Research Article

Improving Farmer's Income and Nitrogen Use Efficiency of Dry Land Wheat through Soil and Foliar Application of N-Fertilizer

Shahid Iqbal Khattak[1]*, Mohammad Safdar Baloch[1], Khalid Naveed[2] and Ejaz Ahmad Khan[1]

[1]Department of Agronomy, Faculty of Agriculture, Gomal University, Dera Ismail Khan, Pakistan; [2]Department of Agricultural Sciences, University of Haripur, Haripur, Pakistan.

Abstract | The current research study was conducted at "Agricultural Research Institute, D.I. Khan, Khyber Pakhtunkhwa (KP), Pakistan" during wheat crop season of 2013-14. The major aims of the study were to test the effect and economics of soil vs. foliar applied nitrogen fertilizer and nitrogen use efficiency on wheat variety Hashim-08. The experimental trial was conducted following RCB design with three replications. Fertilizer applications (foliar and soil) were assigned to main plots, while nitrogen levels 0, 24, 36, 48, 60 and 120 kg ha^{-1} were kept in sub plots. Results revealed that foliar application of N significantly ($P \leq 0.05$) affected plant height (89 cm), tillers m^{-2} (313), grains $spike^{-1}$ (48), 1000-grain weight (43.0 g) and economic yield (3760 kg ha^{-1}). Foliar applied nitrogen also produced higher nitrogen use efficiency, net return, value cost ratio and relative increase in income as compared to soil applied method. However, maximum grain protein content was recorded in soil applied method in comparison to foliar N application. In conclusion, higher results for all the quantitative parameters were observed at 120 kg N ha^{-1}.

Received | July 13, 2017; **Accepted** | June 10, 2017; **Published** | July 27, 2017
***Correspondence** | Shahid Iqbal Khattak, Department of Agronomy, Faculty of Agriculture, Gomal University, Dera Ismail Khan, Pakistan; **Email:** shahidktk_agronomy@yahoo.com
Citation | Khattak, S.I., M.S. Baloch, K. Naveed and E.A. Khan. 2017. Improving farmer's income and nitrogen use efficiency of dry land wheat through soil and foliar application of N-Fertilizer. *Sarhad Journal of Agriculture,* 33(3): 344-349.
DOI | http://dx.doi.org/10.17582/journal.sja/2017/33.3.344.349
Keywords | N fertilizer, Foliar application, Wheat, Yield, Value cost ratio and protein contents, Nitrogen use efficiency.

Introduction

Bread wheat holds prominent position among cereal crops, which is cultivated both in irrigated and rainfed areas of the country. Due to increasing population and decreased cultivated area due to urbanization and industrialization, the demand is increasing day by day. A large acreage lying in the central and southern part of the country is rain fed, including extreme northern mountains (Chaudhry and Rasul, 2004). Thus more emphasis on dry land wheat is needed to feed the ever increasing population of the country.

Dry land wheat due to shortage of irrigation water has various production constraints like drought stress, heat stress, salinity and no use of fertilizer. Among these production constraints, drought, heat and salinity are unpredictable factors, whereas fertilizer is predictable (under human control) factor and can be managed properly through foliar application.

Nitrogen (N) application as a foliar spray can significantly improve the crop growth and yield (Shahzad et al., 2013). In this regard, Raun and Johnson (1999) stated that application of N is essential because it is one of the principle constituents of enzymes and proteins. Therefore, different methods of N application significantly affect its concentration in grain and straw. Previous research findings showed that maximum wheat yield can be achieved with the highest dose of foliar nitrogen (Bakht et al., 2010; Yaseen et

al., 2010). The rate of N fertilizer; however, depends on available soil moisture followed by the precipitation of crop growing season (Stark et al., 2004).

Keeping in view that nitrogen fertilizer is the most important measures that improves grain yield and improves grain quality in wheat, the current research was designed to find out the most cost-effective method of nitrogen fertilizer application and appropriate dose for dry land wheat production.

