barvar-2**(1kg/ha)

*(Nitroxin) is a commercial product of biofertilizer contains *Azotobacter* and *Azospirillum* produced by Asia Bio Technology Institute, Iran.

**(Barvar-2) is a commercial product of biofertilizer contains *Pesudomonas putida* and *Bacilla Lentus* produced by Green Biotech, Iran.

Six genotypes with different growth durations were used. The genotypes included three bread wheat (Veenak, Chamran and Star) and three durum wheat (D-79-15, Karkheh and SP-50).

The experiment site had a hot climate with a moderate winter a dry and hot summer. In experimental design used, each plot consisted of 6 rows, 3 meters in length spaced 20 cm apart. Based on this, the sub - plot size was 3.6 m2 (6* 3*0.2) and seed density for bread and durum wheat was 400 and 500 seed m-2 based on 1000- kernel weight, respectively.

Sampling and analyses:

Chlorophyll content of 20 youngest fully expanded leave/pot was measured using a chlorophyll meter (Model SPAD 502, Minolta, Japan) at anthesis stage. At the maturity stage wheat plants were harvested and samples from grain and whole plants of each treatment were oven dried at 70◦ C for analysis. Total dray matter, grain yield, harvest index (HI) and yield components were estimated. Protein (% dry matter) was calculated by multiplying the corresponding total nitrogen (by Kjeldahl) content by factor 5.7 using an automated N analyzer (Kjeltec system 1002, Foss Tecator AB, Sweden) [6].

Statistical analysis:

All data were analyzed by analysis of variance (ANOVA) procedures using MSTATC software package. Treatment means were separated by Duncan's multiple range tests at (Duncan 0.05).

Results And Discussion

Grain yield:

Analysis of variance indicated significant difference between fertility systems for grain yield (Table, 3), and effects were consistent across cultivars. The highest grain yield was in integrated chicken manure with biofertilizer (7042.5 $kg.ha^{-1}$) Amujoyegbe *et al*., [3] and Rizwan *et al*., [21] showed that, Application integrated chicken manure with biofertilizer caused to be produce highest yield compared with application chemical and chicken manure treatment alone (Table, 3). But this treatment (S_4) was not significant variation with chicken manure (S_3) (6486.9 $kg.ha^{-1}$) and control (S_2) (6530.9 $kg.ha^{-1}$). Organic and biofertilizer applied to the soil affect the plant physiological processes and improved water holding capacity [12] and N uptake, which serves important instruments in yield development. The lowest grain yield of 6142.9$kg.ha^{-1}$ was obtained under inorganic 1 system (S_1). Data in table 2 showed that interaction between the effect of cultivars and fertility system on grain yield was

statistically significant (P <0.01). The highest grain yield (Fig, 1) were in all fertility systems, in late maturing bread (star) and durum (SP50) wheat cultivars were long growth season and extensive root system.

Table 1: Soil properties of experimental field.

Depth (cm)	EC[a] (dSm^{-1})	pH	Texture	Sand	Silt	Clay	Organic matter		avr. P	avr. K
				($gr\ kg^{-1}$)			(%)		($mg\ kg^{-1}$)	
0-30	3.1	7.9	L[c]	394	354	252	0. 89		0.87	143
30-60	2.3	7.8	CL[d]	234	474	292	0.47		0.59	125

aEC, Electrical Conductivity; cL, Loam; dCL, Clay Loam;

Table 2: Analysis of variance for grain, yield component, Chlorophyll content and protein content.

S.O.V	Degree Freedom	Grain Yield ($kg.ha^{-1}$)	Biological yield ($kg.ha^{-1}$)	Harvest index (%)	1000-grain weight (g)	Kernels $spike^{-1}$	Chlorophyll content	Grain protein (%)
Rep	2	105740.01*	2034071.18*	16.53*	8.97ns	10.76ns	22.19ns	0.50ns
Fertilizer system (S)	3	2475488.177*	27345196.76*	101.11**	24.34ns	97.13*	116.67*	13.22*
Error 1	6	551581.18	5086733.2	6.69	9.00	21.82	12.92	2.10
Variety (V)	5	7567872.87**	43830555.6**	17.69**	696.16**	59.71**	85.03**	1.47*
S*V	15	1831077.44**	6083217.6ns	31.9**	15.17**	52.65**	3.55ns	0.83ns
Error 2	40	292349.33	3472786.5	5.46	5.28	15.24	6.84	0.68
C.V. (%)	-	8.25	10.42	6.24	4.61	10.43	4.90	7.44

