Journal of AgriSearch, **6**(1):16-20
An Open Access International Peer Reviewed Quarterly

ISSN : 2348-8808 (Print), 2348-8867 (Online)
https://doi.org/10.12921/jas.v6i1.14914

Effect of levels of Irrigation and Nitrogen on Growth, Yield and Nitrogen uptake in Barley

ARUN KUMAR[1], SHASHANK TYAGI[1], SANTOSH KUMAR DUBEY[1] AND SANJAY KUMAR

ARTICLE INFO

Received on	:	30-01-2018
Accepted on	:	22-02-2019
Published online	:	05-03-2019

ABSTRACT

A field experiment was conducted during *rabi* season at research farm of CS Azad University of Agriculture and Technology, Kanpur, U.P. with the objective to study the effect of irrigation and nitrogen levels on growth, yield and nitrogen uptake by barley. The experiment was laid out in split plot design with three replications with treatments, comprising four levels of irrigation *viz*., I_1= no irrigation, I_2= one irrigation at tillering stage, I_3= one irrigation at flag leaf stage and I_4= two irrigations each at tillering and flag leaf stage in main plots and four nitrogen levels *viz*., N_1= Control, N_2= 30 kg ha^{-1}, N_3= 60 kg ha^{-1} and N_4= 90 kg ha^{-1} in sub-plots. Results revealed that application of two irrigations first at tillering and second at flag leaf stage along with 90 kg nitrogen per hectare gives highest grain yield, straw yield, nitrogen content and nitrogen uptake by grain, straw and protein content as compared to other irrigations (no irrigation, one irrigation at tillering stage, one irrigation at flag leaf stage) and nitrogen treatments (0, 30 and 60 kg ha^{-1}).

KEYWORD

Barley, Irrigation level, Nitro-gen level, N uptake, Yield

INTRODUCTION

In India, barley was grown on an area of about 0.757 m ha, with production of 1.47 m tones. The productivity was 19.41 q ha^{-1} in 2017. In U.P area, production and productivity under barley cultivation was 2.869 lakh ha, 6.384 lakh tonnes and 22.25 q ha^{-1}, respectively (FAO, 2017). Judicious use of water and fertilizer are two important inputs in crop production. These inputs are costly as well as scare. Thus, the problem of shortage of irrigational water is more aggravated under the condition of irregular and in sufficient supply of energy. Under such conditions of limited water availability, the efficient use of water to get the potential yield of a crop becomes very essential.

Among the major nutrients for the crop productivity, nitrogen has unique place in production, which is reported to be widely deficient in our soils. The efficiency of nitrogen fertilizer in increasing the yields depend upon many factors and among these soil moisture is most important. Adequate moisture without fertilizer or adequate fertilizer without sufficient soil moisture may result in very low water and fertilizer use efficiency, respectively.

Fertilizer levels and time of its application also application also affected the grain yield and quality. Insufficient nitrogen can reduce grain yield and quality below acceptable levels, while excess nitrogen usually enhances undesirable high protein level (Amare and Adane, 2015). There was linear increase in grain protein and yield depending upon initial soil nitrogen levels (Terefe *et al*., 2018). Keeping in view, the present investigation was carried out during *rabi* season of year 2002-03 at Research farm, Nawabganj, C.S. Azad University of Agriculture and Technology, Kanpur, U.P with the objective to study the effect of irrigation and nitrogen levels on growth, yield and nitrogen uptake by barley.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* season at research farm of CS Azad University of Agriculture and Technology, Kanpur, U.P. The experimental soil was silty-loam in texture with pH 8.05. The organic carbon, available nitrogen, phosphorus and potash were 0.30%, 145.00, 34.2 and 235.0 kg ha^{-1}, respectively. The total rainfalls received during the crop growth season were 8.56 mm. The experiment was laid out in split plot design with three replications with treatments, comprising four levels of irrigation *viz*., I_1= no irrigation, I_2= one irrigation at tillering stage, I_3= one irrigation at flag leaf stage and I_4= two irrigations each at tillering and flag leaf stage in main plots and four nitrogen levels *viz*., N_1= Control, N_2= 30 kg ha^{-1}, N_3= 60 kg ha^{-1} and N_4= 90 kg ha^{-1} in sub-plots. The test variety of barley 'K-551' was sown in rows 23 cm apart as per scheduled. The crop received a basal dose of P_2O_5 (30 kg ha^{-1}) and K_2O (20 kg ha^{-1}) were applied uniformly in all the plots through DAP and MOP. For application of nitrogen, urea was weighed as per treatment for different plots and half of its requisite dose was drilled through *pora* just before sowing as a basal dose and remaining half dose was broadcasted at tillering stage. Grain yield of barley along with other yield attributing characters like effective tillers m^{-2}, grain per ear head and test weight were recorded at harvest. Grain yield was converted to t ha^{-1} at 14% moisture content. Cost of cultivation and gross return were calculated on the basis of prevailing market prices of different inputs and produces, respectively. All the other recommended agronomic and plant protection measures were adopted to raise the crop as per needs.

