

PERFORMANCE OF BARLEY AS INFLUENCED BY IRRIGATION SCHEDULING AND CULTIVARS

M.D. Parihar*, Sushil Kumar Singh, Manoj Kumar Sharma and J.M. Sutaliya

Department of Soil Science, College of Agriculture CCSHAU, Hisar, Haryana

Received-08.09.2021, Revised-19.09.2021, Accepted-28.09.2021

Abstract: A field experiment was conducted during *rabi* 2020-21 at Research farm, Department of Soil Science, Chaudhary Charan Singh Haryana Agricultural University, Hisar, to assess the impact of irrigation scheduling on yield attributes, yield and water productivity of various barley cultivars. The experiment was consisted two barley cultivar viz., BH 393 and BH 75 with four moisture regimes viz., 60, 80, 100 and 120 mm cumulative pan evaporation (CPE) in split plot design. First irrigation was applied at 36 days after sowing (DAS) irrespective of irrigation schedules then subsequent irrigations were applied based on moisture regimes. The results of the experiment revealed that maximum number of effective tillers per metre row length (69.75), seeds per spike (62.53) and higher test weight (36.35 g) & grain yield (45.13 q/ha) was recorded in BH-393 than BH-75 (61.93, 52.25, 36.01 & 38.90, respectively). Among moisture regimes, CPE-60 mm recorded significantly higher number of seeds per spike (61.50), effective tiller per meter row length (69.30), test weight (36.63 g) and grain yield (43.70 q ha⁻¹) as compared to rest of the treatments. Highest irrigation water productivity (3.48 kg m⁻³) and total water productivity (1.87 kg m⁻³) was recorded when irrigation were applied at 80 mm CPE followed by irrigation at 100, 120 and the least with irrigation at 60 mm CPE. Among the cultivars, BH 393 performed better in term of irrigation water productivity (3.29 kg m⁻³) and total water productivity (1.91 kg m⁻³).

Keywords: Barley, Grain yield, Moisture regimes, Cultivar, Water productivity

INTRODUCTION

Barley (*Hordeum vulgare* L.) is the most important multipurpose winter cereal crop in the world. In India, barley is one of the most widely cultivated among cereal crops. It has low input requirement, so it is preferred by the resource poor farmers in the country. Barley contains about 78% carbohydrates, 1% fat, 10% protein and 10% water. It was cultivated on about 8.10 lakhs hectare area and production of 1.79 Mt with productivity of approximately 26 q/ha (Annual report 2017- 18). The major producing states are Rajasthan, Uttar Pradesh, Haryana and Punjab. In Haryana, it was grown on an area of 0.02 million ha with the production of 0.73 million tonnes and productivity of 3,650 kg/ha (indiastat.com, 2019). Barley has been used as animal fodder, as a source of fermentable material for beer and certain distilled beverages and as a component of various health foods increase its industrial demand and presently 25-30% of total barley produced in the country is used in the manufacturing of malt extract, which is further utilized for brewing, distillation, baby foods, coca-malt drinks and medicinal syrups (Jena, 2016).

The major constraints limiting barley production are poor fertility status of coarse textured sandy soils coupled with imbalanced nutrition and poor irrigation management, out dated varieties and lack of modern technologies. To meet the water crises, the conservation of water through irrigation management is most crucial for sustaining long term agricultural production and livelihood security of fast growing population (Dadhich and Meena, 2015; Dadhich *et al.*, 2014). Soil moisture is one of the most important factors which influence the availability of water and

nutrients to plants Interval of irrigation application greatly influences the soil moisture and hence, growth and grain yield of barley. In irrigation management, irrigation scheduling plays an important role in water saving. Judicious use of irrigation water improves the efficiency of other applied inputs leading to increased crops yield and thus enhances the overall water productivity. So, keeping the above facts in view the present investigation to assess the impact of irrigation scheduling on yield attributes, yield and water productivity of various barley cultivars (*Hordeum vulgare* L.) have been planned with the objectives to study impact of irrigation scheduling on yield attributes, yield and water productivity of barley cultivars.

