Journal of Crop Nutrition Science
ISSN: 2423-7353 (Print) 2322-3227 (Online)
Vol. 1, No. 2, 2015
http://JCNS.iauahvaz.ac.ir
OPEN ACCESS

Evaluation of Nitrogen Fertilizer on Yield and Yield Components of Bread and Durum Wheat Genotypes

Fatemeh Torfi*

MSc. in Agronomy, Agricultural Jihad Organization, Khuzestan, Iran.

RESEARCH ARTICLE

ARTICLE INFO.
Received Date: *5 Apr. 2015*
Received in revised form: *6 May. 2015*
Accepted Date: *4 Jun. 2015*
Available online: *1 Jul. 2015*

To Cite This Article:
Fatemeh Torfi. Evaluation of Nitrogen Fertilizer on Yield and Yield Components of Bread and Durum Wheat Genotypes. ***J. Crop. Nut. Sci., 1(2),*** *49-57, 2015.*

ABSTRACT

The present study aimed at investigating the effect of different levels of nitrogen on yield and yield components of bread and durum wheat. To this end the experiment was conducted in 2010-2011 in south west of Iran as split plots based on randomized complete block design with three replications. Main plot included four levels of nitrogen 60, 120, 180, 240 kg.ha^{-1} and the sub plot included four wheat genotypes (Chamran, S-85-19, Dena, and Behrang). The results showed that effect of nitrogen fertilizer on biological yield and grain yield was significant at 1% level and on the number of spike per area unit, number of spikelet per spike, number of grain per area unit, 1000-grain weight, and harvest index at 5% probability level was significant. The highest grain yield and biological yield by 554.60 and 1271 g.m^{-2}, belonged to treatment with application of 240 kg.ha^{-1} nitrogen, respectively. The highest harvest index by 46.71% belonged to the control treatment. Finally, the results indicated that among the genotypes, the highest number of grains per spike by 30 grain belonged to Dena cultivar and highest grain yield, biological yield, and harvest index by 524.34, 1168.80 g.m^{-2}, and 45.42% belonged to Chamran cultivar, respectively.

Keywords: *Grain yield, Harvest index, Nitrogen, Triticum aestivum* L.

INTRODUCTION

Adequate soil fertility is one of the main requirements to increase the wheat production and nitrogen is the most restricting factor of nutrients in grain yield (Davis *et al*., 2002, Spiertz, 2010). Among the chemical fertilizers, a high correlation reported between nitrogen and the grain yield (Giovanni *et al*., 2004). Nitrogen guarantees growth and acceptable wheat production through development of vegetative growth. Nitrogen use in the wheat crop leads to increase number of tillers, leaf area development, number of grain per spike, carbohydrates and grain protein (Modhej, 2011). In wheat farming usually, for the each 20 to 30 kg of produced grain, 1 kg nitrogen is added to the soil. Therefore, the agricultural operations and environmental conditions affect efficiency of nitrogen use (Morris *et al*., 2005). Cultivars response to nitrogen is also different (Lack *et al*., 2009).

