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Full Length Research Article

Effect of Different Nitrogen Levels and Growth Regulator on Yield Attributes and Yield of Barley (*Hordeum vulgare* L.) Varieties

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Abstract

A field experiment was conducted to study the "Effect of different nitrogen levels and growth regulator on yield attributes and yield of barley (*Hordeum vulgare* L.) varieties" at Research Farm, Vivekananda Global University, Jaipur during Rabi season of 2018-19. Results showed that application of 100% RDN with recommended dose of P_2O_5 and K_2O + foliar spray of CCC @ 1.25 l ha^{-1} at 35 DAS, being at par with 125% RDN with recommended dose of P_2O_5 and K_2O + foliar spray of CCC @ 1.25 l ha^{-1}at 35 DAS gave significantly higher plant height, total number of effective tillers p^{-1}, ear length, number of grains ear^{-1}, grain yield, straw yield and biological yield over control and 75% RDN with recommended dose of P_2O_5 and K_2O + foliar spray of CCC @ 1.25 l ha^{-1} at 35 DAS in barley. However, test weight and harvest index of barley didn't differ significantly with the application of different treatments. Result further showed that RD 2035 was superior to local variety in respect to plant height, total number of effective tillers p^{-1}, ear length, number of grains ear^{-1}, grain yield, straw yield and biological yield. However different varieties did not bring any significant effect on test weight and harvest index.

***Key words*:** *Hordeum vulgare* L., Cycocel, Nitrogen levels, Growth, Yield attributes, Yield

Barley (*Hordeum vulgare* L.) is the world´s fourth most important cereal crop after wheat, rice and maize. It is cultivated in almost all parts of the world. In India, barley is grown over an area of 0.65 m ha^{-1}, with a production of 1.74 million tonns and yield of about 2,700 kg ha^{-1} [1]. Barley having drought-tolerant characteristics is desired and cultivated by most farmers, however it is not true that barley crops can thrive well without or with little nutrients, especially nitrogen. Barely is very sensitive to insufficient nitrogen hence show responsive behaviour with the addition of nitrogen fertilizers. This response to nitrogen fertilizer may differ from varieties in barley. According to Singh *et al.* [2] application of 125 per cent RDF and 150 per cent RDF improved growth parameter, yield attributing parameters, grain yield and straw yield respectively to control. Patel and Meena [3] conducted a field experiment on ten barley cultivars namely RD 2715, RD 2035, RD 2592, RD 2849, RD 2860, RD 2552, RD 2668, RD 2097, BH 946, RD 2052. Results showed that among ten cultivars RD 2552 cultivar significantly recorded maximum plant population, growth parameters like plant height (cm), 50 per cent heading and 50 per cent maturity and yield parameters like number of tillers $plant^{-1}$, number of spike $meter^{-1}$ row length, length of spike, number of grain $spike^{-1}$, test weight (g) and ultimately increased grain and straw yield of barley. Nitrogen being an essential constituent of protein, nucleic acid and chlorophyll plays a major role in driving plant growth and yield. It increases LIA by increasing leaf production and expansion rate that effect interception of photo synthetically active radiation (PAR) and consequently the final dry matter production [4]. One of the major problems faced in cereal crops is lodging, particularly due to high nitrogen fertilizer, inputs and water. Plant growth regulators (PGR's) such as chlormequat chloride (chlormequat) and ethephon are commonly used in small grain management systems around the world to restrict shoot height and control lodging [5-6]. Plant Growth regulators (PGR) can reduce stem length and improves the standing ability of barley [7] and often have helpful effects on quality and quantity of grains while harvesting [8]. In recent time, use of Cycocel (CCC) also known as chlormequat chloride has the highest consumption rate. Cycocel is an essential growth regulator for plants that reduced concentration of gibberellins and interfere with the concentration of other plant hormones, such as cytokinins, ethylene, and abscisic acid, which can affect physiological processes [9]. Based upon the above facts research was conducted to study the effect of different nitrogen levels and growth regulator on yield attributes and yield of barley (*Hordeum vulgare* L.).