MATERIALS AND METHODS

Experiment was carried out during *Rabi* 2020-21 at Research Farm, Department of Soil Science, CCS Haryana Agricultural University, Hisar, situated in semi-arid, subtropics at 29°10'N latitude and 75°46'E longitude at an elevation of 215.2 metres above mean sea level. The average annual rainfall is about 450 mm, with major variations in total rainfall as well as distribution. The soil texture of the experimental site was sandy loam in surface to loam in lower depths in the profile. The experimental soil was slightly alkaline, low in organic carbon content, low in available nitrogen (178.0 kg/ha), medium in available phosphorus (18.0 kg/ha) and high in available potassium (320.0 kg/ha). The soils are calcareous in nature and having few CaCO₃ concretions below 50 cm depth. The pH varies from

*Corresponding Author

7.6 to 8.4 and EC_e from 0.43 to 0.89 $dS\ m^{-1}$. The Ca is the dominating cation and ESP is generally <5. Soil samples were taken at sowing and at harvest of crop to determine soil profile moisture of different soil depths 0-15, 15-30, 30-60, 60-90, and 90-120 cm. The soil moisture percentage (w/w) was calculated on dry weight basis by using the following formula:

Gravimetric soil moisture (%) = {(Weight of wet soil - Weight of dry soil) / Weight of dry soil} x 100

The gravimetric soil moisture was multiplied by the bulk density of the respective soil layer to convert it into volumetric water content. The volumetric water content is multiplied by the depth of the respective layer to obtain the soil water content in terms of depth of water in the soil given soil layer. It was summed up for all the layers to get profile moisture storage.

The impact of irrigation schedules on barley cultivars BH 393 and BH 75 were evaluated under four moisture regimes *viz.*, irrigation at 60, 80, 100 and 120 mm CPE during *rabi* season of 2020-21. Experiment was laid out in split plot design with eight treatment combinations. The experimental area was divided into 24 plots and the treatments were replicated thrice. The size of each experimental plot was 5x15 m area. Experimental crop was sown on 5th December 2020 with a pre-sown irrigation and was fertilized with 80 kg N and 40 kg P_2O_5 /ha through DAP and Urea. Irrigations were applied as per treatments based on cumulating pan evaporation in individual plot by flooding and the depth was measured with the help of water meter. Daily cumulative pan evaporation and rainfall data was collected from meteorological observatory situated near the experimental field. Water productivity was computed as the ratio of grain yield to total water used (WP total) and irrigation water applied (WP irrigation).

RESULTS AND DISCUSSION

Crop water use

The entire amount of rainfall received during the crop season was considered as effective rainfall. The effective rainfall received during barley crop period was 14.3 mm and the cumulating pan evaporation 394.1 mm was recorded is given in Table 1. First irrigation was applied at 36 days after sowing irrespective of irrigation schedules and subsequent schedules of irrigation were based on cumulative pan evaporation (CPE) of 60, 80, 100 and 120 mm. A total of three irrigations were applied at 60 mm CPE and two at 80, 100 and 120 mm CPE. Total depth of water applied at 60 mm CPE was 18.3 cm. In treatments, at 80, 100 and 120 mm CPE only two irrigations were applied as detailed in Table 3. The total depth of water applied in these treatments was 12.2 cm (Table 2).

Soil moisture depletion: Higher amount of moisture was depleted from soil depth 0-120 cm at moisture regime 80 mm CPE (8.99 cm) followed by 100 mm CPE (8.60 cm), 120 mm CPE (8.16 cm) and lowest with 60 mm CPE (8.09 cm).

Total water use: The water use from different sources *i.e.*, rainfall, depletion from soil and post sown irrigations in both the barley varieties was almost similar given in Table 3. Maximum amount of 27.74 cm water was used under high moisture regime of irrigation at 60 mm CPE and lowest was 21.79 cm in moisture regime of 120 mm CPE.

Water productivity (WP): The water productivity of irrigation and total water used was higher of BH-393 (3.29 & 1.91 $kg\ m^{-3}$) than BH-75 (2.83 & 1.64 $kg\ m^{-3}$). Among the moisture regimes, the irrigation and total water productivity was highest with irrigation at 80 mm CPE (3.48 & 1.87 $kg\ m^{-3}$) followed by 100 mm CPE (3.41 & 1.86 $kg\ m^{-3}$), however lowest irrigation water and total water productivity was observed with irrigation at 60 mm CPE (Table 4).

