International Journal of Agriculture, Environment and Biotechnology
Citation: *IJAEB*: **15**(02): 219-224, June 2022
DOI: 10.30954/0974-1712.02.2022.9

ASSOCIATION FOR AGRICULTURE ENVIRONMENT AND BIOTECHNOLOGY

AGRONOMY

Effect of Nitrogen Levels on Growth and Yields of Wheat Varieties under Saline Water Irrigation Conditions

Nasir Ahmad Qazizadah[1*], Bhagat Singh[1], Ramprakash[2] and Khatera Qane[2]

[1]Department of Agronomy, CCS Haryana Agricultural University, Hisar, Haryana, India
[2]Department of Soil Science, CCS Haryana Agricultural University, Hisar, Haryana, India

*Corresponding author: qazizadah.nasir1985@gmail.com (**ORCID ID:** 0000-0001-5932-6193)

Paper No. 979 **Received:** 24-02-2022 **Revised:** 22-04-2022 **Accepted:** 30-05-2022

ABSTRACT

The field experiment was conducted at the Research Farm of Chaudhary Charan Singh Haryana Agricultural University, Hisar during the *Rabi* season of 2015-16. The experiment consisted of twenty treatment combinations comprising four wheat varieties *i.e.* KRL 210, WH 1105, HD 3086 and DBW 88 as main plots of treatment and five nitrogen levels *i.e.* 0, 50, 100, 150 and 200 kg N ha^{-1} as sub-plots treatment, were tested in a split-plot design with three replications. The growth parameters *i.e.* dry matter accumulation, number of tillers meter^{-1} row length and leaf area index, grain yield and straw yield were recorded significantly higher in the wheat variety WH 1105. However, it was at par with varieties HD 3086 and DBW 88 for dry matter accumulation and leaf area index. Whereas, plant height was recorded significantly higher in the wheat variety HD 3086. The incremental N levels significantly increased for plant height, dry matter accumulation, number of tillers meter^{-1} row length, LAI grain yield, straw yield and harvest index up to 150 kg N ha^{-1} but was at par with 200 kg N ha^{-1}.

HIGHLIGHTS

- The growth of wheat crop under saline irrigation conditions could be improved by the judicious use of inorganic fertilizer.
- So, this study was conducted to evaluate the influence of various nitrogen levels on wheat varieties under saline irrigation water.

Keywords: Wheat varieties, nitrogen levels, saline water, growth, and yields

Wheat is a major staple food crop for more than one-third of the world population and is the main staple food of Asia. It originated in South-Western Asia. The cultivation of wheat has also been symbolic of the green revolution, self-sufficiency in food and sustained production. India ranks second among wheat producing countries in the world after China. Wheat cultivation in India is spread between 10°N to 37°N latitudes (Kumar 2012). In India, wheat was sown on an area of about 31.76 m ha with a production of 108.75 m t with average productivity of 34.24 q ha^{-1} during 2020-21. In Haryana, wheat was sown in an area of about 2.52 m ha with a production of 12.15 m t with average productivity of 48.22 q ha^{-1} during 2020-21. (ICAR-IIWBR, 2020-21).

In India, about 9.5 m ha area is affected by soil salinity. A major proportion of ground water in the states of Gujarat (30%), Madhya Pradesh (25%), Punjab (41%), Uttar Pradesh (63%), Haryana (67%) and Rajasthan (84%) is brackish and good quality of water is occasional for assured irrigation (Manchanda 1993). In absence of canal water or good quality water, most of the farmers use brackish water for irrigating their crops, particularly in the *Rabi* season. Wheat crop is a semi-tolerant crop

How to cite this article: Qazizadah, N.A., Singh, B., Ramprakash and Qane, K. (2022). Effect of Nitrogen Levels on Growth and Yields of Wheat Varieties under Saline Water Irrigation Conditions. *Int. J. Ag. Env. Biotech.*, **15**(02): 219-224.

Source of Support: None; **Conflict of Interest:** None

to salinity thus it is found that might be grown with brackish water irrigation at the cost of some losses in yield. Different genotypes of wheat had varied limits to salt tolerance (Abrol and Gupta 1994). Therefore, it was considered necessary to test the newly evolved wheat varieties against saline irrigation water for evaluating the effects on crop productivity and its physiological parameters.

