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# Effect of Integrated Nutrient Management on Barley (*Hordeum Vulgare* L.) Productivity under Different Sowing Dates

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**Abstract**

*A field experiment was conducted during the winter (Rabi) season of 2018-19 at Agricultural Research Farm, Department of Agronomy, R.B.S. College, Bichpuri, Agra (U.P.) the investigation entitled "Effect of integrated nutrient management on barley (Hordeum Vulgare L.) productivity under different sowing dates". The variables involved in this study barley variety BH-946 was sown with three dates of sowing - $D_1$ -Timely (Nov. 10th), $D_2$- late (Dec. 5th) and $D_3$- very late (Dec. 30th) and 6 additives in barley viz. $T_1$- recommended dose of fertilizer (R.D.F.) - 60 kg N + 30 kg $P_2O_5$ + 20 kg $K_2O$ $ha^{-1}$, $T_2$ - RDF + FYM @ 5 t $ha^{-1}$, $T_3$ - RDF+Mulch @ 6 t $ha^{-1}$, $T_4$ - RDF + FYM @ 5 t $ha^{-1}$+ mulch @ 6 t $ha^{-1}$, $T_5$ - RDF + FYM @ 5 t $ha^{-1}$ + mulch @ 6 t $ha^{-1}$+spray of $ZnSO_4$ @ 0.5% at flag leaf stage of crop growth, $T_6$ - RDF + FYM @ 5 t $ha^{-1}$+mulch @ 6 t $ha^{-1}$+2 spray of KCl @ 0.5% at flag leaf and post anthesis stage of crop growth. Thus, in all 18 treatment combinations were compared in a split plot design having dates of sowing in main plots and additives in sub-plots with four replications. The results revealed that barely crop variety BH-946 should be sown timely (November 10th) for harvesting maximum grain yield (51.59 $qha^{-1}$) as compared to late sown (Dec. 5th) with grain yield (45.01 $qha^{-1}$) and very late sown (Dec. 30th) obtained grain yield (40.51 $qha^{-1}$). The barley crop fertilized with recommended doses of fertilizer (60+30+20 kg NPK $ha^{-1}$) along with FYM @ 5 t $ha^{-1}$+mulch 6 t $ha^{-1}$+spray of $ZnSO_4$ @ 0.5% at flag leaf stage gave higher grain yield as well as net income.*

**Key words**: Barley, Fertilizer, Integrated, Treatments, Yield

## Introduction

Barley is one of the most important cereal crop of world. It is cultivated in almost all part of the world except the topical region. Among other cereal grain crops, barley is considered fourth largest cereal crop in the world with a share 87% of the global cereal production (Pal *et. al.,* 2012). Barley production during 2019-20 was 156.08 million tons in the globe. India accounts for only around 1 per cent of world barley production. Indianôs annual production of barley has been steadily around 1.2-1.7 million tons in the recent years, with production of 1.85 million tons in 2019-20 (*World Agricultural Production, USDA, July, 2020*). The major producers of barley in the country are Rajasthan (47%), Uttar Pradesh (40.11%), Madhya Pradesh (7.3%), Haryana (11%) and Punjab (6.05%). Some cultivation is also undertaken in Bihar, Himachal Pradesh and Uttarakhand. Uttar Pradesh has first position in acreage but when it comes to production stood in second position in barley cultivation due to low yield levels (one daily record, March 28, 2018). Almost 60 pen cent of the total barley produced in India is consumed as cattle feed. In addition to direct human consumption about 0.25 million tons of barley is used by malting industries in the country for the production of beer, whisky and other products, viz. industrial alcohol and vinegar (Chakrawarty and Kushwaha, 2009).

The major constraints limiting barleyôs production are cultivation in poor and marginal soils with poor native soil fertility, rainfed cultivation with recurring drought a common feature, negligible coverage under important varieties, application of practically non cash inputs like dates of sowing, use of

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high yielding varieties etc. The dates of sowing trial conducted during past 25 year under AICWP showed that delay in barley sowing from normal to late decrease the yield by 34.2 kg $ha^{-1}$ per day or 19.8 per cent in NWPZ. Similarly, for late sown varieties, delay in barley sowing from late to very late lead to decline by the grain yield.