Table 1. Daily rainfall (mm) and pan evaporation (mm) from December, 2020 to April, 2021

Day	Dec 2020		Jan. 2021		Feb. 2021		Mar. 2021		April 2021	
	Rainf all	Pan Evp	Rainfa ll	Pan Evp	Rainfa ll	Pan Evp	Rainfa ll	Pan Evp	Rainfa ll	Pan Evp
1	0.0	2.0	0.0	0.6	0.0	1.5	0.0	2.8	0.0	6.6
2	0.0	2.9	1.2	1.2	0.0	2.3	0.0	3.3	0.0	6.8
3	0.0	1.6	0.0	1.0	0.0	2.3	0.0	3.8	0.0	6.4
4	0.0	1.3	0.0	1.4	8.7	2.2	0.0	2.8	0.0	5.2
5	0.0	2.0	3.5	1.1	0.0	2.5	0.0	4.4	0.0	2.7
6	0.0	2.0	4.2	0.9	0.0	1.8	0.0	3.3	0.0	7.4
7	0.0	1.6	0.0	1.9	0.0	1.3	0.0	2.6	0.0	7.6
8	0.0	1.3	0.0	1.4	0.0	1.4	0.0	3.0	0.0	8.1
9	0.0	1.2	0.0	1.0	0.0	1.7	0.0	2.8	0.0	6.8

10	0.0	1.6	0.0	1.2	0.0	1.9	0.0	3.8	0.0	7.0
11	0.0	1.8	0.0	1.0	0.0	1.9	0.0	2.8	0.0	6.9
12	0.0	2.1	0.0	1.3	0.0	1.4	1.2	2.3	0.0	6.3
13	0.0	1.3	0.0	0.7	0.0	1.0	0.0	2.6	0.0	6.9
14	0.0	0.9	0.0	0.6	0.0	0.6	0.0	4.5	0.0	5.4
15	0.0	1.2	0.0	0.8	0.0	1.3	0.0	3.3	0.0	8.3
16	0.0	1.2	0.0	1.0	0.0	1.4	0.0	3.0	0.0	8.1
17	0.0	0.9	0.0	0.8	0.0	1.6	0.0	2.8	0.0	5.5
18	0.0	0.9	0.0	1.2	0.0	1.9	0.0	3.5	0.0	5.3
19	0.0	1.6	0.0	1.0	0.0	1.0	0.0	3.6	0.0	6.5
20	0.0	1.6	0.0	1.2	0.0	1.3	0.0	3.5	0.0	7.1
21	0.0	1.2	0.0	0.9	0.0	1.0	0.0	3.7	0.5	4.2
22	0.0	1.3	0.0	1.5	0.0	1.4	0.2	3.9	0.0	4.3
23	0.0	1.4	0.0	1.0	0.0	2.3	4.2	6.4	0.0	8.0
24	0.0	0.8	0.0	1.3	0.0	2.7	0.0	2.9	0.0	7.2
25	0.0	0.9	0.0	0.7	0.0	2.9	0.0	2.6	0.0	7.6
26	0.0	1.0	0.0	1.0	0.0	2.8	0.0	3.8	0.0	8.1
27	0.0	1.0	0.0	1.2	0.0	3.2	0.0	4.0	0.0	7.4
28	0.0	2.7	0.0	1.6	0.0	2.8	0.0	4.4	0.0	8.5
29	0.0	0.8	0.0	1.4	-	-	0.0	4.8	0.0	9.3
30	0.0	1.6	0.0	1.3	-	-	0.0	7.8	0.5	7.3
31	0.0	0.7	0.0	1.4	-	-	0.0	8.1	-	-
Total	0.0	44.4	8.9	34.6	8.7	51.4	5.6	116.9	1.0	202.8