Nutrient deficiency is yet another most prevalent constraint to agricultural production in saline as well as in other soils. Sustained and profitable crop production of salt-affected soils is feasible if appropriate on-farm management practices are used. Under the low fertility status of soil, proper fertilizer applications can increase crop yields regardless of the soil salinity (Mass 1990). Therefore, investigating fertilizer management to maximize crop production under existing salinity is of greater importance. Salinity and fertility interaction showed an improvement in the crop yield by the addition of fertilizer to the soil irrigated with saline water (Muhammad and Khattak 2009). The research studies on the response of the wheat crop to the nitrogen fertilizers in the soils irrigated with saline water are not well documented. Therefore, this study was conducted to evaluate the influence of various nitrogen levels on wheat varieties under saline irrigation water.

MATERIALS AND METHODS

The field experiment was conducted during the *Rabi* season of 2015-16 at Research Farm of CCSHAU, Hisar, Haryana, India. The experiment was laid out in a split-plot design with three replications. The treatments consisted of four varieties *viz.*, KRL 210 (V_1), WH 1105 (V_2), HD 3086 (V_3) and DBW 88 (V_4) in main plots and five levels of nitrogen *viz.*, 0 (N_0), 50 (N_1), 100 (N_2), 150 (N_3) and 200 (N_4) kg N ha^{-1} in sub-plots. Four irrigations were applied with saline water (EC 7.0 dSm^{-1}) at 21, 45, 85, 122 DAS. The crop was sown during the first week of November with row to row spacing of 20 cm. Fertilizer doses of 60 kg P_2O_5 and 40 kg K_2O ha^{-1} and N was applied as per treatment. Half dose of N and full dose of P and K were applied at the time of sowing while the remaining half dose of N was given to the crop at first irrigation as per treatment. Agronomic practices, *i.e.* weeding, hoeing and plant protection measures were carried out as per recommendations at appropriate times. Data were recorded on plant height, dry matter accumulation, leaf area index, number of tillers m^{-1} row length, grain yield, straw yield and harvest index as per the standard procedure. Data collected during the study were statistically analyzed by using the technique of analysis of variance (ANOVA) described by Cochran and Cox (1959).

RESULTS AND DISCUSSION

Growth Parameters: The data pertaining to plant height at different growth stages are summarized in Table 1. The increase in plant height was rapid up to 90 DAS and thereafter, it increased at a slower rate and was almost stationary after 90 DAS. Among the varieties, HD 3086 recorded significantly taller plant height than all other varieties at 120 DAS of crop growth whereas at 60 and 90 DAS it was found statistically at par with variety WH 1105. The variety KRL 210 recorded smaller plant height than all other varieties at different stages of crop growth. The plant height of variety HD 3086 was maximum (94.2) because of its tall-growing nature. More plant height may be attributed to the higher cell division and cell enlargement capacity of these varieties. Similar findings were confirmed by (Rawat *et al.* 2000; Iqtidar *et al.* 2006). The levels of nitrogen also influenced plant height significantly at 60, 90 and 120 DAS of crop growth. The crop fertilized with 200 kg N ha^{-1} recorded significantly higher plant height than the 0, 50, 100 and 150 kg N ha^{-1} at 60, 90 and 120 DAS of crop growth. However, at 60 DAS differences in plant height between 200 kg N ha^{-1} and 150 kg N ha^{-1} were statistically at par, whereas, minimum plant height was recorded in control (0 kg N ha^{-1}) at 60, 90 and 120 DAS of crop growth. Higher nitrogen levels resulted in maximum N uptake, which ultimately results in more rapidly synthesized carbohydrates, converted into protein and increased protein synthesis, cell division and cell enlargement which in turn are elaborated into protoplast and thereby protein is left available for cell wall formation materials, which is expressed as morphological in terms of increased plant height. Similar findings were reported by (Singh *et al.* 2008; Abdelgadir *et al.* 2010; Yousaf *et al.* 2014). Ali *et al.* (2003) also reported that there was a gradual increase in plant height with each successive dose of N. The data revealed that the dry matter

Table 1: Effect of varieties and nitrogen levels under saline water irrigation on plant height (cm), dry matter accumulation (g) and number of tillers at 60, 90 and 120 DAS of wheat

