International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(2): 280-283

Received: 11-01-2019
Accepted: 14-02-2019

Mukesh Kumar
Department of Agronomy, CCS Haryana Agricultural University, Hisar, Haryana, India

Bhagat Singh
Department of Agronomy, CCS Haryana Agricultural University, Hisar, Haryana, India

Correspondence
Mukesh Kumar
Department of Agronomy, CCS Haryana Agricultural University, Hisar, Haryana, India

Growth regulators and nitrogen fertilization effects on performance of barley

Mukesh Kumar and Bhagat Singh

Abstract
To study the effect of different nitrogen doses and plant growth regulators on growth, yield and yield attributes of barley, a split plot design experiment with replicated thrice was carried out during *Rabi* 2016-17 and 2017-18 at Wheat and Barley Research area, CCS Haryana Agricultural University, Hisar, Haryana. The treatments comprised of three doses of nitrogen *viz*., 100% of the recommended dose of nitrogen (RDN), 125% RDN and 150% RDN were in main plot and in sub plot four treatments of plant growth regulators (PGR) *viz*., control *i.e.* without PGR, chlormequat-chloride (CCC) @1.25 L ha^{-1} at GS30-31, ethephon (cerone) @ 0.5 L ha^{-1} at GS32-49 and combination of CCC @1.25 L ha^{-1} at GS30-31 + cerone @ 0.5 L ha^{-1} at GS32-49. On pooled mean basis of two years 2016-17 and 2017-18 data, results of the experiment revealed that among nitrogen levels highest grain and biological yield of 53.10 q/ha and 125.22 q/ha was recorded under 150% RDN, respectively, which was at par with 125% RDN (51.73 and 122.24 q/ha), but significantly superior over 100% RDN (50.48 and 118.93 q/ha). Plant height increased significantly with increased doses of nitrogen. Yield attributes *viz.* grains per earhead and test weight were not affected significantly by increasing doses of nitrogen. Similarly like grain yield, 150% RDN produced significantly more number of effective tillers/m^2 (353.2) than 100% RDN (327.3). Among PGRs treatment, application of cycocel (Chlormequat chloride) + cerone (ethephon) produced the highest grain and biological yield of 53.25 q/ha and 124.07 q/ha, respectively, which was significantly superior over without PGR treatment (control). Maximum effective tillers/m^2 (349.6) were recorded under CCC + Ethephon treatment. Maximum grains/earhead was recorded in Ethephon treatment. Test weight was not affected significantly by different PGRs treatment. Maximum harvest index (42.91%) was recorded in cycocel + cerone, which is significantly superior control. Barley produced highest grain yield with the application of 150% RDN in combination with CCC @1.25 L ha^{-1} at GS30-31 + cerone @ 0.5 L ha^{-1} at GS32-49.

Keywords: barley, nitrogen doses, cycocel, cerone and grain yield

Introduction
Barley (*Hordeum vulgare* L.) is an important coarse cereal crop of India, being grown in rabi season in northern plains as well as in northern hills, mostly under rainfed or limited irrigation condition on poor to marginal soils. It is a widely adapted small-grain annual cereal and is a key feed and fodder in India (Kharub *et al*., 2013) [9]. Traditionally considered as a poor man's crop, barley in India is favoured because of its low input requirement and better adaptability to harsh environments, likely drought, salinity/alkalinity and marginal lands. Barley occupied nearly 6.77 lac hectare area producing nearly 17.88 lac tonnes grain, with a productivity of 2641 kg/ha during 2017-18 in India (ICAR-IIWBR, 2018) [7]. The barley products like "Sattu" (in summers because of its cooling effects on human body) and Missi Roti have been traditionally used in India (Verma et al., 2011) [16].