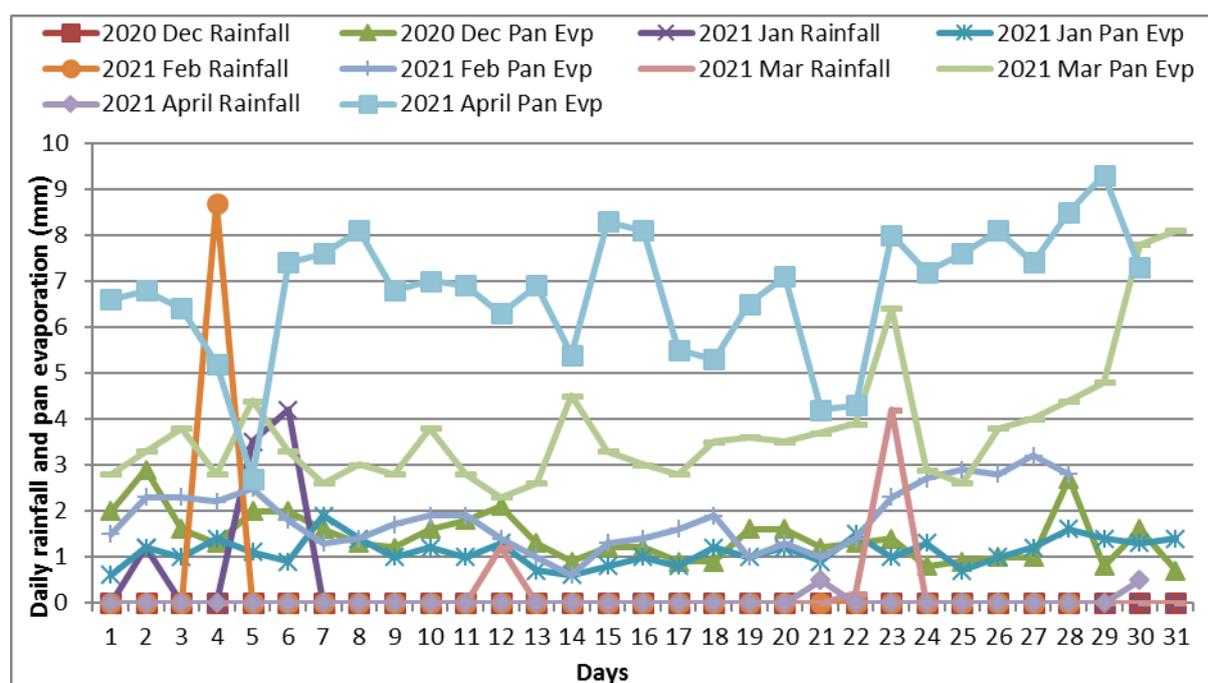


Fig.1. Daily rainfall and pan evaporation (mm) from December, 2020 to April, 2021

Table 2. Irrigation dates under various moisture regimes

Moisture regimes	60 mm CPE	80 mm CPE	100 mm CPE	120 mm CPE
Dates	11.1.2021, 26.2.2021, 17.3.2021	11.1.2021, 4.3.2021	11.1.2021, 11.3.2021	11.1.2021, 17.3.2021
Total depth (cm)	18.3	12.2	12.2	12.2

Table 3. Water use by barley varieties under various moisture regimes

Treatment	Soil moisture depletion (cm)	Rain Fall (cm)	Post sown irrigation (cm)	Total Water use (cm)
Varieties				
BH -393	8.48	1.43	13.73	23.59
BH-75	8.44	1.43	13.73	23.59
Moisture regime				
CPE=60mm	8.09	1.43	18.30	27.74
CPE=80mm	8.99	1.43	12.20	22.62
CPE=100mm	8.60	1.43	12.20	22.23
CPE=120mm	8.16	1.43	12.20	21.79

Growth and yield: Plant height (cm) varied significantly due to varieties. Among the cultivars, maximum plant height at harvest stage was observed in BH 75 (103.61 cm), which was significantly higher than BH 393 (80.88 cm). This difference in plant height may be due to their individual varietal characters. The cultivars have significant effect on yield attributes viz., number of effective tillers per metre row length, seeds per spike, 1000 grain weight (g) and grain yield (q/ha). Maximum number of effective tillers per metre row length (69.75), seeds per spike (62.53), 1000 grain weight (36.35) and grain yield (45.13 q/ha) was observed with BH 393 then BH 75 (61.93, 52.25, 36.01 & 38.90, respectively). Grain yield of BH -393 was 16.01% higher than cultivar BH 75.