Table 1: *Physico-chemical properties of the experimental site at sowing.*

Parameters	Units	Values
EC	(dSm^{-1})	1.26
pH	--	7.35
Organic matter	(%)	0.62
Extractable P	(mg kg^{-1})	4.2
Extractable K	(mg kg^{-1})	200
Texture class	--	Clay loam

Materials and Methods

To study the effect and economics of soil applied vs. foliar spray of N @ 0 kg, 24 kg (20% Recommended Fertilizer Dose: RFD), 36 kg (30% RFD), 48 kg (40% RFD), 60 kg (50% RFD) and 120 kg ha^{-1} (100% RFD) along with recommended levels of P_2O_5 (90 kg ha^{-1}) and K_2O (60 kg ha^{-1}) on wheat variety Hashim-08, an experiment was carried out at Agricultural Research Institute, Dera Ismail Khan, KP, Pakistan, during crop growing season of 2013-14. The geographical coordinates of the Agricultural Research Institute (experimental site) are 31°49′N 70°55′E with an altitude of 171 m, which is situated 06 kilometers north from the city of Dera Ismail Khan on main Bannu Road (Indus highway). The climate of Dera Ismail Khan is arid to semi-arid and sub-tropical continental. Mean annual rain fall ranges from 180 mm to 300 mm. In the month of July the temperature remained very high (more than 45°C). Nitrogen in the foliar form was sprayed 28 days after sowing whereas P & K were applied at the time of sowing. Similarly all of the soil applied N treatments along with P & K were applied at the time of sowing. Experimental design used was RCB with nitrogen doses split over nitrogen application methods having three repeats in a sub-plot size of 5m×1.8m. The physico-chemical analysis of soil before the experimentation is presented in Table 1. Metrological data consisting of air temperature, rainfall and relative humidity was recorded with the help of thermometer, rain gauge and dry and wet bulb psychometer, respectively (Table 2). To reduce the environmental error, standard agronomic necessities were fulfilled in all the treatments.

Table 2: *Monthly air temperature, relative humidity and rainfall of the experimental area for the year 2013-14.*

Month	Temp. (°C)		Humidity (%)	Rainfall (mm)
	Min	Max		
Nov. 2013	10	26	37	02
Dec. 2013	6	22	51	01
Jan. 2014	6	23	53	11
Feb. 2014	7	21	45	38
Mar.2014	12	24	49	50
Apr.2014	18	31	44	69
May 2014	22	36	30	8

Data on plant height (cm), tillers m^{-2}, grains $spike^{-1}$, 1000-grain weight (g), economic yield (kg ha^{-1}) were recorded as per standard procedures. Grain protein content (%) were analyzed using Modified Micro-Kjeldhal method as outlined by Piper (1966). Nitrogen use efficiency (%) was assessed by given formula (Semenov et al., 2007):

$$\text{NUE (kg grains kg}^{-1}\text{ nutrients)} = \frac{\text{Yield with nitrogen} - \text{Yield in control}}{\text{Nutrient (kg)}}$$

Moreover, value cost ratio (VCR) was calculated by formula:

$$\text{VCR} = \frac{\text{Value of increased yield obtained}}{\text{Cost of N}}$$

All the data were subjected to analysis of variance technique as suggested by Steel et al. (1997). Tukey's HSD Test (Gomez and Gomez, 1984) was used for means comparison when analysis of variance showed significant differences.

Results

Agronomic and Yield Attributes

Agronomic and yield related attributes (plant height, tillers m^{-2}, grains $spike^{-1}$, 1000-grain weight and economic yield) were investigated against methods of application, N levels and their interaction.

Plant Height (cm)

The data on plant height showed highly significant ($p \leq 0.01$) differences for N levels and significant

(p≤0.05) differences for application methods and interaction of N doses with methods of application (Table 3). The data showed that foliar applied method produced tallest (89 cm) plants as compared to soil applied method (Table 4). Among different N levels maximum plant height (93 cm) was obtained at 120 kg N ha^{-1} whereas the control produced minimum plant height of 73 cm. In interaction effects, taller plants were recorded (96 cm) at 120 kg N ha^{-1} through foliar application, which was statistically at par to foliar applied 60 kg N ha^{-1} (Table 4).

Number of Productive Tiller m^{-2}

Number of productive tillers m^{-2} revealed highly significant (p≤0.01) differences for application methods, N levels and their interaction (Table 3). The data indicated that increased nitrogen doses resulted in increased number of productive tillers. The highest number of productive tillers (313 m^{-2}) was obtained in foliar applied N in comparison to soil applied (Table 4). Similarly, maximum number of tillers (357) was recorded at 120 kg N ha^{-1}. In interaction effects maximum number of productive tillers (385) at 120 kg N ha^{-1} through foliar application was recorded. Control plots having no fertilizer manifested minimum number of tillers (213 m^{-2}) (Table 4).

