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Maximization of Barley (*Hordeum vulgare* L.) Yield Using Plant Growth Regulators and Higher Nitrogen levels in North Western Plains Zone

S.B. Singh [1], Rajvir Singh[2], Uma[3], S.K. Chauhan[4] and S.K. Singh[5]

1., 2. Associate Professor, 3. Assistant Professor and 4. Agronomist, Soil Salinity Project,
5. Student, Deptt. of Agronomy, Raja Balwant Singh College Bichpuri, Agra

Abstract

A field experiment was conducted during two Rabi seasons of 2016-17 and 2017-18 at Agricultural Research Farm, R.B.S. College, Bichpuri, Agra (U.P.) to study the effect of nitrogen levels and plant growth regulators on yield and economics of Barley (Hordeum vulgare L.). The experiment was laid out in split plot design with three levels of nitrogen and four levels of plant growth regulators with four replications. Results revealed that plant height, number of shoots meter^{-1}, biological yield and straw yield significantly increase with increasing levels of nitrogen from 100 percent to 150 percent of the recommended dose. But length of spike, number of grains spike^{-1}, weight of grains spike^{-1}, 1000 grain weight, grain yield, harvest index, net return and B:C ratio conspicuously decreased with every increase in the levels of nitrogen from 100 percent to 150 per cent of the recommended dose of nitrogen. The highest grain yield (45.97 q ha^{-1}) was obtained by 100 percent of the recommended dose of nitrogen (60kg. ha^{-1}). The growth, yield attributing characters and yield were increased with different growth regulators. The maximum values of these parameters were recorded by CCC @ 1.25L $^{ha-1}$ at GS_{30-31} followed by Terpal @ 1.0L ha^{-1} at GS_{39-40}. The enhanced yield under 100 percent of recommended dose of nitrogen (60 kg ha^{-1}) also resulted in higher net returns (Rs. 51747) and benefit: cost ratio (2.57).

***Key Words**: Barley, nitrogen, plant growth regulators, yield, economics*

Introduction

There is a great scope for increasing the production of Barely by applying balanced fertilization and maintaining soil fertility status[2]. High rates of nitrogen increase lodging by making plants taller.

Plant growth regulators (PGRs) are organic compounds other than nutrients that influence any physiological process of the plant[1].

In cereals, PGRs are used to reduce lodging. PGRs applied before the emergence of the ear. Most growth regulators are only active for a few days after application and can therefore shorten internodes most effectively when applied during their extension.

Materials and Methods

A field experiment was conducted during two *rabi* seasons of 2016-17 and 2017-18 at Agricultural Research farm, Raja Balwant Singh College, Bichpuri, Agra (U.P.) The experimental soil was sandy loam, slightly alkaline in reaction (pH 8.1), low in organic carbon (3.2g kg^{-1}) and available N (183 kg. ha^{-1}), medium in available phosphorus (P_2O_5) (28.3kg ha^{-1}) and rich in potash (K_2O) (290kg ha^{-1}). The experiment was laid out in split plot design with 4 replications. The treatments comprised of three levels of nitrogen (N_1-100% of recommended dose, N_2-125% of recommended dose and N_3-150 % of recommended dose) and four levels of plant growth regulators (G_o- Control, G_1-Chlormequat Chlorid (CCC)@1.25 L ha^{-1} at GS_{30-31}, G_2-Mapiquat-Chlorid (Terpal)@ 1.0 L ha^{-1} at GS $_{39-40}$, G_3-CCC @ 1.25 L ha^{-1} at GS_{30-31} followed by Terpal @ 1.0 L ha^{-1} at GS $_{39-40}$). The N, P and K were

applied through Urea, Di-ammonium Phosphate and Muriate of Potash, respectively. Half dose of Nitrogen and full dose of phosphorus and potassium were applied as per treatments as basal dose at sowing time. Remaining half dose of nitrogen was applied after first irrigation by top dressing as urea. Barley (BH946) was sown in third week of November in both the years. The growth, yield attributing characters and yield were recorded at harvest. The economics was computed using the prices of inputs and outputs as per prevailing market rates. The data generated for both years were pooled together and analyzed statistically.

Results and Discussion

Table 1 Effect of nitrogen levels and plant growth regulators on growth and yield attributing characters of Barley (mean of two years).

Treatments	Plant height (cm)	No. of shoots meter^{-1}	Length of spike (cm)	No. of grains spike $^{-1}$	Weight of grains spike^{-1} (g)	1000 grain weight (g)
Nitrogen levels						
100% of Recommended dose (N_1)	61.79	341.13	6.75	34.78	2.30	48.18
125% of Recommended dose (N_2)	66.07	350.08	6.47	32.99	2.09	46.20
150% of Recommended dose (N_3)	70.47	356.71	6.25	31.23	1.87	44.25
CD (P=0.05)	3.95	NS	0.20	1.45	0.17	1.92
Plant Growth Regulators						
Control (G_0)	64.69	341.26	6.24	32.04	1.94	44.40
Chlormequat chlorid (CCC) @1.25 L ha^{-1} at GS $_{30--31}$(G_1)	66.29	346.48	6.48	33.28	2.11	46.58
Mepiquat-chlorid (Terpal) @1.0 L ha-^{1} GS-$_{39-40}$ (G_2)	66.60	352.74	6.50	33.32	2.12	46.66
CCC @ 1.25 L ha-^{1} at GS $_{30-31}$ followed by Terpal @ 1.0 L ha-^{1} at GS $_{39-40}$ (G_3)	66.86	356.74	6.74	33.36	2.19	47.20
CD (P= 0.05)	NS	10.38	0.23	1.68	0.203	1.86

The Data presented in Table-1 indicated that levels of nitrogen had significant effect on plant height. A critical study of the data in table1 revealed that length of spike decreased significantly with increasing rate of nitrogen. Also number and weight of grains spike^{-1} and 1000grain weight decreased significantly with every increase in the level of nitrogen from 100 percent to 150 percent of the recommended dose of nitrogen. The yield contributing characters decreased with higher levels of nitrogen, because more nitrogen can stimulate leaf and stem growth and interfere with the production of grains. These results are in close conformity with other workers.