Plant height of barley was significantly higher at moisture regimes CPE-60 mm followed by CPE (mm) 80, 100 and 120. It may be due to more frequency of irrigation water which resulted in more availability of soil moisture for longer period. The

similar results were reported by Elmobarak *et al.*, (2007) & Singh *et al.*, (2001). They revealed that application of irrigation after every 10 days gave the highest plant height which was significantly more than irrigation applied after every 20 days. Data presented in table 4 shows different moisture regimes had significantly effect on plant height (cm), number of effective tillers per metre row length, seeds per spike, 1000 grain weight (g) and grain yield (q/ha). Irrigation at CPE-60 mm produced taller plants (95.80 cm), number of effective tillers (69.30 mrl), seeds per spike (61.50), higher 1000grain weight (36.63) and grain yield (43.70 q/ha) of barley followed by moisture regimes of CPE 80 mm (92.53, 66.73, 58.10, 36.23 & 42.46, respectively), CPE 100 mm (91.40, 64.76, 55.76, 36.02 & 41.66, respectively) and CPE 120 mm (89.26, 62.56, 54.20, 35.87 & 40.25, respectively) (Table 4). This might be ascribed to better growth and development of barley crop under moisture regimes 60 mm CPE due to more number of irrigation as compared to lower

moisture regimes. These results are also in conformity with those of Mammouie *et al.*, (2006) and Galav *et al.* (2017).

Table 4. Effect of different moisture regimes on yield, yield attributes water productivity of Barley

Treatment	Plant height (cm)	Effective Tillers per mrl (no.)	Grains/spike	1000-grain wt. (g)	Grain yield (q ha ⁻¹)	Irrigation water productivity (kg m ⁻³)	Total water productivity (kg m ⁻³)
Varieties							
BH -393	80.88	69.75	62.53	36.35	45.13	3.29	1.91
BH -75	103.61	61.93	52.25	36.01	38.90	2.83	1.64
SEm±	0.24	0.47	0.15	0.02	0.20		
CD (p=0.05)	1.57	1.45	1.03	0.14	1.34		
Moisture regime							
CPE=60mm	95.80	69.30	61.50	36.63	43.70	2.38	1.57
CPE=80mm	92.53	66.73	58.10	36.23	42.46	3.48	1.87
CPE=100mm	91.40	64.76	55.76	36.02	41.66	3.41	1.86
CPE=120mm	89.26	62.56	54.20	35.87	40.25	3.29	1.84
SEm±	0.17	0.67	0.18	0.04	0.37		
CD (p=0.05)	0.55	2.05	0.56	0.12	1.16		

CONCLUSION

Based on the results of the study BH 393 with the irrigation at CPE-60 mm it may be recommended to achieve higher grain yield of barley in Haryana.

REFERENCES

- Dadhich, R.K. and Meena, R.S.** (2015). Enhancement of productivity of Indian mustard (*Brassica juncea* L.) by foliar spray of thiourea and thioglycolic acid under different irrigation levels. *Ecology, Environment and Conservation*. 21(3): 131-136.
- Dadhich, R.K., Reager, M.L., Kansoti, B.C. and Meena, R.S.** (2014). Efficacy of Growth Substances on Mustard (*Brassica juncea* L.) under Hyper Arid Environmental Condition of Rajasthan. *The Ecoscan*, 8(3): 269-272.
- Elmobarak, A., Mohamed, M.A., Khair, M.A. and Richter, A.C.** (2007). Effects of irrigation interval, sowing method and nitrogen application on forage

and grain yield of barley in the gezira scheme, Sudan Tropentag, October 9–11, Witzhausen

- Galav, Atu and Bharose, Ram** (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.

Jena (2016). Effect of mix and alone application of herbicides with and without surfactant on weeds in barley. M.Sc. Thesis. Department of Agronomy, BHU, Varanasi.

- Mammouie, E., Fotouhi, G.R., Esfahany, M. and Nakhoda, B.** (2006). The effect of water deficit on crop yield and the physiological characteristics of barley (*Hordeum vulgare* L.) varieties. *Journal of Agricultural Science Technology* 8: 211– 19.

Singh, Paramjit, V.P. and Kaur, A. (2001). Effect of different levels of nitrogen on growth and yield of malt barley var. Alfa-93. *Crop Research* 21: 261–64. Annual report of Agricultural Statistics Division, Directorate of Economics & Statistics, Department of Agriculture, Cooperation and Farmers Welfare, Third

Advance Estimates of Production of Food grains for 2017-18.

Indiastat.com. 2019. Area, production and average yield of barley in India. <http://www.indiastat.com>.