Grains $Spike^{-1}$

Grains $spike^{-1}$ was also significantly influenced by application methods, N levels and their interaction (Table 3). Maximum grains $spike^{-1}$ (48) were recorded in foliar application method in comparison to soil applied method. Regarding N levels, maximum grains $spike^{-1}$ (52) were noted at 120 kg ha^{-1} while minimum were obtained in control plots (Table 4). The interaction among fertilizer application methods and rates showed that maximum grains $spike^{-1}$ (54) were recorded in foliar applied at 120 kg N ha^{-1}, while control plots had relatively less number of grains $spike^{-1}$.

1000-Grain Weight (g)

1000-grain weight was significantly (p≤0.01) affected by application methods, N levels and their interaction (Table 3). Maximum 1000-grain weight (43 g) was noted in foliar application method, while minimum (38.6 g) in soil applied method (Table 4). Fertilizer dose 120 kg N ha^{-1} had higher 1000-grain weight (44.5 g), while minimum (37.4 g) was recorded in control. In interaction effects, maximum 1000-grain weight of 45.8 g at 120 kg N ha^{-1} through foliar application was recorded which was statistically similar with 60 kg N ha^{-1}. Control plots showed minimum 1000-grain weight (Table 4).

Table 3: *Mean squares of the studied attributes as influenced by method of application and N levels.*

Source of variation	DF	Plant height	Productive tillers m^{-2}	Number of grains $spike^{-1}$	1000-grain weight	Grain yield
Rep	2	49.750	507.2	4.2019	0.203	183636
Method	1	312.111*	5650**	94.4136**	169.000**	4152765**
N level	5	289.867**	12068**	92.9636**	35.014**	5666646**
Method x N	5	5.711*	1561.8**	8.9436**	4.242**	311753**
Error	20	1.772	184	0.8531	0.107	67975

Table 4: *Agronomic and yield parameters.*

Treatments	Plant height (cm)			Productive tillers m^{-2}			Number of grains $spike^{-1}$			1000-grain weight (g)			Grain yield (kg ha^{-1})		
	Method*		M	Method*		M	Method*		M	Method*		M	Method*		M
	S	F		S	F		S	F		S	F		S	F	
Control	72 ^{i}	74 ^{i}	73 ^{e}	240 ^{f}	213 ^{f}	226 ^{e}	40 ^{g}	40 ^{g}	40 ^{e}	36.5 ^{h}	38.3^{ef}	37.4 ^{f}	1672 ^{f}	1697^{f}	1684 ^{e}
24 kg N ha^{-1}	82 ^{h}	88^{def}	85 ^{d}	281 ^{e}	289de	285 ^{d}	43 ^{f}	45 ^{e}	44 ^{d}	36.8^{gh}	41.9 ^{d}	39.4 ^{e}	2440 ^{ef}	3787^{bc}	3113 ^{d}
36 kg N ha^{-1}	83 ^{gh}	90 ^{cd}	87 ^{c}	283 ^{e}	311^{cde}	297^{cd}	45 ^{e}	46 ^{d}	46 ^{c}	37.8^{fg}	42.8 ^{d}	40.3 ^{d}	3024 ^{de}	3927^{abc}	3475 ^{cd}
48 kg N ha^{-1}	85 ^{fg}	92 ^{bc}	89 ^{b}	298^{cde}	323^{bcd}	311^{bc}	45 ^{e}	47 ^{c}	46 ^{c}	38.5^{ef}	44.1^{bc}	41.3 ^{c}	3373 ^{cd}	4115^{ab}	3744 ^{bc}
60 kg N ha^{-1}	87 ^{ef}	94 ^{ab}	90 ^{b}	304^{cde}	362 ^{ab}	333^{ab}	45de	52 ^{b}	49 ^{b}	39.1 ^{e}	44.9^{ab}	42.0 ^{b}	3653^{bcd}	4366^{ab}	4010 ^{b}
120 kg N ha^{-1}	89^{cde}	96 ^{a}	93 ^{a}	328 ^{bc}	385 ^{a}	357 ^{a}	49 ^{c}	54 ^{a}	52 ^{a}	43.2^{cd}	45.8 ^{a}	44.5 ^{a}	4323 ^{ab}	4670 ^{a}	4497 ^{a}
Mean	83 ^{b}	89 ^{a}		288 ^{b}	313 ^{a}		44 ^{b}	48 ^{a}		38.6 ^{b}	43.0 ^{a}		3081 ^{b}	3760 ^{a}	

S: *Soil;* **F:** *Foliar;* **M:** *Mean;* ***:** *Method of fertilizer applications; Mean followed by different letter(s) shows statistically significant variation at 5 % probability level.*