***Corresponding Author**: Fatemeh Torfi * f.torfi@yahoo.com

It seems like that the review of appropriate management of nitrogen consumption in wheat, in such a way that in addition to the yield potential emergence it provides the opportunity to enhance the qualitative properties, is highly the important because different levels of nitrogen fertilizer during the consumption are the main factors to obtain high yield and to increase protein content and to develop quality index (Lopez – Bellido, *et al.*, 1998, Grant *et al*., 2001). In studies conducted on the effects of different amounts of nitrogen on grain yield in different wheat genotypes, among the experimental treatments including wheat genotypes and nitrogen fertilizer in two levels (50 and 150 kg), response to nitrogen in Chamran and Showa genotypes was more than that of Falat genotype. Kirda *et al*. (2001) reported that reduction of nitrogen significantly reduced the grain yield, so that this trait in treatments with 50 and 100 kg nitrogen reduced by 41% and 21% respectively, compared with 150 kg nitrogen. Garrido-Lestache *et al*. (2004) stated that decrease of grain yield under nitrogen deficit stress compared with optimal nitrogen is due to the reduction of the number of spikes per square meter, the number of grain per spike and grain weight. Palta *et al*. (2004) reported that at high levels of nitrogen, grain development is mainly done through the stored hydrocarbons before the pollination. Bahrani and Tahmasebi (2006) reported that consumption of 160 $kg.ha^{-1}$ nitrogen with split application in two or three times could increase the yield in both bread wheat and durum wheat. Ehdaie and Waines (2001) stated that reduction of nitrogen fertilizer from 170 to 105 $kg.ha^{-1}$ reduced the mean of grain yield in genotypes of bread wheat and durum wheat in optimal sowing date compared with late matured genotypes. Therefore the nitrogen elements consumption decreases, nitrogen use efficiency increases (Biswas and Mukkherejee, 2007, Greef, 1994, Mousavi *et al*., 2012). This research was conducted to achieve effect of nitrogen fertilizer on grain yield and yield components of bread and durum wheat genotypes.

MATERIALS AND METHODS

Field and treatment information

This experiment was conducted to evaluate the effect of different levels of nitrogen fertilizer on grain yield and yield components of four wheat genotypes in 2010-2011 in Ahvaz city in south west of Iran. Experimental site located at altitude 31° 36' N and longitude 48° 53' E and 51 m above the sea level. Experiment was carried out as split plots on basis of randomized complete block design with three replications. Four levels of nitrogen fertilizer as main plots and genotypes of bread and durum wheat as sub plots were examined. Nitrogen as the main factor in four levels (N_1=60, N_2=120, N_3=180, N_4=240 $kg.ha^{-1}$ pure nitrogen) and control (N_0) were supplied by the urea source of 0.46. Nitrogen fertilizer was consumed twice (a half during the greening and the rest during the stem elongation) equally. Wheat genotypes including bread and durum wheat as the sub treatment were considered in 4 levels as V_1: Behrang (durum variety), V_2: $S_{85\text{-}19}$ (bread line), V_3: Chamran (bread variety) and V_4: Dena (durum variety). Each sup plot with length of 2.5 m and width of 3.5 included 8 planting lines. Distance between two sub plots was 0.4 m and each main plot was separated from adjacent main plot with a string of 1.5 m. To determine soil properties of field, sampling test was done before sowing. Results of soil analysis are shown in Table (1).

Table 1. Physical and Chemical properties of the field soil before planting

Soil depth (cm)	Ec ($ds.m^{-1}$)	pH	Absorbable elements (ppm)			Soil tissue components (%)			Soil type
			Total nitrogen	Phosphorus	Potassium	Clay	Silt	Sand	
0-20	2.7	8.1	740	16.1	210	38.5	44	17.5	Slit clay loam
20-40	2.4	8	380	7.2	120	44.3	42	13.7	

Traits measure

Grain yield and yield components including the number of spikelet per spike, grains per spike, 1000-grain weight, biological yield, and harvest index were studied.

Statistical analysis

Data analysis of variance was done using SAS software (Ver. 8) and the means were compared using Duncan's multi range test at 5% probability level.

RESULTS AND DISCUSSION

Biological Yield

The ANOVA results showed that the effect of nitrogen, different genotypes, and their interactive effect on biological yield was significant at 1% probability level (Table 2). The highest biological yield belonged to 240 $kg.ha^{-1}$ nitrogen and the lowest one belonged to the control treatment (Table 3). Among the genotypes, the highest biological yield belonged to Chamran and Dena genotypes, respectively and the lowest one belonged to line S-85-19 (Table 3). The interactive effect results showed that the highest biological yield belonged to Chamran genotype with 180 $kg.ha^{-1}$ nitrogen and the lowest one belonged to the S-85-19 and control treatment (Table 4). Since consumption of nitrogen fertilizer affects biochemical interactions, photosynthesis, increase of vegetative growth period, and more dry matter accumulation in shoots and grain yield, more consumption of nitrogen enhances dry matter production and increases final dry matter at the end of growth stage (Faraji *et al*., 2006, Jamaati and Zabihi, 2011). As the number of spikelet and the number of grains per spike increased, biological yield increased, too. The results were consistent with the findings of Sayedrahmani (2003).