* and **: Significant at 5 and 1 % levels of probability, respectively(*P <0.05 and**P <0.01).
ns: Nonsignificant

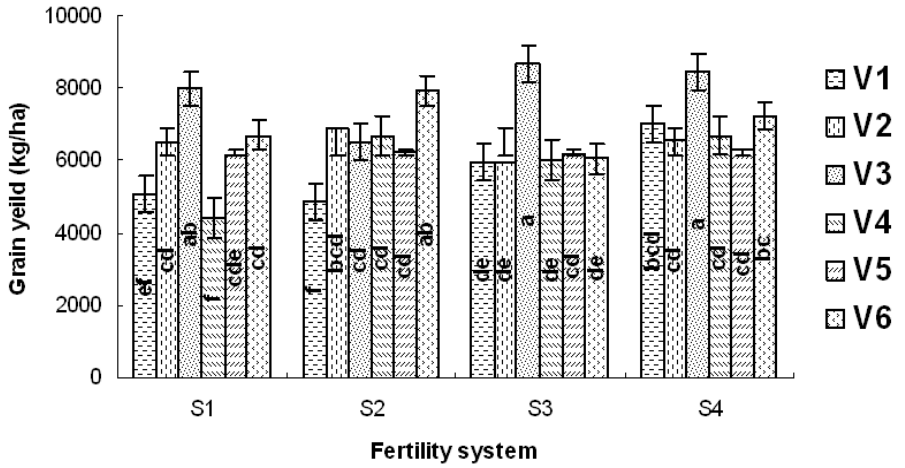

Fig. 1: The effect of fertility system and cultivar on grain yield.

Biological yield:

The effect of cultivars and various organic and inorganic treatments were significant on biological yield (Table 2). The inorganic 1 system produced significantly lower biological yield (16319.4 $kg.ha^{-1}$) than the other fertility treatments (Table, 3). There was no significance difference in biological yield production among other fertility treatments. However, the mixed organic treatment produced more biological yield (19006.9 $kg.ha^{-1}$) than the control and chicken manure treatments. The superiority of mixed organic manure may be attributed to balanced and gradual release of plant nutrients and increased nutrient uptake to support growth. Similar results were obtained by Afifi *et al*., [2] who reported that higher biological yield were recorded with organic and biofertilizer treatments. There was a significant variation between cultivars for biological yield (P <0.01) but the cultivar × fertility system interaction was not significant. Maximum biological yield was in star (20583.3 $kg.ha^{-1}$) and SP50 (19281.3 $kg.ha^{-1}$) cultivars and minimum in D-79-15 (15166.7 $kg.ha^{-1}$).

Harvest index:

Harvest index of wheat was significantly (Table 2) affected by fertility system. The data (Table, 3) revealed that highest index (39.68%) was recorded with application chicken manure (S_3). The lowest harvest index (34.92%) was noted with control (S_2). The harvest index was significantly influenced by cultivars (Table, 2). The highest harvest index of 38.75% was achieved by early maturating variety D-79-15 (Fig, 2). Interaction between cultivar × fertility

system was significant for this trait (Table 2). The cultivar veenak showed highest harvest index with fertility system 4 (S_4). Whereas, cultivar Karkheh gave lowest harvest index with fertility system1 (S_1). There was an inverse relationship between application of chemical fertility and harvest index, this may be due to increased rate of photosynthesis and utilization of assimilates obtained by organic fertility systems which turn resulted in heavier grains, there by increased the harvest index. The same result was observed by White and Wilson, [25].

Thousand grain weight:

D-79-15 cultivar produced highest 1000-grain weight at integrated chicken manure and biological fertilizers (Fig, 3). Generally, late maturing cultivars in inorganic fertility systems had lowest 1000-grain weight. The grain weight gain could have been due to higher rates of photosynthesis and photo-assimilate partitioning to the grains, or longer periods of grain filling or both [24]. The effect of fertilizer treatments weren't significant on 1000-grain weight, but application of organic fertility systems increased the 1000-grain weight (Fig, 3). Grain weight is a genetically controlled trait, which is greatly influenced by environment during the process of grain filling [14].