Table 5: *Quality and economics of the treatments.*

Treatments		Nitrogen use efficiency (%)	Grain protein content (%)	Net return (Rs)	Value cost ratio (Rs)	Relative increase in income (Rs)
Soil Applied N	Control	--	11.03	--	--	--
	24 kg N ha^{-1}	32.04	11.92	22678	12.75	362
	36 kg N ha^{-1}	37.56	11.45	40370	14.94	565
	48 kg N ha^{-1}	35.46	11.63	50605	14.11	683
	60 kg N ha^{-1}	33.03	11.95	58600	13.14	776
	120 kg N ha^{-1}	22.10	11.12	75216	8.79	973
Foliar Applied N	Control	--	10.70	--	--	--
	24 kg N ha^{-1}	87.08	10.14	64950	34.65	782
	36 kg N ha^{-1}	61.94	11.40	68466	24.66	820
	48 kg N ha^{-1}	50.40	10.38	73549	20.06	875
	60 kg N ha^{-1}	44.50	11.83	80616	17.71	950
	120kg N ha^{-1}	24.78	11.26	85220	9.86	1008

Grain Yield (kg ha^{-1})

Analysis of variance manifested highly significant differences ($p \leq 0.01$) for grain yield due to application methods, N levels and their interaction (Table 3). It was the highest (3760 kg ha^{-1}) in plots, treated with foliar application of N as compared to the soil applied which yielded 3081 kg ha^{-1} (Table 4). Similarly, the rates of N application showed significantly higher grain yield of 4497 kg ha^{-1} at 120 kg N ha^{-1}, while the control produced the lowest grain yield (1672 kg ha^{-1}). Interaction of N doses and its application methods produced maximum grain yield of 4670 kg ha^{-1} in foliar application method at 120 kg N ha^{-1}, while the control plots yielded the lowest grain yield (Table 4).

Nitrogen use Efficiency (%)

Nitrogen use efficiency (NUE) of N applied through foliar sprays and soil application are presented in Table 5. Higher NUE (87.08%) was recorded in plants treated with foliar spray than the soil applied at 24 kg N ha^{-1}. Lower NUE (22.10%) was recorded in soil applied treatments at 120 kg N ha^{-1}. The nitrogen use efficiency steeply linearly decreased with increasing N levels both in soil and foliar methods however, the decrease was more in soil applied method in comparison to foliar application.

Grain Protein Content (%)

Grain protein content of wheat determines the quality of wheat. In the present study, maximum grain protein contents were determined in soil applied treatment (60 kg N ha^{-1}) followed by the same application method using 24 kg N ha^{-1} (Table 5). Minimum grain protein contents were found in foliar applied (24 kg N ha^{-1}) treatment. The grain protein content fluctuated with the N levels and application methods, however more grain protein contents were found in soil applied method in comparison to foliar N application.

Economic Analysis

Economic analysis showed that higher net return of Rs. 85220 was obtained in foliar applied (120 kg N ha^{-1}) followed by the same dose of soil applied nitrogen (Table 5). Minimum net return (22678) was obtained in soil applied 24 kg N ha^{-1}. Overall the net return was more in foliar applied N in comparison to soil applied method. Similarly, the value cost ratio (VCR) and relative increase in income (RII) was also higher in foliar applied method as compared to soil applied. Maximum VCR (34.65) was recorded in foliar applied (24 kg N ha^{-1}) which steeply decreased with the increasing N levels. Maximum Relative Increase in Income (1008) was recorded in foliar applied method at 120 kg N ha^{-1}. Relative increase in income also shifted in the same fashion as of net return (Table 5).

Discussion

The present investigation depicted that foliar applied N enhanced the vegetative, reproductive and quality traits more efficiently as compared to soil applied method. Foliar application resulted in increased plant height which might be due to the rapid diffusion through stomata which might result in enhanced photosynthesis. These finding are in line with Jan et al. (2002) and Amjed et al. (2011) who also noted that maximum plant height was attained due to N fertilization. Enhanced vegetative growth after direct N