Grain Yield

The effect of nitrogen on grain yield was significant at 1% level, and the effect of different genotypes and the interactive effect of fertilizer and genotype on grain yield were significant at 5% probability level (Table 2). Mean comparison results showed that in nitrogen fertilizer treatments, the highest grain yield belonged to 240 $kg.ha^{-1}$ nitrogen and the lowest one belonged to 60 $kg.ha^{-1}$ nitrogen (Table 3). Among the genotypes, the highest grain yield belonged to Chamran and Behrang genotypes and the lowest one belonged to line S-85-19 (Table 3). The results of the interactive effect of genotype and fertilizer showed that the highest grain yield belonged to Dena genotype with 120 $kg.ha^{-1}$ nitrogen and the lowest belonged to Behrang genotype and application of 60 $kg.ha^{-1}$ nitrogen fertilizer (Table 4). The increase of the grain yield resulted from the increase of nitrogen consumption due to the increase of yield components particularly the number of fertile spikes per square meter (Palta *et al*., 2004). The results were consistent with the findings of Cassman and Bryant (2002), Whingwiri and Kemp (2010), Bahrani and Tahmasebi (2006).

Table 2. The ANOVA results effect of nitrogen and genotypes on measured traits

S.O.V	df	Biological yield	Grain yield	Harvest index	Number of spikelet per spike	Number of grains per spikelet	Number of grain per spike	Number of grain per m^2	1000-Grain weight
Replication	2	1973^{ns}	15173^{ns}	94.68^{ns}	14.6^{ns}	0.45^{ns}	22.90^{ns}	789395^{ns}	14.90
Nitrogen	4	148058**	44569**	184.84*	118.0*	0.22^{ns}	79.20**	996645*	10.50^{ns}
Error a	8	278^{ns}	2218^{ns}	18.19^{ns}	38.4	0.07	11.10	4401451	7.07
Genotypes	3	21361**	31876*	160.92**	1157.0**	0.28^{ns}	69.60*	200088**	274.00**
Nitrogen * Genotypes	12	3612**	92376*	706.87**	124.0^{ns}	0.24^{ns}	172.30**	581174^{ns}	32.90^{ns}
Error b	30	281	3516	29.73	287.0	0.17	13.30	912599	46.10
CV (%)	-	11.49	12.23	12.80	8.6	7.9	11.8	12.9	7.4

**, * significant difference at 1% and 5% probability level ns: non-significant difference, respectively.

Table 3. Mean comparison effect of nitrogen and genotypes on measured traits

Treatments	Biological yield (g.m^{-2})	Grain yield (g.m^{-2})	Harvest index (%)	Number of spikelet per spike	Number of grains per spikelet	Number of grains per spike	Number of grains per m^2	1000-Grain weight
Nitrogen (kg.ha^{-1})								
Control	972^{e}	444^{d}	46.71^{a}	7^{d}	1^{c}	18^{d}	9233^{d}	29.1^{d}
60	1050^{d}	411^{e}	37.69^{e}	10^{c}	1^{c}	21^{c}	1100^{c}	32.0^{c}
120	1100^{c}	450 ^{c}	39.50^{d}	12^{b}	2^{b}	25^{b}	14400^{ab}	32.0^{c}
180	1190^{b}	525^{b}	43.70^{b}	14^{a}	3^{a}	31^{a}	14800^{a}	34.3^{a}
240	1271^{a}	554^{a}	41.40^{c}	14^{a}	3^{a}	29^{a}	14000^{b}	33.0^{b}
Genotypes								
Dena	1163^{b}	455^{b}	39.26^{d}	13^{a}	3^{a}	30^{a}	15000^{b}	34.0^{b}
Chamran	1168^{a}	524^{a}	45.42^{a}	12^{b}	3^{a}	25^{c}	18967^{a}	28.2^{d}
S-85-19	1086^{d}	432^{c}	41.10^{c}	7^{c}	2^{b}	21^{d}	13700^{c}	30.0^{c}
Behrang	1130^{c}	524^{a}	43.20^{b}	12^{b}	1^{c}	27^{b}	11567^{d}	37.9^{a}

Means with common letters in each column are not significantly different at 5% probability level.

