International Journal of Agronomy and Agricultural Research (IJAAR)
ISSN: 2223-7054 (Print) 2225-3610 (Online)
http://www.innspub.net
Vol. 5, No. 3, p. 1-6, 2014

RESEARCH PAPER OPEN ACCESS

Nutrition management effects on grain yield, yield components and some physiological characteristics of bread wheat cultivars

S. Sh. Jasemi[1], Gh. Abas Akbari[1*], Gh. Ali. Akbari[1], G. Najafian[2], F. Moradi[3]

[1]*Department of Agronomy and Plant Breeding, College of Aburaihan, University of Tehran, Iran*

[2]*Seed and Plant Improvement Institute of Iran*

[3]*Agriculture Biotechnology Research Institute of Iran*

Article published on September 22, 2014

Key words: Wheat, Nutrition management, Grain yield, yield component, cultivar.

Abstract

Nutrition management plays vital role in yield potential of wheat production. In order to investigate the effects of nutrition management on yield, yield components and some physiological characteristics of bread wheat cultivars, this experiment was conducted in karaj SPII (Seed and Plant Improvement Institute) during two cropping seasons 2010-2012. A strip plot experiment with a Randomized Complete Block Design was set up in three replications. Main plots were allocated to nutrition management including: Without fertilizer (control), macronutrient application and macro plus micronutrient application and sub plots were three levels of cultivars. Results showed, that nutrition management effects on grain yield, yield components and some physiological characteristics were significant. Meanwhile, the application of macro plus micronutrient and Parsi Cultivar had the highest grain yield among other treatments in general.

* **Corresponding Author:** Gh. Abas Akbari ✉ sh_jasemi@yahoo.com

Introduction

Wheat (*Triticum aestivum L.*) is one of the most important crop plants in the world. Global wheat data

(2011-12) shows cultivation area 216 million hectares with 629 million tons of production and the average yield of 3.152 (FAO, 2013). Borlaug and Dowswell (1994) stated that 50% of the increase in crop yields worldwide during the 20th century was due to application of chemical fertilizers. They also reported that during the 21st century, the essential plant nutrients would be the single most important factor limiting crop yields, especially in developing countries. Stewart *et al.* (2005) reported that average percentage of yield attributable to fertilizer generally ranged from about 40 to 60% in the USA and England and tended to be much higher in the tropics.

Although, micronutrient elements are needed in relatively very small quantities for adequate plant growth and production, their deficiencies cause a great disturbance in the physiological and metabolic relationships of the plant (Bacha *et al.,* 1997). A balanced fertilization program with macro and micronutrients in plant nutrition is very important in the production of high yield with high quality products (Sawan *et al.*, 2001). Soylu *et al.* (2005) reported significant increase in number of spikes.m^{-2} in wheat with foliar application of different micronutrients individually or in combination. Guenis *et al.* (2003) reported marked increase in number of grains $spike^{-1}$ of wheat for foliar application of boron. Soleimani (2006) reported increase in biological yield for foliar application of Zinc. Each element of micronutrients has its own function in plant growth for example. Potarzycki and Grzebisz (2009) concluded that Zinc exerts a great influence on basic plant life processes, such as nitrogen metabolism, uptake of nitrogen and protein quality, photosynthesis, chlorophyll synthesis and carbon anhydrase activity. Romheld and Marachner (1995) reported that Zn-deficient plants reduce the rate of protein synthesis and protein content drastically. They also stated that Mn is required for enzyme activation, oxygen carrier in nitrogen fixation and it is required for enzyme activation, in photosynthesis electron transport chain and disease resistance.

The aim of the present study was to test application of macronutrients (NPK) and micronutrient (Fe, Mn, Zn, Cu) on grain yield, biological yield, yield component and some physiological characteristics of bread wheat cultivars.

Material and methods

This experiment was conducted Seed and Plant Improvement Institute at karaj with geographical longitude of 50 °, 58´ East and geographical latitude 35°, 56´ North with 1321m asl during 2010- 2012. The experimental soil used was loamy in texture (sand 36%, silt 40% and clay 24%), pH 7.76, EC 1.62 $dS.m^{-1}$, OC 0.49%, P 6.6 ppm, K 240 ppm, Fe, Mn, Zn and Cu ppm were 1.36, 4.08, 0.36 and 1.02, respectively.

