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Effect of N P Level and Zinc Nutrition on Growth Attributes and Yield of Barley (*Hordeum vulgare* L.) in Southern Rajasthan

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ABSTRACT: A field experiment was conducted during *Rabi* 2017-18 at Instructional Farm, Rajasthan College of Agriculture, Udaipur to find out the effect of nitrogen, phosphorus level and zinc nutrition on growth attributes and yield of Barley (*Hordeum vulgare* L.) in southern Rajasthan. The experiment consisted of 12 treatments combinations comprising 4 N P levels (75, 100, 125 and 150% RDF) and 3 zinc levels (2.5 and 5.0 kg ha^{-1}). The experiment was laid out in factorial randomized block design with three replications. The experimental field was clay loam in texture, slightly alkaline in reaction (pH 7.8), medium in available nitrogen (295.30 kg ha^{-1}) and phosphorus (24.5 kg ha^{-1}), medium in potassium (292.70 kg ha^{-1}) and low in available zinc status (0.58 ppm). Application of 125% RDF significantly increased plant height, dry matter accumulation at all the stages, CGR during 90-120 DAS and RGR of barley crop during 30-60 DAS over 75 and 100% RDF. Application of 125% RDF statistically increased grain yield over 75% RDF to the tune of 43.08 per cent.

Keywords: Barley, Growth attributes, yield, protein content, maize.

INTRODUCTION

Barley (*Hordeum vulgare* L.) has the widest ecological range amongst cereals and is widely grown in Rajasthan. Barley crop is frequently being described as the most cosmopolitan of the crops and also considered as poor man's crop because of the low input requirement and better adaptability to drought, salinity, alkalinity and marginal land (FAO, 2020). During 2017-18, at global level the crop was cultivated on nearly 49.00 million hectares area with production of 137.47 million tons with the productivity of 2805 kg ha^{-1}. In India, during the same reference period, the crop occupied nearly 0.68 lakh hectares area producing nearly 17.88 lakh tons grain with a productivity of 2641 kg ha^{-1}. While in Rajasthan, during 2017-18 the crop was cultivated on 2.81 lakh hectares with 8.56 lakh tons of production with the productivity of 3046 kg ha^{-1}. Its cultivation in India was suffered during green revolution period due to replacement of barley from marginal land and rainfed areas by more remunerative oilseed and pulses.

Nitrogen is a major nutrient which provide lush green plant colour on account of increase in chlorophyll. Being an essential element it plays an important role in crop development and yield. The deficiency of this element has been found as one of the major yield limiting factors for barley production. Application of nitrogen at lower rates adversely affects growth and grain yield of this crop. Yield and protein content in barley seeds increase with increase in nitrogen rate which is indispensable for increasing crop production. It is an important constituent of molecules, enzymes, coenzymes and cytochromes. It is also an important constituent of protoplasm and chlorophyll and associated with the activity of living cells. Therefore, for full exploitation of the higher yield potential of high yielding barley varieties, increase rate of nitrogen fertilization is of prime importance. In addition to nitrogen, phosphorous is of paramount importance for energy transfer in living cells by means of high energy phosphate bonds of ATP. Thus, it plays a pivotal role in formation and translocation of carbohydrates, fatty acids, glyceroids and other essential intermediate compounds. With the intensification of agriculture by the use of high yielding short duration varieties and high analysis fertilizer, the deficiency of micro nutrient in general and zinc in particular has turned out to be an important limiting factor in agriculture. According to FAO, about 30% of the cultivated soils in the world are deficient in zinc.