Table 4. Interactive effect results of fertilizer and genotypes on measured traits

Fertilizer ($kg.ha^{-1}$)	Genotype	Biological yield ($g.m^{-2}$)	Grain yield ($g.m^{-2}$)	Harvest index (%)	Number of spikelet per spike	Number of grains per spikelet	Number of grain per spike	Number of grains per m^2	1000-Grain weight
Control	**Dena**	1031^{f}	330^{e}	31.9^{e}	7^{h}	2^{b}	17^{f}	9244^{k}	30^{f}
Control	**Behrang**	1016^{f}	369^{d}	38.5^{d}	6^{i}	1^{c}	14^{i}	9211^{k}	30^{f}
Control	**Chamran**	1035^{e}	423^{d}	41.0^{a}	7^{h}	2^{b}	15^{h}	9255^{i}	28^{h}
Control	**S-85-19**	987^{g}	475^{cd}	48.0^{b}	5^{j}	1^{c}	18^{e}	9229^{j}	29^{g}
60	**Dena**	1154^{c}	400^{d}	35.0^{vd}	11^{d}	2^{b}	17^{f}	1111^{g}	32^{d}
60	**Behrang**	1122^{d}	410^{d}	36.5^{e}	9^{f}	1^{c}	16^{g}	1105^{g}	33^{c}
60	**Chamran**	1156^{c}	500^{bc}	43.2^{d}	10^{e}	2^{b}	20^{d}	1120^{g}	30^{f}
60	**S-85-19**	1063^{e}	433^{cd}	40.7^{b}	8^{g}	1^{c}	23^{c}	1098^{h}	31^{e}
120	**Dena**	1206^{b}	450^{cd}	37.3^{b}	12^{c}	2^{b}	30^{a}	14407^{c}	32^{d}
120	**Behrang**	1167^{c}	596^{b}	52.0^{b}	11^{d}	1^{c}	30^{a}	14380^{d}	33^{c}
120	**Chamran**	1223^{a}	530^{bc}	43.3^{e}	12^{c}	2^{b}	28^{ab}	14501^{c}	30^{f}
120	**S-85-19**	1103^{d}	520^{bc}	47.1^{de}	10^{e}	2^{b}	26^{b}	14390^{d}	31^{e}
180	**Dena**	1234^{a}	590^{b}	49.3^{bc}	14^{a}	3^{a}	26^{b}	14850^{a}	34^{b}
180	**Behrang**	1222^{ab}	610^{a}	49.9^{ab}	13^{b}	1^{c}	28^{ab}	14790^{b}	35^{a}
180	**Chamran**	1238^{a}	554^{bc}	45.3^{c}	14^{a}	2^{b}	28^{ab}	14940^{a}	32^{d}
180	**S-85-19**	1117^{d}	500^{bc}	44.7^{e}	12^{c}	2^{b}	26^{b}	14804^{a}	33^{c}
240	**Dena**	1182^{c}	430^{cd}	36.3^{e}	14^{a}	3^{a}	31^{a}	14040^{e}	32^{d}
240	**Behrang**	1157^{c}	490^{c}	42.3^{b}	12^{c}	2^{b}	28^{ab}	140011^{e}	33^{c}
240	**Chamran**	1175^{c}	491^{c}	41.7^{b}	13^{b}	3^{a}	20^{d}	14060^{e}	31^{e}
240	**S-85-19**	855^{h}	466^{c}	36.8^{d}	12^{c}	3^{a}	26^{b}	130990^{f}	32^{d}

Means with common letters in each column are not significantly different at 5% probability level.