Chandra Shekhar Azad University of Agriculture and Technology, Kanpur-208002, India
[1]Bihar Agricultural University, Sabour, Bhagalpur- 813210
*Corresponding Author Email: arunkumar20052@yahoo.co.in

RESULTS AND DISCUSSION

The plant height at harvest was significantly affected by irrigation and nitrogen levels. The different treatments of irrigation significantly increased the plant height of barley over control (I_0), where no irrigation was applied. Application of two irrigations first at tillering and second at flag leaf stage (I_3) produced maximum plant height (86.91 cm) followed by I_1 (82.04 cm), I_2 (78.04 cm) and I_0 (73.25 cm) treatments of irrigation.

Both irrigation and nitrogen treatments significantly affected the dry matter accumulation per meter row length at harvest. Two irrigations first at tillering and second at flag leaf stage (I_3) produced significantly higher dry matter per row length (126.01 g) followed by I_1, I_2 and I_0 treatments of irrigation. The results are in conformity with the finding of Jai *et al.* (2015). At harvest, as the levels of nitrogen increased the dry matter accumulation per meter row length. Dry matter accumulation per meter row length at harvest increased from 111.47 g to 118.44 g, 123.46 g to 125.84 g under N_{30}, N_{60} and N_{90} treatments of nitrogen, respectively. Similar findings were also corroborated with the results of Pankaj *et al.*, (2015).

Both irrigation and nitrogen treatments significantly affected the number of ear bearing shoots per meter row length at harvest (Table 1). It is evident from the results that application of two irrigation first at tillering and second at flag leaf stage (I_3) produced significantly higher number of ear bearing shoots (88.46) per meter row length followed by I_1 (84.86), I_2 (82.65) and I_0 (80.66) treatments of irrigation. Increasing levels of nitrogen significantly increased the number of ear bearing shoots per meter row length. The magnitude of increase was from 78.44 (N_0) to 82.63, 86.14 and 89.18 under N_{30}, N_{60} and N_{90} treatments of nitrogen, respectively.

Both irrigation and nitrogen treatments significantly affected the number of spikelets per spike at harvest. The different treatments of irrigation significantly affected the production of number of spikelets per spike of barley. Under I_0 level of irrigation where no irrgaiton was applied, the lowest number of spikelets per spike (23.06) was recorded. The application of one irrigation at tillering (I_1), one irrigation at flag leaf stage (I_2) and two irrigations first at tillering and second at flag leaf stage (I_3) produced significantly higher number of spikelets per spike i.e. 24.97, 24.47 and 26.28, respectively as compared to I_0 level of irrigation. I_1 and I_2 treatments of irrigation were at par in respect to production of spikelets per spike. However, I_3 treatment of irrigation produced significantly higher number of spikelets per spike (26.28) as compared to I_2 treatment, which produced 24.47 spikelets per spike. It is pertinent to mention here that the number of spikelets per spike decreased from 24.97 under I_1 to 24.47 under I_2 treatments of irrigation though differences were not significant. With increasing levels of nitrogen, number of spikelets per spike increased from 22.91 under (N_0) 24.47, 25.47 and 25.95 under N_{30}, N_{60} and N_{90} treatments of nitrogen, respectively.