MATERIALS AND METHODS

The field experiment was undertaken during Rabi season of 2018-19 at research farm, Vivekananda Global University,

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Jaipur. Geographically, the study area is located at 07588‟99” E longitude and 2681‟17” N latitude and this region falls under agro-climatic zone III A of Rajasthan (Semi-arid Eastern Plain Zone). The climate of this zone is typically semi-arid characterized by aridity of the atmosphere and extremity of temperature both in summer (45.5 °C) and winter (4 °C) with annual rainfall of 500-700 mm. The experiment was laid out in factorial randomized block design (FRBD) with three replications assigning eight treatment combinations consisting of two varieties (V_1: RD 2035 and V_2: Local variety) and four levels of nitrogen and plant growth regulator (F_0: Control, F_1: 75% RDN with recommended dose of P_2O_5 and K_2O + foliar spray of CCC @ 1.25 l ha^{-1} at 35 DAS, F_2: 100% RDN with recommended dose of P_2O_5 and K_2O + foliar spray of CCC @ 1.25 l ha^{-1} at 35 DAS, F_3: 125% RDN with recommended dose of P_2O_5 and K_2O + foliar spray of CCC @ 1.25 l ha^{-1} at 35 DAS). So, the total unit plot in the entire experimental area was 8 x 3 = 24. The plot size was 4.0 m x 2.7 m = 10.8 m^2. Plot to Plot to distance was maintained at 0.5 m and block to block distance was done at 1.0 m. The crop was sown in rows, spaced at 22.5 cm apart and plant spaced at 5 cm on 10th November 2018 using 100 kg ha^{-1} seed rate as per the treatments. Half dose of nitrogen was applied and a full dose of phosphorus and potassium (30 kg P_2O_5 + K_2O) was applied as basal dose. The remaining half dose of nitrogen was top-dressed at first irrigation. CCC @ 1.25 l ha^{-1} was sprayed 35 DAS. Barley crop was harvested manually with a sickle on March 25, 2019 when the moisture content was about 14%. The plant height was taken from five randomly selected plants of each plot and was measured from the base of the plant to the top of the main shoot by metre scale. The number of ears bearing tillers were counted by placing a metre scale in each plot along the crop row at three randomly selected spots and their average was taken as the number of effective tillers p^{-1}. Five ears were selected randomly from each plot and their length was measured with the help of a metre scale and the mean was recorded and expressed in cm. Five ears from each plot were taken and threshed, the grains were counted and average number of grains ear^{-1} was worked out. One thousand grains were counted from grains of the sample plants of each treatment plot, dried properly and weight by using an electric balance. Grains yield, straw yield and the biological yield so obtained were weighed in kg $plot^{-1}$ and then converted into kg ha^{-1}. Harvest index was obtained through dividing the grain yield by the biological yield in percent.

Data analysis

Various observations were statistically analyzed with the help of Fisher's analysis of variance technique [10]. The critical difference (CD) for the treatment comparisons were worked out wherever the variance ratio (F test) was found significant at 5% level of significance.

RESULTS AND DISCUSSION

Plant height

Height of barley was significantly affected due to different nitrogen levels and plant growth regulator. Application of 125% recommended dose of nitrogen (RDN) with RD of P_2O_5 and K_2O + foliar spray of CCC @ 1.25 l ha^{-1} at 35 DAS significantly increased plant height (106 cm) as compared to other treatments. Lowest was recorded in control (77.84). Enhancement in growth over control was due to increased nitrogen levels despite using plant growth hormone [11]. Higher Nitrogen levels accelerates photosynthetic rate and thereby increase protein synthesis, cell division and cell elongation increasing plant height [12]. The availability of major nutrients (N and P) in the form of fertilizer increased the overall vegetative growth of the crop. This was in conformity with the findings of Kaur *et al*. [13] and Singh *et al*. [14] in barley and wheat crop. Among the varieties RD-2035 (100.83 cm) was taller than local variety (89.27 cm). Since, all the varieties were grown under identical agronomic environment, the observed variation in overall growth of the varieties could be ascribed to their internal genetically make up and external environmental factors to which these were exposed during their life cycle [15-16].

Table 1 Effect of different nitrogen levels and growth regulator on yield attributes and yield of barley varieties

Treatments	Plant height (cm)	Effective number of tillers P^{-1}	Ear length (cm)	Number of grains ear^{-1}	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
				Varieties					
RD 2035	100.83	7.02	7.85	34.57	35.85	3755	5672	9427	39.83
Local variety	89.27	5.82	7.16	30.11	35.26	3273	5075	8348	39.21
SEm ±	2.63	0.16	0.17	0.85	0.97	92	150	194	0.74
CD (P=0.05)	7.97	0.50	0.50	2.59	NS	278	454	587	NS
				Nitrogen and plant growth regulator					
F_0	77.84	4.58	6.33	26.17	34.69	2885	4484	7368	39.14
F_1	92.08	6.19	7.29	31.23	35.42	3412	5234	8646	39.46
F_2	104.29	7.34	8.13	35.57	35.92	3853	5862	9715	39.67
F_3	106.00	7.57	8.28	36.40	36.20	3906	5914	9820	39.80
SEm ±	3.72	0.23	0.23	1.21	1.37	129	212	274	1.05
CD (P=0.05)	11.27	0.70	0.71	3.66	NS	393	642	830	NS
CV (%)	9.58	8.83	7.62	9.13	9.43	9.02	10	7.54	6.44