Harvest index

The effect of nitrogen and different genotypes on the harvest index was significant at 5% level, and their interactive effect on harvest index was significant at 1% level (Table 2). The mean comparison results showed that in the nitrogen fertilizer treatments, the highest harvest index belonged to the control and the lowest one belonged to 60 $kg.ha^{-1}$ nitrogen (Table 3). As the nitrogen levels increased the vegetative growth increased; therefore, the ratio of economic yield to biological yield decreased. The results were consistent with the findings of Faraji *et al*. (2006). Among the genotypes, the highest harvest index belonged to Chamran genotype which was statistically placed in the same group with Behrang genotype, and the lowest one belonged to Dena genotype (Table 3). Higher grain yield of Chamran genotype than the other genotypes has led to the increase of harvest index in that genotype. Therefore, Chmran genotype was superior to the other genotypes in terms of assimilates mobilization into grains. The reverse was true for Dena genotype. The results were consistent with the findings of Faraji *et al*. (2006).

Number of Spikelet per Spike

The ANOVA results showed that the effect of nitrogen on the number of spikelet per spike was significant at 5% level, and the effect of different genotypes on the number of spikelet per spike was significant at 1% level (Table 2). Mean comparison results showed that in nitrogen fertilizer treatments, the highest number of spikelet per spike belonged to 180 and 240 $kg.ha^{-1}$ nitrogen and the lowest one belonged to the control treatment (Table 3). Among the genotypes, the highest number of spikelet per spike belonged to Dena genotype and the lowest number one belonged to line S-85-19 (Table 4). The results were consistent with the findings of Mainard and Jeuffroy (2001).

Number of Grain per Spikelet

The effect of nitrogen, different genotypes, and their interactive effect on number of grain per spikelet were not significant (Table 2). The mean comparison results showed in nitrogen fertilizer treatments, the highest number of grains per spikelet by 3 grains belonged to treatments with application of 180 $kg.ha^{-1}$ nitrogen and the lowest number of grains per spikelet by 1 grain belonged to treatment with application of 60 $kg.ha^{-1}$ nitrogen fertilizer (Table 3). Among genotypes, the highest number of grains per spikelet belonged to Dena genotype and the lowest number of grains per spikelet belonged to Behrang genotype. This trait is affected by genetic characteristics of the plant (Naderi, 2000, Shekoofa and Emam, 2008).

Number of Grains per Spike

The ANOVA results showed that the effect of nitrogen fertilizer and interactive effect of fertilizer and genotype on number of grain per spike were significant at 1% level and the effect of different genotypes on the number of grain per spike was significant at 5% level (Table 2). Mean comparison results showed that in nitrogen fertilizer treatments, highest number of grain per spike belonged to 180 $kg.ha^{-1}$ nitrogen and the lowest one belonged to the control treatment (Table 3). Among the genotypes, the highest number of grains per spike belonged to Dena genotype and the lowest one belonged to line S-85-19 genotype (Table 3). The interactive effect showed that the highest number of grain per spike belonged to Behrang genotype and 240 $kg.ha^{-1}$ nitrogen and the lowest one belonged to Behrang genotype and control treatment (Table 4). According to the results, the number of grains per spike is more affected by nutritional and environmental factors than by plant genetic in wheat because as the nitrogen fertilizer increased, the number of grains per spike increased, too. The results were consistent with the findings of Modhej and Fathi (2008).

Number of Grain per Square Meter

The effect of nitrogen fertilizer on number of grains per square meter was significant at 5% level and the effect of different genotypes on this trait was significant at 1% level (Table 2). In nitrogen fertilizer treatments, highest number of grain per m^2 was belonged to 180 $kg.ha^{-1}$ nitrogen and the lowest one belonged to the control treatment (Table 3). Among the genotypes, the highest number of grain per m^2 grain belonged to Chamran genotype and the lowest one belonged to Behrang genotype (Table 3). High number of grain per m^2 due to the application of more nitrogen fertilizer could be associated with the fact that when the nitrogen availability increases, the rate of abortion of flowers and florets decrease and the number of grain per spike will increase. The results were consistent with the findings of Lopez-Bellido *et al*. (2000).