Nitrogen a key element for plant nutrition an essential constituent of protein, which is associated with all the vital processes in plants. It increases LAI by increasing leaf production and expansion rate that effect interception of photo synthetically active radiation (PAR) and consequently the final dry matter production (Asif *et al.*, 2012) [3]. Nitrogen is one of the major essential nutrients applied to the crop for higher vegetative growth, productivity and quality (Ali *et al*., 2012 and Kumar *et al*., 2018) [3, 10]. As the increase of nitrogen level and basal nitrogen ratio, the basal internodes became slender and fragile with the thick stem wall, while filling degree, chemical components and the strength of the stem decreased gradually, which significantly increased the lodging risk (Zhang *et al*., 2017) [17]. Lodging is still a major problem in barley particularly with high inputs of nitrogen fertilizer and water. Growth regulators are chemical substances which can alter the growth and developmental processes

leading to increased yield, improved grain quality or facilitated harvesting (Espindula *et al*., 2009) [9]. 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 (Rajala *et al*., 2002 and Ramburan and Greenfield, 2007) [11, 12]. Ethephon (Cerone), chlormequat chloride (Cycocel), mepiquat chloride, and trinexapac-ethyl have all been used on barley to control lodging. Higher N levels increased lodging and simultaneously reduced grain yields, however, applications of ethephon significantly controlled lodging at higher N levels. Ethephon and the PGR combination, applied at the flag leaf stage, can be utilized as lodging controlling tools with 'Puma' in environments conducive to lodging (Ramburan and Greenfield, 2007) [12]. Plant growth regulator (PGR) can reduce stem length and improve the standing ability of the barley (Shah *et al*., 2017) [13]. PGR application may be recommended to avoid lodging-flat and to facilitate the harvesting operation (Shah *et al*., 2017) [13]. The increase of wheat grain yield due to the application of cycocel results from the increase of the number of spikes per square meter (Shekoufa and Imam, 2008) [15].

Based upon the above facts in mind, Research was designed to study the response of nitrogen levels and plant growth regulators on yield and yield attributes of barley under Hisar conditions of Haryana.

Material and Methods

A field experiment was conducted to study the response of nitrogen levels and plant growth regulators on yield and yield attributes of barley. Experiment was carried out during the *Rabi* 2016-17 and 2017-18 at Wheat and Barley Research Farm area of CCS Haryana Agricultural University, Hisar (India) with latitude of 29^0 10' North and longitude of 75^0 46' East at 215.2 meters above mean sea level. The soil of the field was sandy loam, having 0.38% organic carbon and pH 7.8. It was low in available N (126 kg/ha), medium in available P_2O_5 (21 kg/ha) and rich in available K_2O (308 kg/ha). Experiment was laid out in split plot design with three replications. Nitrogen doses were taken as main factor consisting of three levels (100% RDN [60 kg N/ha]125% RDN and 150% RDN) and in Sub-plot four treatments were control (without spray), chlormequat-chloride (CCC) @1.25 L ha-1 at GS30- 31, ethephon (cerone) @ 0.5 L ha-1 at GS32-49 and CCC @1.25 L ha-1 at GS3031 + cerone @ 0.5 L ha-1 at GS32-49. To carry out the experiment the land preparation operation was done including pre sowing irrigation, ploughing, and disc operation and levelling. Half dose of nitrogen and full dose of phosphorous were applied as basal and another half dose of nitrogen was top dressed at the time of first irrigation. Feed barley variety BH 946 was sown manually on 17 November, 2016 during first year and on 14 November, 2017 during second year. Other management practices like irrigation, weed control followed as per package and practices of barley crop. Growth attributing characters were recorded at the time of harvest. Five plants were selected randomly from each treatment to record the observations of yield attributes. The crop was harvested on 3rd April of 2017 and 2018 during first and second year. The data collected were subjected to analysis of variance using OPSTAT software. The least significant difference (LSD) test was used for the mean comparisons.