diffusion through leaves also resulted in more number of tillers. These findings are also in close conformity with the previous findings of Ling and Silberbush (2002), Oko et al. (2003), Saddiqui et al. (2008) and Bakht et al. (2010) who also recorded significant effect of foliar application on tiller production. Foliar application also resulted in more grain weight and ultimately grain yield on account of having enhanced plant height, more tillers and longer spikes in comparison to soil applied method. The results reported earlier by Defan et al. (1999) are in close proximity with our findings, who testified that foliar application method increased the grains spike^{-1} of wheat. Similarly, El-Metwally et al. (2010) reported that number of grains increased with increasing nitrogen levels. More grain weight and grain yield due to foliar application of N might be attributed to the readily availability of nitrogen which might enhanced vegetative growth of crop and accumulation of assimilates in the grains. Similar enhanced results due to foliar N application were recorded earlier by Guenis et al. (2003) and Soylu et al. (2005). It might also be due to the increased rate of assimilates accumulation in the grains, which resulted in higher grain yield. Similarly, Swenson et al. (2009) reported yield increase in wheat due to foliar spray of urea before booting stage. Warraich et al. (2002) also reported yield increase in wheat with corresponding increase in nitrogen dose. The nitrogen use efficiency increased with the nitrogen levels might be due to the maximum availability of N at higher levels for growth and development of crop. Foliar application of N is readily available to crop through stomata of leaves and attain maximum nitrogen use efficiency as compared to soil applied method. Ahmed et al. (2014) also reported maximum nitrogen use efficiency at higher levels of applied N. The maximum grain protein content in soil applied method might be due to the prolong availability of nitrogen to crop in soil applied method as compared to foliar applied. The extent of grain protein content increased significantly with increased N level, which might be resulted from maximum amount of N available to crop during crop growth period. Our findings are in line with the results of Cowell and Doyle (1993), who stated that maximum grain protein content requires consistent and prolonged availability of N through soil and increased N levels increased the grain protein content accordingly. In contrast, Selles et al. (1996) confirmed that foliar applied N may produce leaf burn and in turn caused reduction in grain protein content. The maximum net benefit value, VCR and RII in foliar applied method might be due to the readily available nitrogen for crop growth and development at higher N levels as compared to soil applied method. Shah et al. (2011) also reported maximum net return at higher levels of nitrogen.

Conclusion

The instant results suggests that foliar application of N @ 120 kg ha^{-1} produced more grain yield on account of having maximum tillers, height, grains spike^{-1} and grain weight. Foliar applied nitrogen also produced higher nitrogen use efficiency and economic parameters as compared to soil applied method. However grain protein content was recorded more in soil applied method as compared to foliar N application, similarly the levels of N showed significantly higher results for all the agronomic and yield parameters.

Authors' Contribution

SIK concieved the idea, collected adn analyzed the data and wrote the manuscript. MSB provided overall management of the article. KN and EAK provided technical support.

Conflict of Interest

Authors have declared no conflict of interest.

References

Ali, A., M.A. Choudhry, M.A. Malik, R. Ahmad and Saifuulah. 2000. Effect of various doses of nitrogen on the growth and yield of two wheat cultivar. Pak. J. Biol. Sci. 3(6): 1004-1005. https://doi.org/10.3923/pjbs.2000.1004.1005

Ahmed, M., M.A. Aslam, F.U. Hassan, M. Asif and R. Hayat. 2014. Use of APSIM to model nitrogen use efficiency of rain fed wheat. Int. J. Agric. Biol. 16(3): 461-470.

Amjed, A., A. Ahmad, W.H. Syed, T. Khaliq, M. Asif, M. Aziz and M. Mubeen. 2011. Effect of nitrogen on growth and yield components of wheat. Sci. Int. 23(4): 331-332.

Bakht, J., M. Shafi, M. Zubair, M.A. Khan and Z. Shah. 2010. Effect of foliar vs. soil application of nitrogen on yield and yield components of wheat varieties. Pak. J. Bot. 42(4): 2737-2745.

Chaudhry, Q.Z., and G. Rasul. 2004. Agroclimatic classification of Pakistan. Sci. Vision. 9: pp. 59.

Cowell, L.E. and P.J. Doyle. 1993. Nitrogen use efficiency. In: Impact of macronutrients on crop responses and environmental sustainability on the Canadian Prairies (eds. Rennie, D.A., Campbell, C.A. and Roberts, T.L.). Can. Soc. Sci. Ottawa. pp. 49-109.

Defan, T.A.A., H.M.A. Kholi, M.G.M. Rifaat and A.E.A. Allah. 1999. Effect of soil and foliar application of potassium on yield and mineral content of wheat grains grown in sandy soils. Egypt. J. Agric. Res. 77: 513-522.