The efficient use of nutrients with in crop production system has been in focus for several decades. Application of organic materials alone or in combination with inorganic fertilizer helped in proper nutrition and maintenance of soil fertility. Organic manures increased the efficiency of chemical fertilizers (*Mani et al, 2008*).

Mulching has been proved to be useful in conserving moisture and increasing productivity of barley. Straw mulch also provides benefits in terms of increasing infiltration rate, lower the temperature improves fertilizer availability and increase crop yield. Zn and KCl are one of the micronutrients that play a very important role in plant metabolism particularly under stress environments including saline conditions; it had a positive effect on growth parameters, yield and yield, components under water stress conditions. Zn has a control mechanism and/ or a regulatory function on the Na and Cl uptake and translocation rate.

## Materials and Methods

The field experiment was carried out during winter (*Rabi*) season of 2018-19 at Agricultural Research Farm, Department of Agronomy, R.B.S. College, Bichpuri, Agra (U.P.). The soil was a sandy loam in texture with pH 8.2, organic carbon %, 0.31 available N 182.80 kg $ha^{-1}$, $P_2O_5$ 27.95 kg $ha^{-1}$ and Potash 291.20 kg $ha^{-1}$. The experiment was laid out in ósplit Plot Designô having 18 treatments having dates of sowing (D - Timely. 10th November, Dā - Late 5th December and $D_3$-very late 30th December) in main plots and fertility treatments (additives) in sub plots. With four replications, half of recommended dose of nitrogen (30kg N $ha^{-1}$), full dose of phosphorus (30 kg $P_2O_5$) and potash (20 kg $K_2O$) were supplied through urea, DAP and MOP respectively as a basal dose at sowing time. Remaining half dose (30 kg $ha^{-1}$) nitrogen was applied through urea as a top dressing after 1st irrigation. The application of recommended dose of FYM @ 5 t $ha^{-1}$ in respective treatments were applied before sowing the seed and mulching (Bajra straw) also applied @ 6 t $ha^{-1}$ in the respective treatments just after sowing the crop in inter row spacingôs. The spray of Zn and KCl were applied in treatment wise at respective crop growth stage. The barley variety BH-946 which is most suitable cultivar for harvesting maximum grain yield in NWPZ was sown in this experiment.

## Results and Discussion

*Growth and Development*

Data pertaining to different growth and yield attributing traits and yield are presented in Table 1 & 2. The maximum number of shoots $m^{-1}$ row length, shoot height, dry matter accumulation in plants of 250 cm row length, days taken 75 percent spike emergence and days to maturity are obtained with timely sown crop (Nov. 10th) and it was considerably reduced with late (Dec. 5th) and very late (Dec. 30th) dates of sowing at all the stages of crop growth. The dry matter accumulation in plants of 25 cm row length was increased continuously almost linearly upto harvest of the crop. However, the rate of dry matter accumulation was much faster after 30 days of seeding. The rapid increase in spike weight might be the principal reason for faster dry matter accumulation in plants of 25 cm row length. Dry matter accumulation in plants reduced considerably from timely sown date (Nov. 10th) to late (Dec. 5th) and very late (Dec. 30th) dates sowing at all the stages of crop growth except 30 DAS (Table 1).

The plants in timely sowing dale are benefited to soil moisture and nutrients from the soil for longer period over the plants in late and very late dates of seeding these finding confirm the results of Singh and Sharma, 2006b and Singh *et. al.* 2013 have also reported similar results.

Different additives along with RDF influenced appreciably the number of shoots $m^{-1}$ row length at 15 DAS as well at various stages of crop growth except 30 DAS. Similarly, different additives along with RDF increased shoot height significantly at all the stages of crop growth except at 30DAS stage as compared to RDF alone. Application of RDF+ FYM @ 5 t $ha^{-1}$ + mulch @ 6 t $ha^{-1}$ + spray of $ZnSo_4$ @ 0.5% at flag leaf stage of crop growth ($T_5$) proved its significant superiority over all other additive treatments and RDF alone except RDF+ FYM @ 5 t $ha^{-1}$ + mulch @ 6t $ha^{-1}$ + 2 sprays of KCl @ 0.5% at flag leaf and post anthesis stage of crop ($T_6$), with respect to shoot height. Dry matter accumulation in plants of 25 cm row length was significantly affected due to various additives along with RDF when compared RDF alone at various stage of crop growth. The days taken 75 per cent spike emergence and days to maturity were not affected appreciably due to various additives along with RDF.