Table 1: Effect of different treatments on growth and yield attributes of barley

Treatment	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)	Protein content in grain (%)
Irrigation				
I0 (no irriga tion)	33.85	51.03	39.91	6.93
I1 (at tillering stage)	35.16	58.33	37.46	8.19
I2 (at flag leaf stage)	35.09	55.50	38.72	7.41
I3 (at tillering + flag leaf stage)	37.03	60.40	38.01	8.28
SE (d)	0.44	1.14	0.15	0.02
CD at 5%	1.08	2.81	0.38	0.04
Nitrogen Levels				
N 0 (no nitrogen)	32.29	50.10	39.24	7.15
N 30(30 kg N ha^{-1})	34.63	55.12	38.62	7.47
N 60(60 kg N ha^{-1})	36.40	59.02	38.18	8.00
N 90(90 kg N ha^{-1})	37.80	61.44	38.05	8.18
SE (d)	0.67	1.07	0.25	0.04
CD at 5%	1.40	2.21	0.51	0.08

It is obvious from the above data that 1000-grain weight of barley was significantly affected by irrigation levels. The application of increasing levels of nitrogen did not affect 1000-grain weight significantly. Application of two irrigations first at tillering and second at flag leaf stage (I_3) produced significantly higher 1000-grain weight (42.22 g) followed by I_1 (41.88 g), I_2 (41.39 g) and I_0 (41.18 g) treatments of irrigation. I_1 and I_2 treatments of irrigation were at par in respect to production of 1000-grain weight. Though application of nitrogen did not affect 1000-grain weight significantly but with the increasing levels of nitrogen, 1000-grain weight increased markedly from 41.48 g under N_0 to 41.94 g under N_{60} treatments. N_{30} and N_{90} treatments of nitrogen did not increase 1000-grain weight of barley over N_0 and N_{60} treatments of nitrogen, respectively. The beneficial effect of higher dose of nitrogen application on the yield attributes of barley have also been reported by Kouzegaran *et al.* (2015).

Similarly, Galav and Bharose (2017) and Anjum et *al.* (2017) have reported that yield attributes increased with the increasing number of irrigations in barely. It is clear from the data that both irrigation and nitrogen treatments significantly affected the grain yield of barley. The different treatments of irrigation significantly increased the grain yield of barley over control (I_0), where no irrigation was applied. Application of two irrigations first at tillering and second at flag leaf stage (I_3) gave significantly higher grain yield (37.03 q ha^{-1}) over I_0 (33.85 q ha^{-1}) followed by I_1 (35.16 q ha^{-1}) and I_2 (35.09 q ha^{-1}) treatments of irrigation. However, I_1 and I_2 treatments of irrigation were at par in respect to grain yield (Table 2).

Table 2: Effect of different treatments on grain yield, straw yield and protein content of barley

Treatment	Plant height (cm)	Dry matter/m row length (g)	No. of ear bearing shoots/m row length	No. of spikelets/spike	1000-grain weight (g)
			Irrigation		
I0 (no irrigation)	73.25	110.52	80.66	23.06	41.18
I1 (at tillering stage)	82.04	124.94	84.86	24.97	41.88
I2 (at flag leaf stage)	78.04	118.03	82.62	24.47	41.39
I3 (at tillering + flag leaf stage)	86.91	126.01	88.46	26.28	42.22
SE (d)	0.77	2.79	0.89	0.44	0.27
CD at 5%	1.89	6.84	2.18	1.08	0.68
			Nitrogen Levels		
N 0 (no nitrogen)	69.34	111.47	78.44	22.91	41.48
N 30(30 kg N ha^{-1})	79.12	118.44	82.63	24.47	41.47
N 60(60 kg N ha^{-1})	84.27	123.46	86.14	25.47	41.94
N 90(90 kg N ha^{-1})	87.52	125.84	89.18	25.95	41.78
SE (d)	1.52	3.44	1.67	0.37	0.33
CD at 5%	3.15	7.10	3.45	0.77	NS

Increasing levels of nitrogen significantly increased the grain yield of barley from 32.29 q ha^{-1} under control (N_0) to 34.63, 36.40 and 37.80 q ha^{-1} under N_{30}, N_{60} and N_{90} treatments of nitrogen, respectively.