Results and Discussion

The influence of different nitrogen levels and plant growth regulators on yield and yield attributes of barley shown in Table-1. This study highlights the pivotal role played by the nitrogen levels and plant growth regulators on plant growth, yield and yield attributes characters of feed barley like: plant height, earhead/m^2, grains/earhead, test weight, grain yield, biological yield and harvest index. The data pertaining to effect of nutrient levels and plant growth regulators on different growth parameters are presented and discussed here under.

Plant height

Maximum plant height was recorded with the application of 150% Recommended dose of nitrogen (150% RDN), which was significantly higher then application of 100% RDN but at par with 125% RDN application (Table 1). Increasing nitrogen levels increased the plant height. Maximum plant height was recorded under 150% RD of nitrogen, which was mainly due to more availability of nitrogen. Higher nitrogen levels resulted in higher nitrogen uptake, which could ultimately result in to increased protein synthesis, cell division and cell elongation and finally expressed morphologically on increased in height of the plant. Similar findings were reported by Dubey *et al*., 2018 [5] alter the growth and developmental processes. Among the PGR's treatment, significantly higher plant height was recorded in control (105.33 cm) then other PGRs treatment. Application of Cycocel + Cerone produced minimum plant height (95.44 cm). Plant growth regulator (PGR) can reduce stem length and improve the standing ability of the barley (Shah *et al*., 2017) [13]. Berkesia *et al*., 2018 [4] also reported that the PGRs application had reduced plant height as compare to control. Reductions in plant height as a consequence of both growth regulators were associated with reduced elongation of the internodes. The uppermost internodes and peduncle, in particular, were shortened (Shekoofa and Emam, 2008).

Effective tillers/m^2

Nitrogen levels and application of plant growth regulators had significant influence on the number of tillers (Table 1). As the nitrogen level increased, the number of earhead/m^2 increased significantly. Similarly like plant height, maximum number of effective tillers/m^2 (353.2) was recorded with the application of 150% RDN, which was significantly higher then application of 100% RDN but at par with 125% RDN application. An improvement in effective tillers due to nitrogen might be due to increased more and continuously supply of nitrogen to plants. Similarly findings have been reported by Kazemaini *et al*., 2008 and Shaker *et al*., 2014. Increasing nitrogen levels increased to a certain extent of fertile and non-fertile tillers respectively (Aghdam and Samadiyan, 2014). Effective tillers/m^2 of 349.6 were recorded highest under cycocel+cerone (PGR's combination) treatment which was significantly higher over other treatments except alone application of cerone treatment (344.7), whereas, minimum effective tillers/m^2 were reported under control (332.5), which is in consistent with the findings of Berkesia *et al*., 2018 [4].

Grains/earhead and 1000-grain weight

Pooled data of 2016-17 and 2017-18 revealed that the highest grains/earhead 50.19 were recorded under treatment of 150% RDN, although it was at with other levels of nitrogen. Grains per earhead were found maximum with the application of ethephone (50.81), which was statistically at par with the cycocel+cerone treatment (50.48) but significantly higher

over control (48.72). The effect of different levels of nitrogen and plant growth regulators on test weight of barley was not found significantly different. Although test weight was numerically more in combination of Cycocele+Cerone application.

Grain and Biological Yield (q/ha)

The effect of nitrogen levels and PGR's on the grain yield and biological yield was found significant (Table 1). Highest grain and biological yield of 53.10 q/ha and 125.22 q/ha was recorded under 150% RDN, respectively, which was at par with 125% RDN (51.73 and 122.24 q/ha), but significantly superior over 100% RDN (50.48 and 118.93 q/ha). 150% RDN produced 2.58 and 4.93% higher grain yield then 125% RDN and 100% RDN. The increase of grain yield due to the increase of nitrogen doses mainly resulted from more number of grains per spike and the increase of number of effective tillers/m^2 and creating more photosynthesis surface which were consistent with the findings of Shaker *et al*., 2014.