Kernel number per spike:

Data presented in Table 2 clear that fertility systems and cultivars and their interactions had significant effects on the kernel number per spike. The number of grains in spike in mentioned cultivars shows an increase relative under control treatment; however the increase was higher in Star cultivar (Fig, 4). The lower kernel number per spike obtained at control treatment (39 kernels per spike) in this treatment Star cultivar had highest kernel number per spike (47 kernels per spike). The increase in kernel number per spike may result from increase in the various components of kernel set: the number of spikelets per spike, the frequency of spikelets bearing grains, the number of differentiated florets, the survival of florets, the frequency of grain setting by florets [19].

Chlorophyll content:

Application of organic manure especially mixed treatment (S_4) (56.43), resulted in a significant increase in chlorophyll content of wheat leaves (Table 2). A promotion effect of organic fertilizers on chlorophyll contents might be attributed to the fact that N is a constituent of chlorophyll molecule. Moreover, nitrogen is the main constituent of all amino acids in proteins and lipids that acting as a structural compounds of the chloroplast [4,5].

Grain protein content:

Data on protein content in wheat grain showed variable response to different fertilizer treatments (Table 2). For example control produced significantly greater protein content in wheat grain compared with the other treatments. It was noted that maximum protein content of 12.63% was found in control (Table, 3). Generally, inorganic treatment had the highest protein content. This may be due to negative correlation between grain yield and protein content. Dilution of protein by non-nitrogen compounds in grain seemed to be the primary cause for the negative association between grain yield and protein content [18].

Among cultivars, early maturing cultivars (veenak (11.43 %) and D-79-15(11.67 %)) had the highest protein content (Table, 3). In early maturing cultivars that shorten the duration of grain filling period, starch deposition appears to be more affected than protein deposition. Therefore, the increase in grain protein percentage obtained in Veenak and D-79-15 cultivars, may be mainly attributed to reduced starch accumulation.

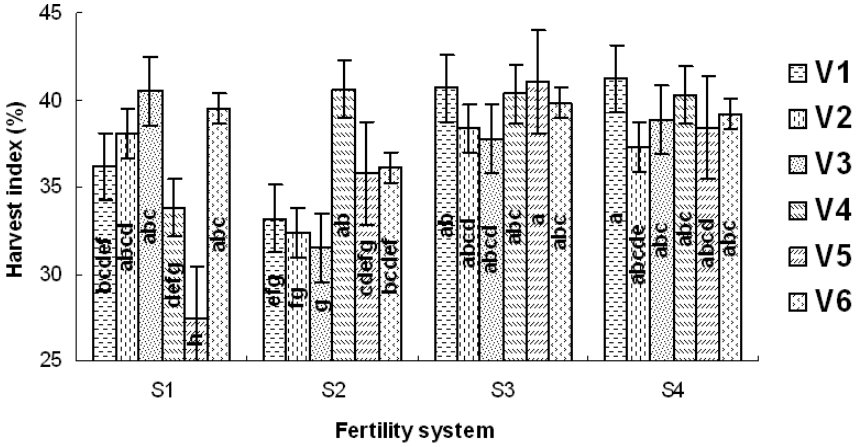

Fig. 2: The effect of fertility system and cultivar on harvest index.

Table 3: Mean comparison of grain, yield component, Chlorophyll content and protein content as affected by different fertility system and cultivar.