Results showed that both irrigation and nitrogen treatments significantly affected the straw yield of barley. The perusal of data makes it clear that the different treatments of irrigation significantly increased the straw yield of barley over control (I_0), where no irrigation was applied. Application of two irrigations first at tillering and second at flag leaf stage (I_3) produced significantly higher straw yield (60.40 q ha^{-1}) over I_0 (51.03 q ha^{-1}) followed by I_1 (58.33 q ha^{-1}) and I_2 (55.50 q ha^{-1}) treatments of irrigation. Increasing levels of nitrogen significantly increased the straw yield of barley i.e. from 50.20 q ha^{-1} under control (N_0) to 55.12, 59.02 and 61.44 q ha^{-1} under N_{30}, N_{60} and N_{90} treatments of nitrogen, respectively.

The per cent increase recorded with application of two irrigations first at tillering and second at flag leaf stag over no irrigation (I_0), one irrigation at tillering (I_1), one irrigation at flag leaf stage (I_2) was 9.38, 5.31 and 5.50 per cent in grain yield and 18.27, 3.53 and .82 per cent in straw yield, respectively. Increase in grain yield might be on account of higher number of ear bearing shoots per meter row length, higher dry matter accumulation and improved yield attributing characters with application of two irrigations.

The increase in grain yield with application of higher dose of nitrogen might be due to higher number of tillers, higher dry matter accumulation and improved yield attributing characters on account of balance nutrition of the crop, which finally improved the grain and straw yields of barley. Similar results were also reported by Kouzegaran *et al.* (2015).

Results showed that both irrigation and nitrogen treatments significantly affected the harvest index of barley. From the data, it is clear that HI decreased significantly from 39.91 under I_0 treatment of irrigation to 38.72 under I_2 followed by I_3 (38.01) and I_1 (37.46) treatments of irrigation. The harvest index decreased with increase in the frequency of irrigation from 39.91 to 38.72, 38.01 and 37.46 with application of one irrigation at flag leaf stage (I_2), one irrigation at tillering (I_1), and application of two irrigation first at tillering and second at flag leaf stage (I_3), respectively. This might be due to increased vegetative growth as well as yield attributes under higher number of irrigations. Similar results were also reported by Tani *et al.* (2016).

The increasing levels of nitrogen significantly decreased the HI from 39.24 under N_0 to 38.62, 38.18 and 38.05 under N_{30}, N_{60} and N_{90} levels of nitrogen, respectively. However, N_{30}, N_{60} and N_{90} levels of nitrogen were at par in respect to harvest index. This might be on account of increased vegetative growth which could not be transformed into grain in same proportion under higher levels of nitrogen. Similar results were also reported by Reddy *et al.* (2018).

Data revealed that both irrigation and nitrogen treatments significantly affected the nitrogen content in grain of barley.

Table 3 : Effect of different treatments on nitrogen content and uptake in barley

Treatment	N content in grain (%)	N content in straw (%)	N uptake by grain	N uptake by straw (kg ha^{-1})	Total N uptake (kg ha^{-1})
Irrigation					
I_0 (no irrigation)	1.11	0.31	37.68	16.00	53.68
I_1 (at tillering stage)	1.30	0.35	46.73	20.30	67.03
I_2 (at flag leaf stage)	1.18	0.33	41.80	18.52	60.32
I_3 (at tillering + flag leaf stage)	1.31	0.36	48.74	21 .78	70.53
SE (d)	0.002	0.002	0.19	0.10	0.27
CD at 5%	0.005	0.004	0.48	0.24	0.66
Nitrogen Levels					
N 0 (no nitrogen)	1.14	0.31	37.09	15.97	53.06
N 30(30 kg N ha^{-1})	1.19	0.33	41.50	18.67	60.17
N 60(60 kg N ha^{-1})	1.25	0.34	46.70	20.26	66.96
N 90(90 kg N ha^{-1})	1.31	0.35	49.66	21.70	71.36
SE (d)	0.003	0.003	0.35	0.22	0.42
CD at 5%	0.007	0.007	0.73	0.47	0.88

Results make it clear that different treatments of irrigation brought significant increase in nitrogen content in grain. Maximum nitrogen content in grain (1.31%) was recorded under I_3 treatment of irrigation followed by I_1, I_2 and I_0 treatments of irrigation. The data presented in Table 3 indicated that the increasing levels of nitrogen significantly increased the nitrogen content in grain from 1.14 per cent under N_0 to 1.19, 1.25 and 1.31 per cent under N_{30}, N_{60} and N_{90} treatments of nitrogen, respectively.