Table 1: Yield contributing characters of barley as influenced by sowing dates and different additives

| Treatments | Stand count/m² | Spike length (cm) | No. of spike/m² | No. of spikeletõs spike⁻¹ | No. of fertile spikeletõs spike⁻¹ | No. of grains spike⁻¹ | Grain weight spike⁻¹ | 1000-grain weight (g) |
|---|---|---|---|---|---|---|---|---|
| Sowing dates | | | | | | | | |
| $D_1$ | 315.46 | 6.78 | 295.52 | 52.25 | 48.74 | 45.37 | 1.95 | 42.92 |
| $D_2$ | 313.85 | 6.43 | 293.82 | 45.82 | 44.24 | 39.82 | 1.58 | 39.72 |
| $D_3$ | 282.46 | 6.13 | 264.44 | 41.54 | 36.01 | 35.83 | 1.28 | 35.75 |
| SEm ± | 0.20 | 0.08 | 0.33 | 1.14 | 1.64 | 0.48 | 0.07 | 0.55 |
| CD (P=0.05) | 0.69 | 0.28 | 1.16 | 3.94 | 5.66 | 1.66 | 0.24 | 1.90 |
| Additives | | | | | | | | |
| $T_1$ | 297.19 | 6.26 | 281.36 | 42.12 | 39.94 | 38.17 | 1.42 | 37.26 |
| $T_2$ | 303.53 | 6.37 | 284.10 | 44.27 | 41.41 | 40.10 | 1.57 | 39.16 |
| $T_3$ | 300.50 | 6.36 | 283.15 | 46.73 | 41.22 | 39.63 | 1.53 | 38.56 |
| $T_4$ | 306.25 | 6.54 | 285.46 | 47.46 | 42.55 | 40.45 | 1.62 | 40.02 |
| $T_5$ | 308.68 | 6.63 | 287.18 | 50.82 | 48.51 | 42.33 | 1.74 | 41.02 |
| $T_6$ | 307.40 | 6.54 | 286.32 | 47.86 | 44.38 | 41.35 | 1.69 | 40.77 |
| SEm ± | 0.18 | 0.07 | 0.45 | 1.09 | 1.57 | 0.57 | 0.05 | 0.44 |
| CD (P=0.05) | 0.50 | 0.20 | 1.27 | 3.09 | 4.43 | 1.63 | 0.18 | 1.26 |

**Note:** $D_1$ ï Timely (Nov. 10th), $D_2$ ï Late (Dec. 5th), $D_3$ ï Very late (Dec. 30th),
$T_1$ ï RDF (60-30-20), $T_2$ ï RDF + FYM @ 5 t ha⁻¹,
$T_3$ ï RDF + Mulch @ 6 t ha⁻¹, $T_4$ ï RDF + FYM @ 5 t ha⁻¹ + Mulch @ 6 t ha⁻¹,
$T_5$ ï RDF + FYM @ 5 t ha⁻¹ + Mulch @ 6 t ha⁻¹ + spray of $ZnSO_4$ @ 0.5% at flag leaf stage,
$T_6$ ï RDF + FYM @ 5 t ha⁻¹ + Mulch @ 6 t ha⁻¹ + sprays of KCl @ 0.5% at flag leaf stage and post anthesis stage.

These results are corroboration with the findings of Singh and Manik Chandra 2018 & Kumar and Singh, 2018 yield attributes and yield. The data presented in Table 2 reveled that number of shoots/m², spikes /m², spike length, no. of spikeletõs spike⁻¹, No. of fertile spikeletõs spike⁻¹, no. of grains spike⁻¹, and weight of grains spike⁻¹ were increased significantly with timely sown coup (Nov. 10th) than late (Dec. 5th) and very late (Dec. 30th) dates of seeding. The 1000ï grain weight reduced with every delay in sowing dates from timely sown crop. Thus, the 1000-grain weight was appreciably higher with timely sown crop than late and very late date of sowing. These results are in accordance with Mishra et al. 2003, and Li *et al.* 2008.