Among PGRs treatment, barley produced highest grain yield with the application of 150% RDN in combination with CCC @1.25 L ha^{-1} at GS30-31 + cerone @ 0.5 L ha^{-1} at GS32-49. Application of cycocel (chloremquat chloride) + cerone (ethephon) gave the highest grain and biological yield of 53.25 q/ha and 124.07 q/ha, respectively, which was significantly superior over without PGR treatment. The grain yield of cycocel+cerone was 2.89%, 1.47% and 6.78% higher over cycocel, cerone and control, respectively. Similar findings have been reported by Berkesia *et al*., 2018 [4]. Maximum grain and biological yield found in combination of cycocel+cerone treatment was mainly due to more number of effective tillers/m^2 and 1000-grain weight rather then other treatments. Plants treated with PGRs (CCC or ethephon) under different N rates showed higher grain yield compared with the control plants (Shekoofa and Emam, 2008). The use of PGRs increased the grain yield compared to the control treatment by affecting the yield contributing traits and also reduced the plant height. By increasing the number and survival of effective tillers and leaf area, PGRs causes more photosynthesis and more assimilates are mobilized towards grains and lead to the increase of grain yield (Berkesia *et al.*, 2018) [4].

Harvest Index (%)

Maximum harvest index (42.45%) was recorded under 100% RDN treatment, although it was at par with the increased doses of nitrogen. Maximum harvest index (42.91%) was reported under cycocel + cerone, which was significantly higher than control, which is in consistent with the findings of Berkesia *et al.*, 2018 [4].

Table 1: Effect of different nitrogen doses and plant growth regulators on growth, yield and yield attributes of barley (Pooled data of 2016-17 and 2017-18)

Treatments	Plant height (cm)	Effective tillers/ m^2	Grains earhead^{-1}	1000-grain weight	Grain yield (q/ha)	Biological yield (q/ha)	Harvest Index (%)
Main Plot: Nitrogen levels							
100% of the recommended dose of nitrogen (100% RDN)	95.17	327.3	49.47	42.21	50.48	118.93	42.45
125% RDN	100.42	344.3	49.83	42.55	51.73	122.24	42.32
150% RDN	103.25	353.2	50.19	42.51	53.10	125.22	42.39
SEm±	1.25	3.86	0.43	0.21	0.40	0.98	0.22
LSD (P=0.05%)	5.03	15.57	NS	NS	1.62	3.96	NS
Sub Plot: PGRs							
Chloromequat-chloride (cycocel) @ 1.25 L ha^{-1} at GS30-31	97.56	339.8	49.29	42.39	51.71	121.23	42.65
Ethephone (Cerone) @ 0.5 L ha^{-1} at GS32-49	100.11	344.7	50.81	42.50	52.49	123.61	42.47
Cycocel @ 1.25 L ha^{-1} at GS30-31 + Cerone @ 0.5 L ha^{-1} at GS32-49	95.44	349.6	50.48	42.64	53.25	124.07	42.91
Control (Without PGR)	105.33	332.5	48.72	42.16	49.64	119.60	41.52
SEm±	1.33	2.12	0.36	0.20	0.43	1.00	0.20
LSD (P=0.05%)	3.99	6.35	1.07	NS	1.28	2.99	0.61

Conclusion

Based on two years 2016-17 and 2017-18 data, experiment concluded that among nitrogen doses, highest grain and biological yield (53.10 and 125.22 q/ha, respectively) were recorded with 150% RDN, which were at par with 125% RDN, but significantly superior over 100% RDN. The grain and biological yields recorded with 150% RDN were 4.93 & 5.02% higher over 100% RDN and 2.58 & 2.37 per cent higher over 125% RDN, respectively. Among PGRs, application of Cycocel + Cerone produced the highest grain and biological yield of 53.25 and 124.07 q/ha, respectively, but it was at par with the grain yield of alone application of Ethephon (52.49 q/ha).