MATERIALS AND METHODS

The experiment was conducted at the Instructional Farm, Rajasthan College of Agriculture, MPUAT, Udaipur which is situated at 24°35′N latitude, 72° 42′E longitude and at an altitude of 579.5 m above mean sea level. It falls under agroclimatic zone IVa (Sub-Humid Southern Plain and Aravalli Hills) of Rajasthan. This zone falls under sub-tropical climatic conditions characterized by mild winters and moderate summers associated with high relative humidity during the months of July to September. The mean annual rainfall of the region is 637 mm, most of which is contributed by South-West monsoon from July to September. Rainfall received during crop season was only 4.20 mm. The experimental field was clay loam in texture, slightly alkaline in reaction (pH 7.8), medium in available nitrogen (295.30 kg ha^{-1}) and phosphorus (24.5 kg ha^{-1}), medium in potassium (292.70 kg ha^{-1}) and low in available zinc status (0.58 ppm). The experiment consisted of 12 treatments combinations comprising 4 N P levels and 3 zinc levels with three replication. The gross plot area of each plot was 5.0 m × 3.15 m and net plot area was 4.0 m × 1.80 m. The treatment details are as follows:

(A) N P levels: 75% RDF, 100% RDF, 125% RDF and 150% RDF

(B) Zinc levels (kg ha^{-1}): 1. 0 kg ha^{-1}, 2.5 kg $ha^{-1}$and 5 kg ha^{-1}.

The recommended dose of fertilizer is 60 kg N and 20 kg P_2O_5 ha^{-1}.

The barley variety 'RD 2035' was sown on 14th November 2017 in furrows opened at 22.5 cm apart and seeds were placed at a depth of 3-4 cm after pre sowing irrigation using seed rate of 100 kg ha^{-1}. The recommended dose of N and P was 60 and 20 kg ha^{-1}. Nitrogen, phosphorus and zinc were applied as per treatment through urea, DAP and zinc sulphate as source of nitrogen, phosphorus and zinc, respectively. The total quantity of phosphorus and zinc and half of nitrogen were drilled in furrows at sowing. The remaining half nitrogen was applied in two equal splits *i.e*., at first and second irrigations. Three irrigation was given during whole crop growth period on 09th Dec. 2017, 14th January 2018 and 13th Feb. 2018. Urea was top dressed in two split doses as per treatment. The crop was harvested on 18th March 2018.

The height of five randomly tagged plants from each plot was measured in cm from base of plant to the tip of flag leaf at 30, 60, 90 DAS and at harvest. The periodical change in dry matter accumulation at 30, 60, 90 DAS and at harvest was recorded in gram by collecting whole plant samples from randomly selected observational rows of each plot in 1 m running length of row.

CGR Crop growth rate (g m^{-2} day^{-1}) was computed between 30-60, 60-90 and 90-120 DAS by the following formulae as given by Redford (1967).

$$\text{CGR}\left(\text{g m}^{-2}\text{day}^{-1}\right)=\frac{W_2 - W_1}{t_2 - t_1}$$

Where,

W_1 and W_2 are plant dry weight (g) at time t_1 and t_2, respectively.

$$\text{RGR}\left(\text{g g}^{-1}\text{day}^{-1}\right)=\frac{\text{loge}W_2 - \text{loge}W_1}{t_2 - t}$$

Where,

W_1, W_2 are dry matter at time t_1 and t_2, respectively. Grain yield was recorded in as kg $plot^{-1}$, thereafter; it was converted into kg ha^{-1}.

RESULTS AND DISCUSSION

Results are presented in Tables 1 and 2 and discussed under following heads:

Effect of N P levels: Data perusal in Table 1 revealed that plant height was significantly influenced with 125% RD of N P at 30 DAS, 60 DAS, 90 DAS and at harvest. However, there is successive increase up to 150% NP level but at par with 125% NP level. Application of 125% RD of N P significantly influenced the dry matter accumulation (g m^{-1} row length) at all the stages over 75% and 100% RD of NP. It is evident from data that 100% RDF significantly increased crop growth rate as compared to 75% RDF whereas 125% and 150% N P levels could not significantly affect CGR during 30- 60 DAS, 60-90 DAS and 90-120 DAS crop growth period. Data pertaining in Table-1 revealed that except 30-60 days stage of crop growth RGR was not affected significantly both at 60-90 DAS and 90-120 DAS. N P levels could not influence days to 50% heading significantly. 150% RDF recorded maximum days to maturity (120.8) compared to rest of the treatments and it was significantly superior over 75 and 100% RDF. The minimum days to maturity of 110.5 days was recorded with 75% RDF. It is obvious that higher N P levels increased nutrient supply in the *rhizosphere*, which culminated into more absorption and higher uptake of nutrients by the crop. This could have resulted into better growth in terms of plant height and dry matter accumulation. Significant improvement in these growth parameters probably resulted into better interception, absorption and utilization of radiant energy leading to higher photosynthetic rate and finally more accumulation of dry matter by plants. Increase in plant height and dry matter accumulation with increasing N P levels are in close conformity with the findings of several researches in cereals including barley (Tigre *et al.,* 2014; Wakene *et al.,* 2014; Amanullah *et al*., 2016). Increasing N P levels enrich soil media which in turns provide more opportunity of their availability right from the sowing of the crop and cause vigorous growth of individual plant. Among both these nutrients, nitrogen plays a very important role in crop productivity (Oikeh *et al*., 2007; Worku *et al*., 2007). Shafi *et al.* (2011) considered that nitrogen is the element which helps in achieving consistently high yields in cereals and it is a constituent of many fundamental cell components such as nucleic acids, amino acids, enzymes and photosynthetic pigments. Thus, nitrogen is the most indispensible for growth and development of crop. On the other hand phosphorus has a great importance in plant nutrition and involves in the processes of energy transformations, genetic inheritance, protein synthesis and cell division. Moreover, it enhances root development and strengthening of straw, affects flowering, fruiting, seed formation and crop maturation (Gebreslassie and Demoz, 2016).

Table 1: Effect of N P level and zinc nutrition on growth attributes of barley.

Treatment	Plant height (cm)				Dry matter accumulation (g m^{-1} row length)				CGR (g m^{-2} day^{-1})			RGR (g g^{-1} day^{-1})			Days to 50% heading	Days to maturity
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest	30-60 DAS	60-90 DAS	90 – 120 DAS	30-60 DAS	60-90 DAS	90 – 120 DAS		
N P levels																
75% RDF	30.7	54.0	67.7	69.3	18.80	64.63	145.75	181.45	1.528	2.704	1.190	0.0597	0.0109	0.0075	82.7	110.5
100% RDF	35.6	63.3	79.7	81.2	22.45	77.03	174.95	223.45	1.819	3.264	1.617	0.0576	0.0103	0.0078	85.5	113.8
125% RDF	39.3	69.9	85.3	87.0	26.29	82.91	187.44	266.69	1.887	3.484	2.524	0.0541	0.0104	0.0078	86.6	118.4
150% RDF	41.0	72.7	88.3	90.0	26.82	85.49	196.67	272.39	1.956	3.706	2.642	0.0518	0.0106	0.0073	87.8	120.9
SEm±	0.7	1.0	1.1	1.1	0.38	1.77	3.33	4.12	0.061	0.144	0.116	0.0010	0.0012	0.0005	1.4	1.9
CD (P=0.05)	2.0	2.8	3.2	3.3	1.11	5.20	9.77	12.09	0.179	0.423	0.339	0.0028	NS	NS	NS	5.5
Zinc levels (kg ha^{-1})																
0	33.9	60.1	73.1	74.7	22.07	72.10	160.86	213.19	1.668	2.958	1.744	0.0557	0.0108	0.0076	84.8	115.2
2.5	37.1	66.1	82.2	83.9	23.85	78.00	179.01	241.45	1.805	3.367	2.081	0.0570	0.0101	0.0077	85.7	116.2
5.0	39.0	68.7	85.3	87.1	24.85	82.44	188.74	253.34	1.920	3.543	2.153	0.0548	0.0107	0.0074	86.5	116.3
SEm±	0.6	0.8	0.9	1.0	0.33	1.54	2.89	3.57	0.053	0.125	0.100	0.0008	0.0010	0.0004	1.2	1.6
CD (P=0.05)	1.7	2.4	2.8	2.8	0.96	4.50	8.47	10.47	0.155	0.367	0.294	NS	NS	NS	NS	NS