This research was carried out in split plot using Randomized Complete Block Design, with three replications. The main plots were allocated to nutrition management including: Without fertilizer (F_0), macronutrient application (F_1) and macro nutrient plus micronutrient application (F_2) and bread wheat cultivars (Parsi, Marvdasht and Pishtaz) assigned to sub plots. Each part was consisted of 12 rows with 20 cm distance between the rows. The length of each plot was 5 meters and its width was 2.4 meters. Nitrogen was applied according to the amount of 150 kg ha^{-1} of net nitrogen from urea in three equal splits at planting, tillering and stem elongation stages. Phosphorus (P) at 100 kg ha^{-1} and potash (K) at 50 kg ha^{-1}were applied according to wheat requirement. Micro fertilizers were applied before sowing according to soil test recommendations (50 kg ha^{-1} Ferric Sulfate, 40 kg ha^{-1} Manganese Sulfate and 40 kg ha^{-1} Zinc Sulfate). Planting the seeds was carried out in 25- 30 October. The first irrigation was performed immediately after planting and during the growing period totally in seven times according to the plant need. Flag leaf area index, plant height and flag leaf chlorophyll (SPAD) were measured at flowering stage.

At physiological maturity stage, the inner six rows of each sub plot harvested to estimate grain yield, while sub sample of one meter square was obtained for determining yield components characteristics vs.

1000 kernels weight (g), kernel per spike and spikes per unit area, biological yield and harvest index.

The SAS software was employed to statistically analyze the data and to compare the means using DMRT at 5% and 1% levels of probability.

Results and discussion

Plant height

Results showed that the nutrition management and cultivar had significant effects at 1% probability level on plant height (table 1). The maximum (100.1 Cm) and minimum (88.1 Cm) were recorded for F_2 and F_0, respectively (table 2). Macronutrients specially nitrogen increased plant height through elongation of internodes. Several authors (Kumar and Agarwal, 1990; Lorzadeh, 1993) have reported direct relationship between nitrogen application and plant height. To describe the relationship between plant height and applied nitrogen, a model was worked out by regression analysis and the least squares procedure (Moghaddam, 1999). The obtained model was as:

Plant height = 87.131+ 0.265 N-0.001 N2 r^2=0.99

Where plant height in Cm and nitrogen in kg.ha^{-1}.

Table 1. Combined Anova results for grain yield, yield component and some physiological characteristics in two crop seasons (2010-2012).

S.O.V.	d. f	1000 kernel weight	Kernels. Spike^{-1}	Spikes. m^{-2}	Grain yield	Biological yield	Harvest index	Plant height	Flag leaf SPAD	Flag leaf area
Year	1	269.3**	85.63*	19873ns	6942353*	1500333ns	0.0104ns	80.67ns	1.08ns	1.59ns
Rep (y)	4	11.12	4.18	8398	1021258	5801039	0.0033	13.72	4.78	1.06
Fertilizer	2	23.73ns	109.5**	132243*	52311637*	190185450**	0.0163**	75.4**	162.9**	90.1**
Y. x F.	2	27.26ns	5.29ns	23553ns	1104124ns	8859036ns	0.0006ns	0.17ns	1.46ns	1.31ns
Error$_1$	8	12.58	12.46	24974	794669	8303179	0.0012	0.58	1.83	4.01
Cultivar	1	642.5**	111.5**	7041ns	1193426ns	14684166*	0.0084**	280.7**	5.16ns	38.79**
C. x F.	2	6.35ns	3.38ns	2689ns	1056027*	3815603ns	0.0005ns	0.52ns	7.28*	1.76ns
C. xY.	1	7.75ns	6.35ns	18188ns	567176ns	2520118ns	0.0009ns	1.02ns	1.06ns	2.25ns
C. xY. x F.	2	2.19ns	3.93ns	4509ns	522542ns	5230819ns	0.0018ns	1.080*	2.23ns	2.51ns
Error$_2$	12	5.36	3.84	5577	262498	3256218	0.0011	0.35	2.54	1.67
C. V.%		5.5	8.1	10.2	7.1	8.6	9.5	7.5	3.5	12.7

* and **: Significant at the 5% and 1% probability levels, respectively.

ns: Not-significant.

Flag leaf area

As indicated in table 1, effect of nutrition management and cultivar on flag leaf area were significant at 1% probability level. The highest flag leaf area was obtained by treatment of F_2 treatment with mean of 11.72 Cm^2 (Table 2). Also the highest flag leaf area was recorded in Pishtaz CV. (11.41 Cm^2).