References

1. Aghdam S, Samadiyan F. Effect of nitrogen and cultivars on some of traits of barley (*Hordeum vulgare* L.). International journal of Advanced Biological and Biomedical Research. 2014; 2(2):295-299.
2. Ali A, Ahmad A, Syed WH, Khaliq T, Asif M, Aziz M. Effect of nitrogen on growth and yield component of wheat. Science International. 2011; 23:331-332.
3. Asif M, Maqsood M, Ali A, Hassan SW, Hussain A, Ahmad S. Growth, yield components and harvest index of wheat (*Triticum aestivum* L.) affected by different irrigation regimes and nitrogen management strategy. Science International. 2012; 24(2):215-218.
4. Berkesia N, Singh B, Kainwal MK, Satpal. Potential productivity and economics of feed barley as influenced by different nitrogen levels and plant growth regulators. International Journal of Agriculture Sciences. 2018; 10(10):6150-6152.
5. Dubey SN, Tiwari A, Pandey VK, Singh V, Singh G. Effect of nitrogen levels and its time of application on growth parameters of barley (*Hordeum vulgare* L.). Journal of Pharmacognosy and Phytochemistry. 2018; 7(1):333-338.

6. Espindula MC, Rocha VS, Grossi JAS, Souza MA, Souza LT, Favarato LF. Use of growth retardants in wheat. Planta Daninha. 2009; 27:379-387.
7. ICAR-IIWBR. Director's report of AICRP on Wheat and Barley. 2017-18, Ed: G.P. Singh. ICAR-Indian Institute of Wheat and barley Research, Karnal, Haryana, India, 2018, p94.
8. Kazemaini S, Ghadiri H, Karimian N, Kamkar HA, Kherad NM. The interactive effect of nitrogen and organic matters on growth and grain yield of rainfed wheat. Science and Technology of Agriculture and Natural Resources. 2008; 12(45):461-472.
9. Kharub AS, Verma RPS, Kumar D, Kumar V, Kumar RS, Indu Sharma. Dual purpose barley (*Hordeum vulgare* L.) in India: Performance and potential. Journal of Wheat Research. 2013; 5:55-58.
10. Kumar M, Pannu RK, Singh B. Effect of irrigation regimes and nitrogen levels on phenology and grain yield of late sown wheat. Wheat and Barley Research. 2018; 10(1):151-155.
11. Rajala A, Peltonen-Sainio P, Onnela M, Jackson M. Effects of applying stem-shortening plant growth regulators to leaves on root elongation by seedlings of wheat, oat and barley: mediation by ethylene. Plant Growth Reg. 2002; 38:51-59.
12. Ramburan S, Greenfield PL. Use of ethephon and chlormequat chloride to manage plant height and lodging of irrigated barley (cv. Puma) when high rates of N-fertiliser are applied. South Africa journal of plant soil. 2007; 24(2):181-187.
13. Shah SSM, Chang X, Martin P. Effect of dose and timing of application of different plant growth regulators on lodging and grain yield of a Scottish landrace of barley (Bere) in Orkney, Scotland. International Journal of Environment, Agriculture and Biotechnology. 2017; 2(4):2010-2019.
14. Shaker E, Mojaddam M, Nejad TS. The effect of cycocel and different levels of nitrogen fertilizer on yield and yield components of barley. Indian Journal of Fundamental and Applied Life Sciences. 2014; 4(4):13-17.
15. Shekoofa A, Emam Y. The increase of wheat grain yield due to the application of cycocel results from the increase of the number of spikes per square meter. Journal of Agriculture Science and technology. 2008; 10:101-108.
16. Verma RPS, Kharub AS, Kumar D, Sarkar B, Selva kumar R, Singh R, *et al*. Fifty years of co-ordinated barley research in India. Directorate of Wheat Research, Karnal. Res. Bull, 2011; 27:46.
17. Zhang M, Wang HYiY, Ding J, Zhu M, Li C. Effect of nitrogen levels and nitrogen ratios on lodging resistance and yield potential of winter wheat (*Triticum aestivum* L.). Plos One. 2017; 12(11):e0187543.