NS= Non-significant

Yield attributes

Nitrogen levels and application of plant growth regulator (CCC) had significant influence on the yield attributes of barley. However, the test weight of barley was not influenced due to application of different treatments (Table 1). Application of 125% RDN with RD of P_2O_5 and K_2O + foliar spray of CCC @ 1.25 l ha^{-1} at 35 DAS gave maximum number of effective tillers $plant^{-1}$ (7.57), ear length (8.28 cm) and number of grains ear^{-1} (36.40) which was on par with 100% with RD of P_2O_5 and K_2O + foliar spray of CCC @ 1.25 l ha^{-1} at 35 DAS. Lowest yield attributes viz., effective number of tillers p^{-1} (4.58), ear length (6.33 cm) and number of grains ear^{-1} (26.17) was

recorded in control. The beneficial response of nitrogen and plant growth regulator on yield attributes of barley seems to be due to an increase in source size (i.e., leaf area of the treated plants) or photosynthesis rate [17] hence an increase in growth and productivity. The increased fertilizer levels have also provided stability in higher supply of photosynthates towards the sink (seeds spike^{-1}). The increased growth in terms of plant height, dry matter accumulation and number of ear plant^{-1} might also have provided better site for ear formation and grain development. As a result, almost all yield attributes of crop resulted into significant improvement due to nitrogen application. Similar findings were also observed by many researchers at various palaces who support the results of present experiment viz., Abera *et al*. [18], Jat *et al*. [19] and Singh *et al*. [20] in wheat and barley crop. Among the varieties, data showed that the yield attributing characters of RD 2035 viz., effective number tillers p^{-1} (7.02), ear length (7.85cm) and number of grains ear^{-1} (34.57) were significantly higher than local variety (Table 1). However, test weight was not influenced by different varieties. Probably these results are consequences of similar genetic potential of varieties to grains formation. Mattas *et al*. [15] and Mumtaz *et al*. [16] also reported significant differences in number of grains ear^{-1}.