El-Metwally, I.M., M.S. Abd El-Salam and R.M.H. Tagour. 2010. Nitrogen fertilizer levels and some weed control treatments effects on barley and associated weeds. Agric. Biol. J. N. Am. 1(5): 992-1000. https://doi.org/10.5251/abjna.2010.1.5.992.1000

Gomez, K.A., and A.A. Gomez. 1984. Statistical procedure for agricultural research. John Willey and Sons Inc., New York.

Guenis, A., M. Alpaslan and A. Unal. 2003. Effects of boron fertilization on the yield and some yield components of bread and durum wheat. Turk. J. Agric. 27: 329-335.

Halepyati, A.S. 2001. Influence of irrigation and nitrogen levels on growth and yield of wheat. Karnataka. J. Agric. Sci. 14(2): 449-450.

Jan, M.T., M. Shah and S. Khan. 2002. Type of N-fertilizer, rate and timing effect on wheat production. Sarhad J. Agric. 18(14): 405-410.

Ling, F., and M. Silberbush. 2002. Response of maize to foliar vs. soil application of nitrogen-phosphorus-potassium fertilizer. J. Plant Nutr. 25(11): 2333-2342. https://doi.org/10.1081/PLN-120014698

Oko, B.F.D., A.E. Eneji, W. Binang, M. Irshad, S. Yamamoto, T. Honna and T. Endo. 2003. Effect of foliar application of urea on reproductive abscission and grain yield of soybean. J. Plant Nutr. 26: 1223-1234. https://doi.org/10.1081/PLN-120020366

Piper, C.S. 1966. Soil and plant analysis. Hans Publication, Bombay.

PMD. 2014. Pakistan Meteorological Department. Available at: www.pmd.gov.pk.

Raun, W.R., and G.V. Johnson. 1999. Improving nitrogen use efficiency for cereal production. Agron. J. 91: 357-363. https://doi.org/10.2134/agronj1999.00021962009100030001x

Saddiqui, M.H., F. Mohammad, M.N. Khan, M. Masroor and A. Khan. 2008. Cumulative effect of soil and foliar application of nitrogen, phosphorus and sulpher on growth, physic-biochemical parameters, yield attributes and fatty acid composition in soil of Erucic acid free rapeseed mustard genotypes. J. Plant Nutr. 31: 1284-1298. https://doi.org/10.1080/01904160802135068

Semenov, M.A., P.D. Jamieson and P. Martre. 2007. Deconvoluting nitrogen use efficiency in wheat: A simulation study. Eur. J. Agron. 26: 283-294. https://doi.org/10.1016/j.eja.2006.10.009

Shah, W.A., H.U. Khan, S. Anwar and K. Nawab. 2011. Yield and yield components of wheat as affected by different seed rates and nitrogen levels Sarhad J. Agric. 27(1): 17-25.

Selles, F., R.P. Zenter, C.A. Campbell and D.C. James. 1996. Split nitrogen application for management of yield and protein of wheat grown in dry land. Agric. and Agric-food Can. S. Arid Prairie Agric. Res. Cen. Swift current, SK S9H 3x2. Pp. 274-283.

Swenson, L.J., W.C. Dahnke, J. Arlyce and A. Johnson. 2009. The effect of foliar application of urea and ammonium nitrate on yield and protein content of wheat. Farm Res. 46(2): 20-23.

Shahzad, K., A. Khan and I. Nawaz. 2013. Response of wheat cultivars to different nitrogen levels under agro-climatic conditions in Mansehra. Sci. Tech. Dev. 32(2): 99-103.

Soylu, S., B. Sade, A. Topal, N. Akgun and S. Gezgin. 2005. Responses of irrigated durum and bread wheat cultivars to boron application in low boron calcareous soil. Turk. J. Agric. 29: 275-286.

Steel, R.G.D., J.H. Torrie and D.A. Deekey. 1997. Principles and procedure of statistics: A biometrical approach, 3rd Ed., McGraw Hill Book Co. Inc. New York. pp. 400-408.

Stark, J.C., R.L. Mahler and T.A. Tindall. 2004. Nutrient management for dry land wheat production in Southern Idaho. South Idaho Dry-Land Winter Wheat Production Guide. pp. 28-31.

Waraich, E.A., S.M.A. Basra, N. Ahmad, R. Ahmad and A. Muhammad. 2002. Effect of nitrogen on grain quality and vigour in wheat (*Triticum aestivum* L.). Int. J. Biol., 4(4): 517-520.

Yaseen, A., E.A.A. Abou El-Nour and S. Shedeed. 2010. Response of wheat to foliar spray with urea and micronutrients. J. Am. Sci. 6(9): 14-22.