The data revealed that irrigation and nitrogen treatments significantly affected the nitrogen content in straw content of barley. It is evident from the Table 3, that different treatments of irrigation significantly increased the nitrogen content in straw. Maximum nitrogen content in straw (0.36%) was recorded under I_3 treatment of irrigation followed by I_1, I_2 and I_0 treatments of irrigation. Increasing levels of nitrogen significantly increased the nitrogen content in straw from 0.31 per cent under N_0 to 0.33, 0.34 and 0.35 per cent under N_{30}, N_{60} and N_{90} treatments of nitrogen, respectively.

Application of two irrigations increased the nitrogen content by 18.02, 0.77 and 11.01 per cent in grain and 16.12, 2.85 and 9.09 per cent in straw over no irrigation, one irrigation at tillering and one irrigation at flag leaf stage, respectively. This might be due to more absorption of nitrogen by the crop with increasing number of irrigations.

Both irrigation and nitrogen treatments significantly affected the nitrogen uptake by grain of barley. The data reveals that N uptake by grain was significantly affected by various irrigation treatments. The maximum N uptake by grain (48.74 kg ha^{-1}) was significantly higher under I_3 followed by I_1, I_2 and I_0 treatments of irrigation. The N uptake by grain significantly increased from 37.09 kg ha^{-1} under N_0 to 41.50, 46.70 and 49.66 kg ha^{-1} under N_{30}, N_{60} and N_{90} treatments of nitrogen, respectively.

Both irrigation and nitrogen treatments significantly affected the nitrogen uptake by straw of barley. The data presented in Table 3 makes it clear that N uptake by straw was significantly affected by various irrigation treatments. The maximum N uptake by straw (21.78 kg ha^{-1}) was significantly higher under I_3 followed by I_1, I_2 and I_0 treatments of irrigation. Increasing levels of N also increased N uptake by straw significantly from 15.97 kg ha^{-1} under N_0 to 18.67, 20.26 and 21.70 kg ha^{-1} under N_{30}, N_{60} and N_{90} treatments of nitrogen, respectively.

The nitrogen uptake increased significantly with the application of higher number of irrigations. The nitrogen uptake by grain increased from 37.68 kg ha^{-1} under no irrigation (I_0) to 41.80, 46.73 and 48.74 kg ha^{-1} with I_2, I_1 and I_3 treatments of irrigation, respectively. Likewise the nitrogen uptake by straw increased from 16.00 kg ha^{-1} under I_0 to 18.52, 20.30 and 21.70 kg ha^{-1} under I_2, I_1 and I_3 treatments of irrigation, respectively. The higher production of total biomass (grain + straw) as a result of high frequency of irrigation might have increased the nitrogen uptake by grain and straw of barley. Similar results have also been reported by Hingonia *et al.* (2016).

The data pertaining to total N uptake is presented in Table 3. The results indicated that total N uptake by barley was significantly affected by both irrigation and nitrogen levels. It is evident from Table 3 that total N uptake increased from 53.68 kg ha^{-1} under I_0 to 60.32, 67.03 and 70.53 kg ha^{-1} under I_2, I_1 and I_3 treatments of irrigation, respectively. The increasing levels of nitrogen increased total N uptake from 53.06 kg ha^{-1} under N_0 to 60.17, 66.96 and 71.36 kg ha^{-1} under N_{30}, N_{60} and N_{90} levels of nitrogen, respectively. Similar findings were also reported by Pankaj *et al.* (2016).

Both irrigation and nitrogen treatments significantly affected the protein content in grain of barley. Perusal of data given in Table 3 make it clear that application of two irrigations first at tillering and second at flag leaf stage (I_3) significantly increased the protein content in grain (8.28%) as compared to I_0 (6.93%), I_1 (8.19%) and I_2 (7.41%) treatments of irrigation. This might be attributed to increase in nitrogen content in grain with the increasing number of irrigations. Similar results were also reported by Tabarzad *et al.* (2016). The increasing levels of nitrogen increased the protein content in grain significantly from 7.15 per cent under N_0 to 7.47, 8.00 and 8.18 per cent under N_{30}, N_{60} and N_{90} treatments of nitrogen, respectively. These findings are corroborated with the results of Waluchio *et al.* (2015).