1000-Grain Weight

The ANOVA results showed that the effect of nitrogen fertilizer on 1000-grain weight was significant at 5% level and the effect of different genotypes on this trait was significant at 1% level, but the interactive effect of fertilizer and genotype on 1000-grain weight was not significant (Table 2). In nitrogen fertilizer treatments, the highest 1000-grain weight belonged to 180 $kg.ha^{-1}$ nitrogen and the lowest one belonged to control treatment (Table 3). Among the genotypes, highest 1000-grain weight belonged to Behrang genotype and the lowest one belonged to the Chamran genotype (Table 3). Durum genotypes including Behrang and Dena had higher grain weight than bread wheat because the weight of grain is mainly controlled by genetic (Kirda *et al*., 2001). The results were consistent with the findings of Giovanni *et al*. (2004). As nitrogen fertilizer increased up to 180 $kg.ha^{-1}$, 1000-grain weight increased too. It could be due to the fact that since the distribution of assimilates resulting from current photosynthesis or stored materials during the grain filling stage after flowering stage up to maturity stage determines grain weight during the harvest and on the other hand, since nitrogen fertilizer increases dry matter production and leaf area duration, the grain is expected to get heavier with the increase of the nitrogen consumption (Alcozen *et al*., 2003). Morris and Paulesn (2005) got the same results in this regard.

CONCLUSION

In general, results of the research showed that increase of nitrogen up to 100 $kg.ha^{-1}$ significantly increased the grain yield. The increase of grain yield due to the increase of the number of grains per spike and grain weight. The genotypes of bread (Chamran) and durum (Behrang) had the highest grain yield.

REFERENCES

Alcozen, F., M. Honz. and A. Haby. 2003. Nitrogen fertilization timing effect on wheat production, nitrogen uptake efficiency and residual soil nitrogen. Agron. J. 85: 1198-1203.

Biswas, T. D. and S. K. Mukkherejee. 2007. Test book of science. Tata McGraw- hill, Publishing Co. Ltd New Dehli. 13: 202- 209.

Bahrani, A. and Z. Tahmasebi. 2006. The effect nitrogen consumption rate and timing on yield. Yield components, and efficiency of the dry matter remobilization in two genotypes of winter wheat. J. Agric. Sci. 2: 369–376.

Cassman, K. G. and D. C. Bryant. 2002. Nitrogen supply effects on the partitioning of dry matter and nitrogen to grain of irrigated wheat. Crop Sci. 32: 251-255.

Davis, J. G., D. G. Westfall, J. J. Mortvedt. and I. F. Shanahan. 2002. Fertilizing the winter wheat (*Triticum aestivum* L.). Agron. J. 84: 1198-1203.

Ehdaie, B. and J. G. Waines. 2001. Sowing date and nitrogen rate effects on dry matter and nitrogen partitioning in bread and durum wheat. Field Crop Res. 73(1): 47-61.

Faraji, H., A. Siadat, Gh. Fathi, Y. Imam, H. Nadian. and A. Rasekh. 2006. The effect of nitrogen fertilizer on the yield of wheat under drought stress conditions at the end of growth stage. J. Agric. 29: 99–111.

Garrido-Lestache, E., R. J. Lopez-Bellido. and L. Lopez-Bellido. 2004. Effect of N rate, timing and splitting and N type on bread-making quality in hard red the spring wheat (*Triticum aestivum* L.) under the Mediterranean conditions. Field Crops Res. 85: 213-236.

Giovanni, G., P. Silvano. and D. Giovanni. 2004. Grain yield, nitrogen-use efficiency and baking quality of old and the modern Italian bred-wheat genotypes grown at different nitrogen levels. Euro. J. Agron. 34: 321-332.

Grant, C. A., K. R. Brown, G. J. Racz. and L. D. Bailey. 2001. Influence of the source, timing and placement of nitrogen on grain yield and nitrogen removal of durum wheat under reduced and conventional tillage management. Can. J. Plant Sci. 81: 17-27.