Treatments	Plant height (cm)			Dry matter accumulation (meter^{-1} row length)			Number of tillers (meter^{-1} row length)		
	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS
Varieties									
KRL 210	42.8	77.8	85.8	42.6	124.0	206.9	90.1	81.4	79.2
WH 1105	45.2	80.4	89.2	49.0	129.3	214.8	100.4	92.5	89.7
HD 3086	47.4	82.2	92.0	51.4	132.1	215.6	96.0	88.3	84.3
DBW 88	44.3	78.2	86.3	45.5	127.6	211.5	95.7	86.1	83.5
SEm±	0.9	0.6	0.3	0.4	1.5	2.4	0.9	1.2	0.4
CD at 5 %	3.1	2.1	1.2	1.4	5.2	8.4	3.3	4.1	1.5
Nitrogen levels (kg ha^{-1})									
0	39.0	59.4	63.9	33.3	92.0	149.4	70.5	63.5	60.8
50	43.1	68.7	83.0	43.9	117.2	191.2	89.1	80.8	77.9
100	45.8	85.8	94.9	50.4	138.8	230.2	101.2	93.7	90.6
150	47.4	87.9	97.8	53.7	146.3	244.2	108.9	98.6	95.4
200	49.3	94.4	102.1	54.4	147.1	247.5	108.3	98.9	96.3
SEm±	0.9	0.5	0.5	1.0	1.5	1.4	1.1	1.1	0.4
CD at 5 %	2.5	1.5	1.4	3.0	4.4	4.1	3.1	3.2	1.3

Table 2: Effect of varieties and nitrogen levels under saline water irrigation on leaf area index (LAI) at 60, 90 and 120 DAS, grain yield, straw yield and harvest index of wheat

Treatments	Leaf area index (LAI)			Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	HI (%)
	60 DAS	90 DAS	120 DAS			
Varieties						
KRL 210	2.90	3.22	1.33	3,397	5,130	39.5
WH 1105	3.35	3.51	1.61	4,250	6,226	40.3
HD 3086	3.28	3.48	1.49	3,920	5,767	40.2
DBW 88	2.95	3.34	1.48	3,898	5,480	41.3
SEm±	0.06	0.04	0.02	65	68	0.4
CD at 5 %	0.24	0.13	0.06	229	241	1.2
Nitrogen levels (kg ha^{-1})						
0	2.12	2.54	1.11	2,369	3,856	38.0
50	2.83	3.16	1.43	3,323	5,153	39.2
100	3.29	3.63	1.57	4,315	6,182	40.1
150	3.69	3.83	1.70	4,585	6,477	41.3
200	3.66	3.77	1.60	4,739	6,585	41.9
SEm±	0.12	0.05	0.02	89	73	0.5
CD at 5 %	0.36	0.16	0.07	258	211	1.6

accumulation was significantly influenced by the varieties at different stages of crop growth. Among the varieties, HD 3086 accumulated significantly higher dry matter than the variety KRL 210. However, it was statistically at par with varieties WH 1105 and DBW 88 at 60, 90 and 120 DAS. Dry matter accumulation is one of the most important parameters of growth, which is the cumulative product of plant height and leaf area index. Maximum dry matter (221.8) was accumulated in variety WH 1105 which might be attributed due to its higher tillering ability. In wheat, an increase in plant height and dry matter accumulation was substantial up to 90 DAS and thereafter, it increased marginally up to 120 DAS. The higher dry matter accumulation is attributed to increased plant height and higher leaf area index (Tables 1 and 2). Kumar *et al.* (2002) also reported significant variations in total dry matter accumulation among the genotypes. There was a significant increase in dry matter accumulation with the increase in nitrogen level from 0 to 150 kg N ha^{-1}. The crop fertilized with 200 kg N ha^{-1} recorded significantly higher dry matter accumulation than all the N levels except 150 kg N ha^{-1} and the minimum was obtained in control. This might be due to the contribution of nitrogen toward dry matter production. Similarly, findings were also reported by (Singh 1991). Alam (2013) found that the total dry matter accumulation was higher at the highest N level. A perusal of data revealed that the number of tillers $meter^{-1}$ row length increased with the advancement of crop growth up to 60 DAS. From 90 DAS to120 DAS, the number of tillers was slightly decreased. Among the varieties, WH 1105 recorded significantly higher number of tillers $meter^{-1}$ row length (88.8) than all other varieties. Whereas, the minimum number of tillers in KRL 210 (77.3). This was mainly due to the better tillering ability of this variety. (Jat and Dhakar 2002) found that the better supply of photosynthesis from leaves to tillers and partly due to the genetic makeup of the variety. The number of tillers significantly increased with the increase in nitrogen rates from 0 to 150 kg N ha^{-1} at different stages of crop growth, however, these were found statistically at par with 200 kg N ha^{-1}. These results confirm the findings of Hussain *et al.* (1984) who observed that increasing nitrogen application increased the number of fertile tillers in $unit^{-1}$ area. (Ali *et al.* 2003) also found that the increase in the number of fertile tillers with the increase in nitrogen levels can be attributed to the reduction in mortality of tillers and enabling the production of more tillers from the main stem.