Treatments	Grain yield ($kg.ha^{-1}$)	Biological yield ($kg.ha^{-1}$)	Harvest index (%)	1000-grain weight (g)	Kernels $spike^{-1}$	Chlorophyll content	Grain protein (%)
Fertilizer system (S)							
S_1	6142.9b	16319.4b	35.92b	50.01a	34 b	50.24c	10.57b
S_2	6530.9ab	18701.4a	34.92b	48.16a	39a	53.03bc	12.63a
S_3	6486.9ab	17458.3ab	39.68a	50.63a	37ab	53.75ab	10.48b
S_4	7042.5a	19006.9a	39.22a	50.59a	38a	56.43a	10.54b
Variety (V)							
V_1	5725.6e	17458.3c	37.82ab	42.82c	38ab	51.42b	11.43ab
V_2	6500.9c	18052.1bc	36.53bc	.50b	34c	50.32b	11.13ab
V_3	7902.8a	20583.3a	37.16abc	46.92b	39ab	56.39a	10.64b
V_4	5962.6de	15166.7d	38.75a	59.15a	35bc	56.24a	11.67a
V_5	6225.8cd	16687.5cd	35.68c	59.27a	37abc	54.41a	10.74b
V_6	6987.0b	19281.3ab	38.66a	42.43c	40a	51.40b	10.71b

Means, in each column and for each treatment, followed by similar letters are not significantly different at the 5% of probability level - using Duncan 's Multiple Range Test.

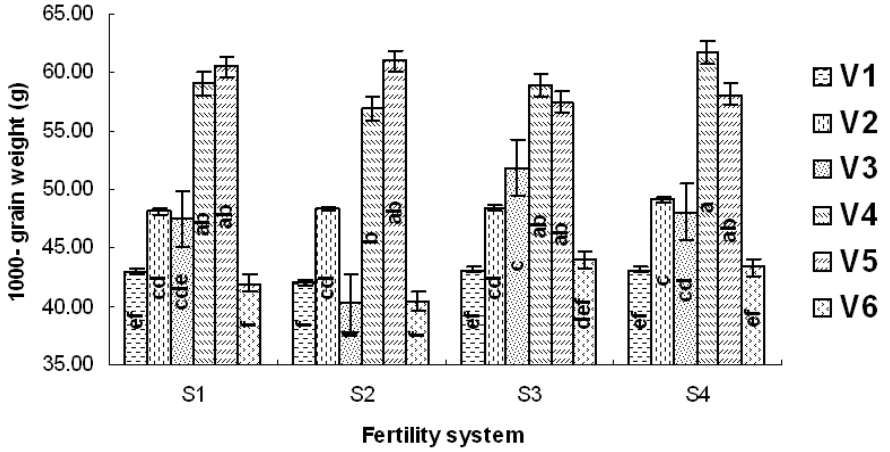

Fig. 3: The effect of fertility system and cultivar on 1000-grain weight.

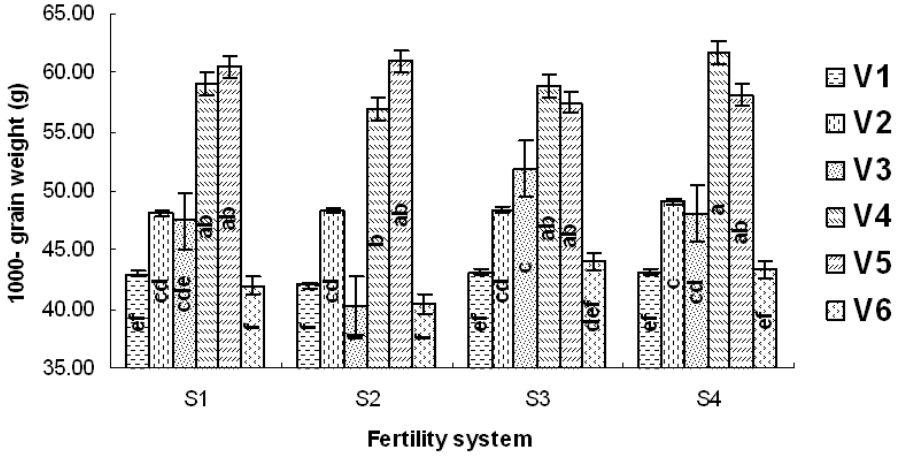

Fig. 4: The effect of fertility system and cultivar on kernel per spike.

Conclusion:

Our results suggested that wheat yield and its component can be raised significantly by modifying agronomic practices. Yields were increased, by application of animal manure and biofertilizer, as well as from application of inorganic nutrients. In addition to, the integrated use of animal manure and biofertilizer performed better than the use of inorganic fertility or animal manure alone. Also animal manure combined with biofertilizer was benefit to the environment because with decrease use of chemical fertilizer and use of inputs organic can move to sustainable agriculture.

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