Flag leaf chlorophyll content

Results showed that the nutrition management had significant effect at 1% probability level on flag leaf chlorophyll content (Table 1). The highest flag leaf chlorophyll content was recorded in F_1 treatment (Table 2). As indicated in table 1, cultivar effect was not significant on flag leaf chlorophyll content.

Thousand kernel weight

According to the Anova result, effect of nutrition management on thousand kernel weight was not significant, but cultivars had significant effect at 1% probability level on thousand kernel weight (Table 1). As indicated in table 2, the highest thousand kernel weight was recorded from Parsi cv. with 46.7 g (Table 2). In this regard, researchers reported that thousand kernel weight was affected by genetic traits, potential kernels in spike, kernel competition as main sink, kernel filling period and environmental conditions before and after anthesis (Shanahan *et al.,* 1984). The correlation analysis showed that thousand kernel weight had a positive correlation with harvest index (Table 3). Similar findings were also reported by several researchers showing significant positive correlation of harvest index and thousand kernel weight (Cattivilli *et al*., 2001).

Table 2. Mean comparison for grain yield, yield component and some physiological characteristics in two crop seasons (2010-2012).

Treatment		1000 kernel weight(g)	Kernels. Spike^{-1}	Spikes. m^{-2}	Grain yield (kg. ha^{-1})	Biological yield (kg. ha^{-1})	Harvest index	Plant height (cm)	Flag leaf SPAD	Flag leaf area (cm^2)
Fertilizer	F_0(control)	43.3 a	21.2 b	633 b	5395 b	17359 b	0.31 b	88.1 b	43.9 b	7.45 b
	F_1(Macronutrient)	41.6 a	25.4 a	761 a	8020 a	22397 a	0.36 a	98.2 a	50.0 a	10.94 a
	F_2(Macro plus	41.1 a	25.6 a	795 a	8592 a	23437 a	0.37 a	100.1 a	49.6 a	11.72 a
Cultivar	C_1 (Parsi)	46.7 a	22.5 b	730 a	7607 a	20773 b	0.36 a	95.2 a	47.5 a	8.86 c
	C_2 (Marvdasht)	35.3 c	26.9 a	710 a	7095 b	22077 a	0.32 b	99.5 a	47.6 a	9.85 b
	C_3 (Pishtaz)	44.0 b	22.8 b	749 a	7304	20342 b	0.36 a	91.6 c	48.4 a	11.41 a
F x C	F0 x C1	48.2 a	19.0 c	627 c	5089 d	16084 d	0.32 cd	87.5 h	44.8 c	6.59 f
	F0 x C2	36.8 c	24.7 b	614 c	5400 d	15584 c	0.29 d	92.2 g	43.2 c	7.44 ef
	F0 x C3	44.9 b	20.0 c	658 bc	5696 d	17409 cd	0.33 cd	84.5 i	43.6 c	8.33 de
	F1 x C1	46.3 ab	24.5 b	744 ab	8515 b	22390 ab	0.38 ab	98.0 d	49.0 b	9.38 cd
	F1 x C2	35.0 c	28.3 a	762 a	7820 c	22384 ab	0.34 bc	102.3 b	49.4 b	10.50
	F1 x C3	43.5 b	23.5 b	776 a	7724 c	21417 b	0.36 abc	94.2 f	51.6 a	12.93 a
	F2 x C1	45.6 ab	24.0 b	818 a	9217 a	23845 a	0.39 a	100.2 c	48.8 b	10.60
	F2 x C2	34.0 c	27.8 a	754 a	8066	24264 a	0.34 bc	104.0 a	50.0 ab	11.61 ab
	F2 x C3	43.7 b	24.8 b	815 a	8493 b	22202 ab	0.38 ab	96.2 e	50.1 ab	12.98 a

Means, in each column, followed by at least one letter in common are not significantly different at the %5 probability level-using DMRT.

Table 3. The correlation coefficient of yield and other traits in two crop seasons (2010-2012).