Leaf area index (LAI): The data on leaf area index 60, 90 and 120 DAS of crop growth are presented in Table 2. The differences in leaf area index due to different varieties was found significant at 60, 90 and 120 DAS. In general, the leaf area index increased up to 90 DAS and it declined thereafter. Among the varieties, WH 1105 recorded significantly higher leaf area index than all other varieties at different stages of crop growth, except at 60 and 90 DAS it was statistically at par with variety HD 3086. The KRL 210 recorded the lowest leaf area index than all other varieties at 60, 90 and 120 DAS of crop growth. Alam (2013) reported that the green leaf area is the source of food production for green plants and significant variation was observed with respect to leaf area index among the varieties. LAI increased up to 90 DAS and decreased thereafter at 120 DAS because of senescence of leaves associated with the re-mobilization of the seed of the stored metabolism from leaves to the grains *i.e.*, conversion of solar energy to produce energy (Nag *et al*. 1999). The maximum leaf area index was recorded with 150 N kg ha^{-1}, being significantly higher than 0, 50, 100 and 200 kg N ha^{-1} at 120 DAS of crop growth except at 60 and 90 DAS where it was found statistically at par with 200 kg N ha^{-1}. However, significantly lower leaf area index was recorded in the control. Higher nitrogen levels resulted in higher nitrogen uptake, which may be due to increased nitrogen assimilation**,** which causes increased chlorophyll formation, cell division and cell enlargement and ultimately results in to higher LAI (Lonhard and Ragasits 1990). Alam (2013) observed that the highest LAI was found at the highest level of nitrogen application. This might be due to favourable synthesis of growth favouring constituents in plant system due to better supply of nitrogen, which led to the increased number of leaves $unit^{-1}$ area resulting in enlargement in leaf area.

Grain Yield, Straw yield and Harvest Index

The grain and straw yields were significantly influenced by different varieties Table 2. Among the varieties, WH 1105 recorded significantly higher grain yield (4250 kg ha^{-1}) and straw yield (6226 kg ha^{-1}), whereas, the lowest grain (3397 kg ha^{-1}) and straw (5130 kg ha^{-1}) yields were obtained in KRL 210. The yield is expected as the cumulative function of the factors which contribute to it. The economic yield of the crop depends on the source-sink relationship and on different components of the sink itself *viz.*, number of effective tillers $meter^{-1}$ row length, number of grains $spikes^{-1}$, test weight, grain yield, straw yield and harvest index. The source components may be the number of leaves, tillers and dry matter of the plants before anthesis. As the main component of growth, the number of effective tillers at maturity decides the grain yield. The characteristics which contributed to the yields are specific and depend upon the genetic potential of a genotype and the increase in grain yield could be attributed to the higher number of effective tillers, increased number of grains $spike^{-1}$, spike length and 1000-grain weight. Genetic variation among different wheat cultivars was also reported by (Alam 2009; Panwar *et al*. 2013; Baloch *et al*. 2014). There was significant increase in grain and straw yield with an increase in nitrogen level from