Application of N, P @ 125% RDF significantly increased grain and straw yield of barley (Table 2). The per cent increase in grain and straw yield by 125% RDF was 43.08 & 44.89 over 75% RDF. Increasing the N P levels from 75 to 100% RDF and 100 to 125% RDF tended to increase grain yield by 21.34 and 17.92 per cent, respectively. The higher level of N P favorably and significantly enhanced grain and straw biological yield of the crop over its lower levels. This may possibly due to the reason that grain yield is the function of dry matter accumulation and yield attributes which were significantly improved with higher N P levels. Higher grain yield at higher N P levels may also be attributed due to higher nutrient availability and uptake by the crop. These results are in accordance with the findings of Singh *et al.* (2009); Meena *et al.* (2011); Shafi *et al*. (2011).

Effect of Zinc levels: Data (Table 1) indicate that Application of 5.0 zinc kg ha^{-1} significantly affected the plant height at 30, 60, 90 and at harvest**.** Each successive increase in zinc level from 0 to 2.5 and 5.0 kg ha^{-1} significantly enhanced dry matter accumulation over their counter parts. Application of zinc @ 2.5 kg zinc ha^{-1} significantly affected CGR during 30- 60 DAS, 60-90 DAS and 90-120 DAS. Critical examinations of data further indicate that significantly enhanced CGR by 8.3, 13.83 and 23.45 per cent compared to control during 30- 60 DAS, 60-90 DAS and 90-120 DAS, respectively. However, zinc fertilization did not affect the RGR. N P levels zinc nutrition in barley also failed to record any significant impact on days to 50% heading and days to maturity.

The favorable effect of applied zinc on these parameters might be assigned to its physiological functions in the plants. It has metabolically important role in plant growth, development and synthesis of proteins, enzyme activation, oxidation and revival reactions and metabolism of carbohydrates. The performance and quality of crop get enhanced due to this element while shortage of this element decline in plant photosynthesis and destroys RNA, amount of soluble carbohydrates and synthesis of protein, resulting in decrease in performance and quality of crop (Efe & Yarpuz, 2011). Zinc is also a constituent of carbonic anhydrate and there is direct relationship between carbonic anhydrase and photosynthetic carbon dioxide assimilation on growth of crops. Carbonic anhydrase activity is closely related to zinc content as such zinc enhances photosynthetic efficiency thereby enhanced dry matter accumulation. Results corroborate with the findings of Mehdi *et al*. (2012); Hossain *et al*. (2011).

Application of significantly increased in grain yield of barley to the tune of 22.21 per cent over control (Table 2). Straw yield was also significantly influenced with the application of 5 kg zinc ha^{-1}. The enhancement in yield might be due to the fact that zinc plays a role in biosynthesis of indole acetic acid (IAA) which in turn resulted in initiation of reproductive parts and partitioning of photosynthesis towards them consequently resulted into better yield. The increase in yield components may also be due to enhanced supply of available zinc to crop through its addition to soil which reflected in better growth & development and ultimately led to enhance yield components and yield of the crop. The results of present investigation were supported by Hossain *et al.* (2011); Babaeian *et al.* (2012); Dhaliwal *et al*. (2012).

Table 2: Effect of N P level and zinc nutrition on yield of barley.

Treatment	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	B C ratio
N P levels			
75% RDF	2530	3754	0.89
100% RDF	3070	4584	1.26
125% RDF	3620	5438	1.62
150% RDF	3868	5835	1.75
SEm±	107	160	0.06
CD (P=0.05)	315	470	0.18
Zinc levels (kg ha^{-1})			
0	2931	4327	1.17
2.5	3304	4929	1.40
5.0	3582	5454	1.57
SEm±	93	139	0.05
CD (P=0.05)	272	407	0.16

FUTURE SCOPE

Looking to significant response of N P fertilization, in future the experiment may be conducted with seed treatment and soil application along with some organic sources to sustain soil health as well as productivity.

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