Trait	Grain yield	Biological yield	1000 kernel weight	Spike. m^{-2}	Kernel. spike^{-1}	Harvest index	Plant height	Flag leaf SPAD	Flag leaf area
Grain yield	1								
Biological yield	0.79**	1							
1000 kernel weight	0.03	-0.35*	1						
Spike. m^{-2}	0.64**	0.57**	0.29	1					
Kernel. spike^{-1}	0.54**	0.58**	-0.44	0.12	1				
Harvest index	0.71**	0.13	0.41**	0.36**	0.23	1			
Plant height	0.67**	0.75**	-0.53**	0.37*	0.62**	0.25	1		
Flag leaf SPAD	0.73**	0.68**	-0.12	0.55**	0.41**	0.42**	0.63**	1	
Flag leaf area	0.58**	0.50**	-0.12	0.56**	0.31*	0.39**	0.46**	0.70**	1

Kernels per spike

Results showed that the nutrition management and cultivar had significant effect at 1% probability level on kernel per spike (Table 1). Mean comparison showed that F_2 and F_0 treatments produced the highest and the lowest kernels per spike with mean of 25.6 and 21.2 kernels per spike, respectively. Thus Marvdasht CV. produced the highest kernels per spike among cultivars (Table 2). Similar finding was also reported by Rehman *et al.* (2008) stating that grains. spike^{-1} was significantly increased with each increment of NPK fertilizer. Further results showed a positive correlation between the numbers kernels per spike is functioning (Table 3). Similar finding was also reported by PvrsyahyBidi (1997) indicating a positive correlation between grain yield and kernels per spike.

Spikes per square meter

Results in the table 1 indicated that the nutrition management had significant effect at 5% probability level on spikes. m^{-2}, but effect of cultivar was not significant on this trait. Mean comparison showed that F_2 and F_0 treatments produced the highest and the lowest spikes. m^{-2} with mean of 795 and 633, respectively. Significant increase in spikes. m^{-2} with the application of different levels of N, NP and NPK combinations has been reported by Iqtidar *et al.*

(2006). Based on the results of correlation analysis, positive correlation of spikes. m^{-2} with the traits of grain yield, biological yield, kernels per spike, height, flag leaf chlorophyll, flag leaf area and harvest index was also observed (Table 3).

Grain yield

According to combined Anova results (Table 1), the effect of nutrition management showed significant differences at 5% probability level on grain yield of wheat cultivars. The highest grain yield was recorded of F_2 treatment (8592 kg.ha^1). The lowest grain yield was recorded from control (4150 kg.ha^1) treatment (Table 2). Similar findings were also reported by Zeidan *et al.* (2010). Although, Parsi CV. recorded higher grain yield (7607 kg. ha^{-1}), the differences between three cultivars were not statistically significant (Table 1). The correlation analysis showed that grain yield trait had positive correlation with biological yield, spikes. m^{-2}, kernels per spike, harvest index, plant height, flag leaf chlorophyll content and flag leaf area (Table 3). This experiment were in accordance with the results of other researchers showing significant positive correlation of grain yield and harvest index had (Cattivilli *et al.,* 2001).

Biological yield

The results of analysis of variance showed that effects of nutrition management and cultivar were significant on biological yield (Table 1). Mean comparison effect showed that the highest biological yield obtained from treatment of F_2 with the mean of 23437 kg. ha^{-1} (Table 2). With due attention to this subject that plant vegetative growth and biological yield has much dependence to consumption of chemical fertilizers, application of these fertilizers led to increasing biological yield of wheat. The results showed that Marvdasht CV. had the highest biological yield (22077 kg. ha^{-1}) and the lowest biological yield was obtained from Pishtaz CV. (20342 kg. ha^1). The correlation analysis showed that biological yield had a positive correlation with grain yield, kernels per spike, Spikes. m^{-2}, harvest index, plant height, flag leaf chlorophyll content and flag leaf area (Table 3). Sinebo (2002) reported that biological yield had the highest correlation with grain yield.

Harvest Index

According to combined Anova results, the effects of nutrition management and cultivars showed significant differences at 1% probability level on harvest index (Table 1). Mean comparison results showed that F_2 and F_0 treatments produced the highest and the lowest harvest Index with mean of 0.37 and 0.31, respectively (Table 2). Although Parsi and Pishtaz CV. had the highest harvest index percentages (0.36), the lowest harvest index was obtained from Marvdasht CV. (0.32).

Conclusion

Although, the effects of nutrition management treatments had significant differences on grain yield but the differences between macronutrient and macro plus micronutrient application was not significant. According to the anova results the fertilizer effect was significant for all the studied characteristics except thousand kernel weight. Results of this experiment were in accordance with the results of other researcher showing significant positive correlation of grain yield and harvest index.

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