CONCLUSION

Hence this might be concluded that application of two irrigations first at tillering and second at flag leaf stage along with 90 kg nitrogen per hectare gives highest grain yield, straw yield, nitrogen content and nitrogen uptake by grain, straw and protein content as compared to other irrigations (no irrigation, one irrigation at tillering stage, one irrigation at flag leaf stage) and nitrogen treatments (0, 30 and 60 kg ha^{-1}).

REFERENCES

Amare A and Adane L. 2015. Grain quality and yield response of malt barley varieties to nitrogen fertilizer on brown soils of Amhara region, Ethiopia. *World Journal of Agricultural Sciences* **11** (3): 135-143.

Anjum MM, Ali N and Owais IM. 2017. Growth and yield of barley (*Hordeum vulgare* L.) as influenced by potassium under water deficit conditions of Peshawar valley. *Research in Agricultural and Veterinary Science* **1** (2): 96-102.

FAO. 2017. Statistical Information. Food and Agricultural Organization of the United Nations accessed on 2017.

Galav A and Bharose R. 2017. Effect of dates of sowing, varieties, irrigation schedule and agro meteorological indices on growth and yield attributes of barley varieties under Allahabad conditions. *Journal of Pharmacognosy and Phytochemistry* **6** (5): 1363-1366.

Hingonia K, Singh RK, Meena RN, Verma HP and Meena RP. 2016. Effect of mulch and irrigation levels on yield and quality of barley (*Hardeum vulgare* L.). *Journal of Pure and Applied Microbiology* **10** (4): 2925-2930.

Jai P, Siddiqui MZ, Dwivedi A, Thaneshwar Bankoti P and Singh A. 2015. Effect of irrigation and fertility balance on performance and production economics of barley (*Hordeum vulgare* L.). *International Journal of Agriculture Sciences* **7** (13): 817-821.

Kouzegaran MR, Moosavi SG and Seghatoleslami MJ.2015. Effect of irrigation and nitrogen levels on yield and some traits of barley. *Biological Forum – An International Journal* **7** (1): 470-476.

Pankaj SC, Sharma PK, Chouksey HD. and Singh, S. K. 2015. Growth and development pattern of barley varieties as influenced by date of sowing and nitrogen levels. *The Bioscan* **10** (3): 1299—1302.

Pankaj SC, Sharma PK and Singh SK. 2016. Chlorophyll content and nitrogen uptake by barley varieties as influenced by date of sowing and nitrogen levels. *Environment and Ecology* **34** (2A): 745—749.

Reddy BC, Singh R, Praveena R and Sohail SA. 2018. Effect of sowing dates and levels of nitrogen on yield attributes, protein content and economics of barley (*Hordeum vulgare* L.). *International Journal of Current Microbiology and Applied Sciences* **7** (8): 435-440.

Tabarzad A, Ghaemi AA and Zand-Parsa S. 2016. Barley grain yield and protein content response to deficit irrigation and sowing dates in semi-arid region. *Modern Applied Science* **10** (10): 193-207.

Tani NN, Reza SN, Kader MA, Hasan AK and Akter MA. 2016. Performance of wheat, barley and triticale as influenced by irrigation levels and terminal heat stress. *Asian Australian Journal of Bioscience and Biotechnology* **1** (3): 402-409.

Terefe D, Desalegn T and Ashagre H. 2018. Effect of nitrogen fertilizer levels on grain yield and quality of malt barley (*Hordeum vulgare* L.) varieties at Wolmera district, Central highland of Ethiopia. *International Journal of Research Studies in Agricultural Sciences* **4** (4): 29-43.

Waluchio NS, Othieno CO, Ngetich WK and Ochuodho J. O. 2015. Evaluation of nitrogen fertilizer and lime on grain yield, protein content and kernel weight of barley (*Hordeum vulgare* L.) in Kenya. *International Journal of Plant and Soil Science* **8** (4): 1-7.

Citation:

Kumar A, Tyagi S, Dubey SK and Kumar S. 2019. Effect of levels of irrigation and nitrogen on growth, yield and nitrogen uptake in barley. *Journal of AgriSearch* **6**(1): 16-20