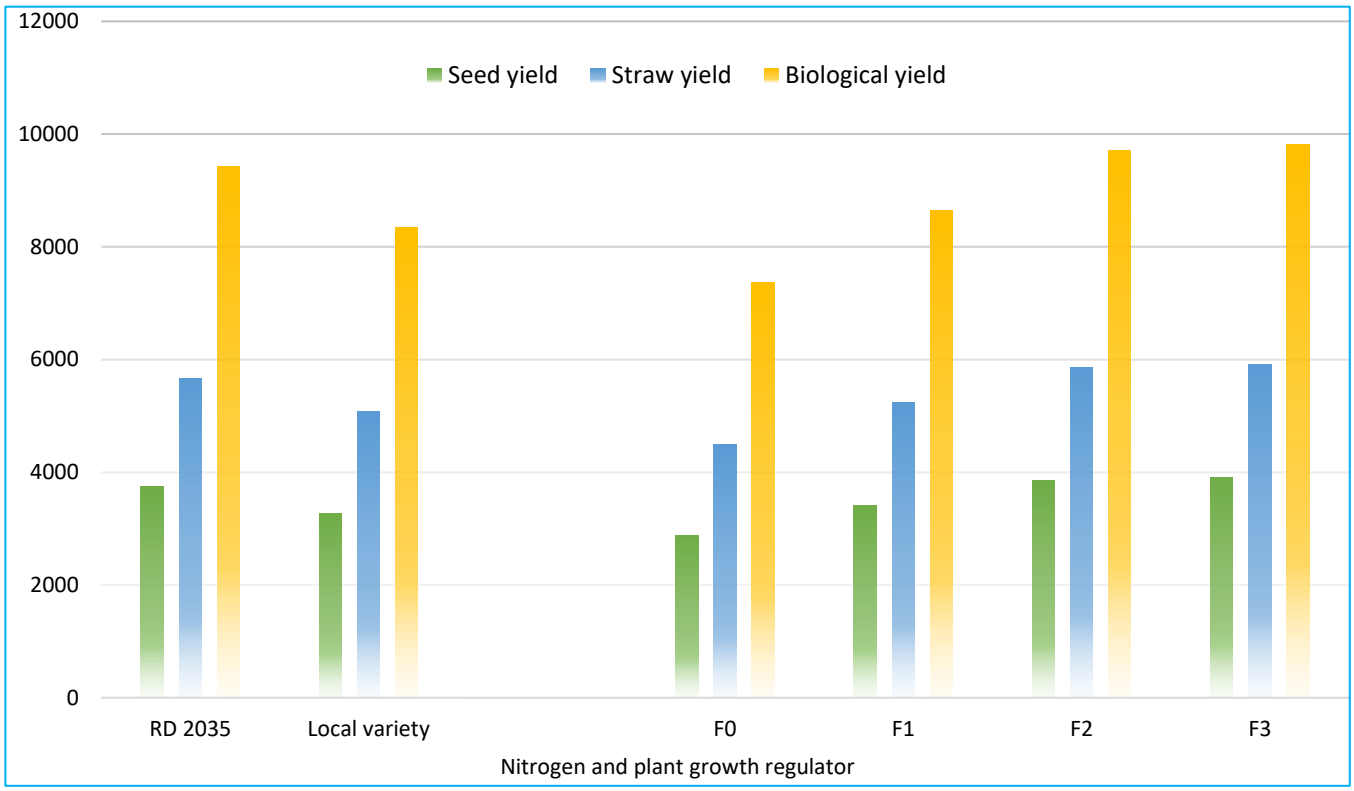

Fig 1 Effect of nitrogen and plant growth regulator on yield of barley varieties

Yield

Plants treated with plant growth regulator (CCC) under different nitrogen rates showed higher grain yield compared with the control plants. Among the treatment rates, the highest yield viz., grain yield (3906 kg ha^{-1}), straw yield (5914 kg ha^{-1}), biological yield (9820 kg ha^{-1}) was obtained with the application of 125% RDN with RD of P_2O_5 and K_2O + foliar spray of CCC @ 1.25 l ha^{-1} at 35 DAS, which was closely followed by application of 100% RDN with RD of P_2O_5 and K_2O + foliar spray of CCC @ 1.25 l ha^{-1} at 35 DAS i.e., grain yield (3853 kg ha^{-1}) straw yield (5862 kg ha^{-1}) and biological yield (9715 kg ha^{-1}). With higher levels of N, dry matter accumulation increased and number of ear plant^{-1} ultimately enhanced grain and straw yield of barley [21-22]. Both cycocel and nitrogen increased fertility of flowers causing more grain formation and more green leaf area and more mobilization of assimilates into grains [23]. Grain yield increased due to higher number of grains which was the result of more number of fertile tillers. Thus, increase in grain yield attributed both to a higher biological yield and number of grains plant^{-1} [17], [23]. Although harvest index was not influenced due to application of different treatments, the highest was recorded in 125% RDN with RD of P_2O_5 and K_2O + foliar spray of CCC @ 1.25 l ha^{-1} at 35 DAS (Table 1). Experimental findings revealed that barley variety RD-2035 significantly increased grain yield (3755 kg ha^{-1}), straw yield (5672 kg ha^{-1}) and biological yield (9427kg ha^{-1}) [24-25]. The corresponding increase in grain yield, straw yield due to barley variety RD 2035 in terms of per cent was 11.76%, 14.7% and 12.93% respectively over local variety. High yield of RD 2035 may be attributed to its higher biomass accumulation due to higher number of tillers, leaves and its proper partitioning as evident from equally higher harvest index and good yield attributes i.e., ear length, ear weight and test weight [26]. A critical examination of data presented in (Table 1) revealed that the harvest index of barley was not affected due to different varieties.

CONCLUSION

Based on the results of the research it was concluded that application of 100% RDN with recommended dose of P_2O_5 and K_2O + foliar spray of CCC @1.25 l ha^{-1} at 35 DAS, being at par with 125% RDN with recommended dose of P_2O_5 and K_2O + foliar spray of CCC @1.25 l ha^{-1} at 35 DAS gave significantly higher grain and straw yield over control and 75% RDN with recommended dose of P_2O_5 and K_2O + foliar spray of CCC @1.25 l ha^{-1} at 35 DAS in barley. Among the varieties, RD 2035 was found superior in respect to all yield parameters over local variety.

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