0 to 150 kg N ha^{-1}. Crop fertilized with 200 kg N ha^{-1} resulted in maximum grain (4739 kg ha^{-1}) and straw yields (6585 kg ha^{-1}) however, they were statistically at par with 150 kg N ha^{-1}. The minimum grain yield (2369 kg ha^{-1}) and straw yield (3856 kg ha^{-1}) were obtained in the control. The beneficial effect of nitrogen on grain yield can be very well explained in the light of the fact that nitrogen application increased the number of effective tillers unit^{-1} area, the number of grains and grain weight spike^{-1} which ultimately contributed to higher grain yield. Bali *et al*. (1988) also reported that higher nitrogen levels had a positive relationship with the number of spike m^{-1}, the number of grains and grain weight spike^{-1} but 1000-grain weights remain unaffected. These findings were in accordance with those of (Bakhsh *et al*. 1999; Iqtidar *et al*. 2006). The maximum straw yield was recorded with 200 kg N ha^{-1}, this might be probably due to more plant height and also an increased rate of dry matter production. The data on harvest index as given in Table 2 revealed that differences in harvest index were significantly influenced by different varieties. Among the varieties, maximum harvest index (41.3%) was recorded in DBW 88, being statistically at par with WH 1105 (40.3%) and HD 3086 (40.2%), however, minimum HI was recorded in KRL 210 (39.5%) and this was mainly due to the fact that grain and biological yields increased almost in the different pattern during the period of the season. Similar results were founded by (Chandra and Das 2000; Cui *et al.* 2000). The harvest index increased significantly with an increase in nitrogen rates from 0 to 200 kg N ha^{-1}. Crop fertilized with 200 kg N ha^{-1} recorded significantly higher harvest index (41.9 %) than all other levels of nitrogen except at 150 kg N ha^{-1} (41.3 %) and the lowest HI (38 %) was recorded in control. Similar results were also reported by (Khan *et al.* 2005; Waraich *et al.* 2007).

CONCLUSION

Wheat variety WH 1105 was found most suitable in terms of dry matter accumulation, number of tillers meter^{-1} row length, leaf area index, grain yield and straw yield. However, it was at par with varieties HD 3086 and DBW 88 for dry matter accumulation and leaf area index. The incremental N levels significantly increased LAI up to 150 kg N ha^{-1} but was at par with 200 kg N ha^{-1} for plant height, dry matter accumulation, number of tillers meter^{-1} row length, grain yield, straw yield and harvest index. On the basis of one year study, it can be concluded that among the varieties tested, wheat variety WH 1105 may be grown for higher productivity and be fertilized with 150 kg of nitrogen under saline water irrigation conditions.

REFERENCES

Abdelgadir, E.M., Fadul, E.M., Fageer, E.A. and Ali, E.A. 2010. Response of wheat to nitrogen fertilizer at reclaimed high terrace salt-affected soils in Sudan. *J. Agric. Soc. Sci*, **6**: 43–47.

Abrol, I.P. and Gupta, R.K. 1994. Managing salt affected soils and poor quality irrigation on waters for sustained crop productivity. *In:* Sadaphal M.N, De R (eds.) Resource Management for Sustained Crop Production. *Indian Society of Agronomy*, New Delhi, India, pp: 102-123.

Alam, M.S. 2013. Growth and yield potentials of wheat as affected by management practices. *Af. Agric. Res.*, **8**: 47: 6068-6072.

Alam, M.Z., Haidar, M.F. and Paul, N.K. 2009. Influence of different irrigation regimes on the phonology and accumulated heat unit in four bread wheat cultivars. *Pak. J. Biolog. Sci.*, **7**: 1477-1480.

Ali, L., Mohy, Q., Din. U.D. and Ali, M. 2003. Effect of different dose of nitrogen fertilizer on the yield of wheat. *Int. J. Agric. and Bot.*, **5**: 438-439.

Bakhsh, A., Gurmani, A.H., Bhatti, A.U. and Rehman, H. 1999. Effect of balanced application of N, P and K on the grain yield of wheat. *Sarhad. J. Agri.*, **15**: 453-457.

Bali, S.K., Singh, R. and Rao, M.H. 1988. Effect of date of sowing and row spacing on yield of wheat (*T. aestivum L*). *Crop Res. Hisar*, **5**: 199-206.

Baloch, S.K., Kandhro, M.N., Muhammed, A.S.S., Baloch, F.A., Baloch, S.U., Osman, K.A. and Ali, S.A.I. 2014. Studies on performance of wheat varieties under saline conditions. *Persian Gulf Crop Prot.*, **3**: 6-17.

Chandra, K. and Das, A.K. 2000. Correlation and inter-correlation of Physiological parameters in rice under rainfed transplanted condition. *Crop Res. Hisar, Assam Agric. Univ.*, **19**: 251-254.

Cochran, W.C. and Cox, G.M. 1959. Experimental designs, Asia Publishing House, Bombay.

Cui, J., Kusutani, A., Toyata, M. and Asanuma, K. 2000. Studies on the varietal differences of harvest index and morphological characteristics of rice. *Japanese J. Crop Sci.*, **69**: 359-364.