Greef, J. M. 1994. Productivity of maize in relation to the morphological and physiological characteristics under varying amounts of nitrogen supply. J. Agron. Crop Sci. 173: 317-2326.

Jamaati-e-somarin, Sh. and R. Zabihi mahmodabadi. 2011. Impacts of the Nitrogen Fertilizer and Plant Density Management on Growth, Dry Matter Remobilization and Yield of Durum Wheat. J. Res. Agric. Sci. 7(1): 37-46.

Kirda, C., M. R. Derici. and J. S. Schepers. 2001. Yield response and Ns. Fertilizer recovery of rained wheat growing in the Mediterranean region. Field Crops Res. 71: 113-122.

Lack, Sh., A. Modhej. and A. Enayat. 2009. Evaluating the effect of different levels of nitrogen on grain yield, pattern of the rate of singe distribution of assimilates in grain and leaf area index of flag in genotypes of the bread wheat and durum wheat in Ahvaz weather conditions. Proceedings of National Conf. Sci. Water. Soil. Plant. Agric. Mechanization.

Lopez- Bellido, L., R. J. Lopez-Bellido, J. E. Castillo. and F. J. Lopez- Bellido. 2000. Effects of tillage, crop rotation and nitrogen fertilization on wheat (*Triticum aestivum* L.) under the rainfed Mediterranean conditions. Agron. J. 91: 1054- 1063.

Lopez-Bellido, L., J. E. Castilo, M. Fuentes. and F. T. Lopezgarrido. 1998. Effects of tillage, crop rotation and nitrogen fertilization on the wheat-grain quality grown under rain fed Mediterranean conditions. Field Crops Res. 80: 36-71.

Mainard, S. D. and M. H. Jeuffroy. 2001. Partitioning of dry matter and nitrogen to the spike throughout the spike growth period in wheat (*Triticum aestivum* L.) crops subjected to nitrogen deficiency. Field Crop Res. 70: 153-165.

Modhej, A. and Gh. Fathi. 2008. The effect of Planting date and nitrogen fertilizer on yield, yield components, and protein percentage in durum wheat, Arya genotype. J. Res. Agric. 9: 17–35.

Modhej, A. 2011. The Relationship between physiological source and sink in wheat genotypes and triticale in Ahvaz environmental conditions. J. Agric. Res. 9: 258–264.

Morris, C. F. and G. M. paulesn. 2005. Development of the hard winter wheat after anthesis is affected by nitrogen. Crop Sci. 25: 1007-1010.

Mousavi, S. G., M. J. Seghatoleslami. and R. Arefi. 2012. Effect of N fertilization and plant density on yield and yield components of grain sorghum under climatic conditions of Sistan, Iran. Plant Ecophysiology J. 4: 141-149.

Naderi, A. 2000. Evaluation of genetic diversity and potential modeling of nitrogen and assimilates remobilization into grain in wheat genotypes under drought stress conditions, PhD. Thesis. Sci. Res. Branch. Islamic Azad Univ. (Abstract in English).

Palta, J. A., T. Kobata, N. C. Turner. and L. R. Filery. 2004. Remobilization of carbon and nitrogen in wheat as influenced by the post anthesis water deficits. Crop Sci. 34: 118-124.

Seyyedrahmany, S. 2003. Response of the durum wheat at different weed densities. Msc. Thesis in Agron. Faculty of Agric. Depart. Agron. Univ. Tabriz. 122 pp. (Abstract in English).

Shekoofa, A. and Y. Emam. 2008. Effects of nitrogen fertilization and plant growth regulators (PGRs) on yield of wheat (*Triticum aestivum* L.). J. Agric. Sci. Technol. 10: 101-108.

Spiertz, J. H. J. 2010. The nitrogen fertilizer, sustainable agriculture and the food security in all worlds. A review. Agron. Sustainable Develop. 30: 43-55.

Whingwiri, E. E. and D. R. Kemp. 2010. Spiklet development an response to applied nitrogen. Aust. J. Agric. Res. 31: 637-647.