The data computed in table-1 indicated that use of different growth regulators namely chlormequat chlorid (CCC) @ 1.25 L ha^{-1} at GS $_{30-31}$(G_1), mepiquat chlorid (Terpal) @ 1.0L ha^{-1} at GS $_{39-40}$ (G_2), and CCC @ 1.25L ha^{-1} at GS $_{30-31}$ followed by Terpal @ 1.0L ha^{-1} at GS $_{39-40}$ (G_3) were statistically at par among themselves, but they produced significantly higher number of shoots meter^{-2}area. Different growth regulators were not appreciable among themselves, but they produced significantly longer spike than the control. Table under reference further

showed that the variations in growth regulators with respect to number of grains spike^{-1} were nominal and could not reach the level of significance. Table-1 showed that growth regulators were not significantly among themselves, but they had appreciably higher weight of grain spike^{-1} over the control. 1000 grain weight showed that different growth regulators were nominal among themselves and could not reach the level of significance, but they had significantly highest test weight over the control.

Table 2 Effect of nitrogen levels and plant growth regulators on yield and economics of Barley (mean of two years)

Treatments **Nitrogen levels**	Biological yield (q ha^{-1})	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)	Net return (Rs ha^{-1})	B:C ratio
100% of Recommended dose (N_1)	98.75	45.97	52.78	46.55	51747	2.57
125% of Recommended dose (N_2)	100.93	42.74	58.19	42.35	50330	2.52
150% of Recommended dose (N_3)	102.70	39.76	62.94	38.71	48957	2.46
CD (P=0.05)	1.74	2.2	2.96	2.93	1395	0.05
Plant Growth Regulators						
Control (G_0)	97.56	40.44	57.12	41.45	49604	2.53
Chlormequat chlorid (CCC) @1.25 L ha^{-1} at GS $_{30-31}$(G_1)	102.15	42.04	60.11	41.15	49860	2.51
Mepiquat-chlorid (Terpal) @1.0 L ha-^{1} at GS-$_{39-40}$ (G_2)	107.10	43.82	63.28	40.91	51023	2.53
CCC @ 1.25 L ha-^{1} at GS $_{30-31}$ followed by Terpal @ 1.0 L ha^{-1} at GS $_{39-40}$ (G_3)	111.64	44.94	66.70	40.25	50892	2.49
CD (P= 0.05)	7.25	2.55	3.25	NS	709	0.02

Table 2 indicated that biological yield significantly increase with increasing levels of nitrogen from 100 per cent to 150 percent of the recommended dose. The grain yield conspicuously decreased with every increase in the levels of nitrogen from 100 per cent to 150 per cent of the recommended dose of nitrogen. The magnitude of decrease in grain yield with 125 and 150 percent of the recommended dose of nitrogen was to the tune of 7.03 and 13.52 percent, respectively over 100 per cent recommended dose of nitrogen. The straw yield increased significantly with increasing rates of the nitrogen from 100 percent to 150 percent of the recommended dose of nitrogen. The magnitude of increase in straw yield with 125 and 150 percent of the recommended dose of nitrogen was to the tune of 10.25 and 19.25 per cent, respectively over 100 percent of the recommended dose. Every increase in the level of nitrogen from 100 percent recommended dose of nitrogen decrease the harvest index significantly. Hence, the maximum harvest index (46.55%) was obtained with 100 percent recommended dose of nitrogen which was 9.92and 20.25 percent higher than that of

125 and 150 percent recommended dose of nitrogen, significantly.

Table-2 showed that biological yield significantly increase with different growth regulators over control. Highest biological yield was recorded with CCC @ 1.25 L ha^{-1} at GS $_{30-31}$ followed by Terpal @ 1.0L ha^{-1} at GS $_{39-40.}$. The grain yield was increased with different growth regulators over control[3]. Highest grain yield was obtained with CCC @ 1.25 L ha^{-1} at GS $_{30-31}$ followed by Terpal @ 1.0L ha^{-1} at GS $_{39-40.}$ There was no significant difference between mepiquat-chlorid(Terpal) @ 1.0L ha^{-1} at GS $_{39-40}$ and CCC@ 1.25 L ha^{-1} at GS $_{30-31}$. followed by Terpal @ 1.0L ha^{-1} at GS $_{39-40}$. The straw yield was also increase with different growth regulators. But highest straw yield was obtained with CCC@ 1.25 L ha^{-1} at GS $_{30-31}$ followed by Terpal @ 1.0L ha^{-1} at GS $_{39-40}$ over other growth regulators.Table-2 indicated that different growth regulators had no significant impact on harvest index. The highest harvest index (41.45%) was obtained with control.

The table-2 under reference narrated that the highest net return Rs. 51,747 ha^{-1} was obtained with recommended dose of nitrogen (60kg. ha^{-1}). Application of mepiquat-chlorid(Terpal) @ 1.0L ha^{-1} at GS $_{39-40}$ gave highest net return over control. As the benefit cost ratio is concerned the highest B: C ratio (2.57) was noticed in case of 100% of recommended dose of nitrogen (60kg. N $ha^{-1)}$ without using plant growth regulators as compared to use of plant growth regulators.

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