Hussain, M.M., Ibrahim, S.A. and Zietoon, M. 1984. Effect of nitrogen levels on growth, yield and mineral composition of wheat plant under different seed rates. *Egyptian J. Soil Sci.*, **24**: 7-18.

Iqtidar, H., Ayyaz, K.M. and Ahmad, K.E. 2006. Bread wheat varieties as influenced by different nitrogen levels. *J. Zhejiang Univ. Sci. B.*, **7:** 70-78.

Indian Council of Agricultural Research-Indian Institute of wheat and barley research (ICAR-IIWBR) (2021) Director's report of AICRP on wheat and barley 2020-2021, Ed: G. P. Singh. ICAR- India Institute of wheat and barley research, Karnal, Haryana, India. P72.

Jat, B.L. and Dhakar, L.L. 2002. Yield attributes and yield of wheat (*Triticum aestivum L.*) varieties under sowing dates, seed rates. *Agric. Sci. Digest.*, **23**: 84-87.

Khan, M., Khan, R.U., Wahab, A. and Rashid, A. 2005. Yield and yield components of wheat as influenced by intercropping of chickpea, lentil and rapeseed in different row proportions. *Pakistan J. of Agric. Sci.*, **42**.

Kumar, R., Agarwal, S.K. and Nanwal, R.K. 2002. Economic of bread wheat as affected by planting system, seed rate and nitrogen fertilization in sandy lome soils of Haryana. *Haryana Agric. Univ. J. Res.*, **32**: 23-25.

Kumar, V. 2012. Effect of dates of sowing on growth and yield of wheat (*Triticum aestivum* L.) varieties. Thesis, M.Sc. (Agronomy), Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi.

Lonhard-Bory, E. and Ragasits, I. 1990. The effect of nitrogen fertilizer rate and date of application on leaf area in wheat. *Novenytemetes*, **39**: 325-335.

Manchanda, H.R. 1993. Management of brackish waters for Irrigation. *In:* Singh DP, Sharma HC (eds.) important aspects of on-form water Management. CCS Haryana, Agricultural University, Hissar, India.

Mass, E.V. 1990. Crop salt tolerance. *In:* K.K. Tanji, ed. Agricultural Salinity Assessment and Management. American Society of Civil Engineering.

Muhammad, D. and Khattak, R.A. 2009. Growth and nutrients concentrations of maize in press mud treated saline-sodic soils. *Soil Environ.*, **28**: 145-155.

Nag, B.L., Rahman, A.K.M.., Hassan, M.S. and Uddin, M.S. 1999. Growth analysis and yield of wheat as influenced by seed rates. *Ann. Bangladesh Agric*., **8**: 25-34.

Panwar, I.S., Redhu, A.S., Verma, S.R., Karwasra, S.S., Bishnoi. O.P and Arya. R.K. 2013. A new wheat variety for timely sown irrigated conditions in the North Western Plains Zone of India. *J. Wheat Res.*, 5: 74-75.

Rawat, A.K., Sharma, R.S., Dubey, A.K. and Naik, K.R. 2000. Refinement of agro-techniques for improving productivity of wheat (*Triticum aestivum L.*) under Rice (*Oryza sativa*) wheat agro- system. *Indian J. Agron.*, **45**: 636-640.

Singh, G. 1991. Tillage and nitrogen requirement of wheat sown after paddy. Thesis, M.Sc. P.A.U., Ludhiana 97 p (c.f Thesis abastract. **17**: 25-26).

Singh, Y.P., Singh, R. and Gautam, A.K. 2008. Effect of nitrogen levels on yield and nutrient uptake by salt-tolerant rice and wheat cultivars in gypsum-amended sodic soils. *J. Indian Soc. Soil Sci.*, **56**: 86-91.

Waraich, E.A., Ahmad, R., Ali, A. and Saifullah. 2007. Irrigation and nitrogen efficient on crop development and yield in wheat (*Triticum aestivum L.*). *Pak. J. Bot.*, **39**: 1663-1672.

Yousaf, M., Shaaban, M., Ali, S.A.I., Fahad, S., Khan, M.J., Wang, Y., Shah, A.N., Sabiel, S.A.I. and Osman, K.A. 2014. The effect of nitrogen application rates and timings of first irrigation on wheat growth and yield. *Int. J. Agric. Innov. and Res.*, **2**: 645-653.