The data given in Table 2 shows that timely sown crop (Nov. 10th) appreciably increased biological yield qha⁻¹ over late (Dec. 5th) and very late (Dec. 30th) dates of sowing. The trends of biological yield contributing characters i.e. number of shoots/m² and dry matter accumulation in plants of 25 cm row length was similar to that biological yield which might be held responsible for higher biological production ha⁻¹.

It may be seen that the grain yield ha⁻¹ with timely sown (Nov. 10th), late (Dec. 5th) and very late (Dec. 30th) was 51.59, 45.01 and 40.51 qha⁻¹ respectively. The magnitude of increase in grain yield with timely sown crop was to the tune of 14.62 and 27.35 per cent, respectively over late and very late dates of sowing. Grain yield contributing characters namely no. of spike /m², No. of grains spike⁻¹ also had similar trends to that recorded in grain yield ha⁻¹ which might be held responsible for higher grain yield ha⁻¹ with timely sown crop. Similar results have also been

Table 2: Biological, grain, straw yield and harvest index of barley as influenced by sowing dates and additives

| Treatments | Biological yield(qha⁻¹) | Grain yield (qha⁻¹) | Straw yield (qha⁻¹) | Harvest Index (%) |
|---|---|---|---|---|
| Sowing dates | | | | |
| $D_1$ | 120.29 | 51.59 | 68.21 | 42.88 |
| $D_2$ | 106.41 | 45.01 | 61.40 | 42.30 |
| $D_3$ | 95.77 | 40.51 | 55.26 | 42.30 |
| SEm ± | 0.28 | 0.30 | 0.24 | 0.24 |
| CD (P = 0.05) | 0.97 | 1.03 | 0.84 | NS |
| Additives | | | | |
| $T_1$ | 101.42 | 42.64 | 58.79 | 42.04 |
| $T_2$ | 106.60 | 45.19 | 61.41 | 42.38 |
| $T_3$ | 105.00 | 44.33 | 60.67 | 42.21 |
| $T_4$ | 108.91 | 46.31 | 62.60 | 42.53 |
| $T_5$ | 112.13 | 48.32 | 63.81 | 43.08 |
| $T_6$ | 110.89 | 47.42 | 63.47 | 42.73 |
| SEm ± | 0.79 | 0.25 | 0.74 | 0.33 |
| CD (P=0.05) | 2.22 | 0.71 | 2.09 | NS |

NS = Not significant

reported by Mani *et al.* 2008 and Chakrawarty and Kushwah, 2009.

Like biological and grain yield, straw yield was also significantly affected due to different dates of sowing. Timely sown crop produced appreciably higher straw yield than late and very late sown crop. In this investigation the highest harvest index was recorded with timely sown crop (Nov. 10$^{th}$) and it was statistically at par with late (Dec. 5$^{th}$) and very late (Dec. 30$^{th}$) date of seeding.

*Effect of additives*

Biological yield improved significantly due to various additives along with RDF over RDF applied alone. The trends of biological contributing characters viz. no. of shoots/m$^2$ and dry matter accumulations in plants of 25 cm row length was similar to that biological production ha$^{-1}$ which might be held responsible for such results of biological yield ha$^{-1}$. Application of FYM @ 5 t ha$^{-1}$ + Mulch @ 6 t ha$^{-1}$ + spray of $ZnSO_4$ @ 0.5% at flag leaf stage along with RDF (60 N + 30 $P_2O_5$+ 20 $K_2O$ ha$^{-1}$) was at par with RDF+ FYM @ 5 t ha$^{-1}$ + mulch @ 6 t ha$^{-1}$ + 2 sprays of KCl @ 0.5%, at flag leaf and post anthesis stage of crop, but both the treatments produced higher biological yield over all other additives and RDF alone tested in the experiment. These findings confirm the results of Meena *et al.* 2012, Kumar and Singh, 2018.

Similarly grain and any straw yields were also increased due to various additives along with RDF over RDF applied alone. Application of FYM @ 5 t ha$^{-1}$ + mulch 6 t ha$^{-1}$ + spray of $ZnSO_4$ @ 0.5% at flag stage + RDF and RDF + FYM @ 5 t ha$^{-1}$ + mulch @ 6 t ha$^{-1}$ + 2 sprays of KCl @ 0.5% at flag leaf and post anthesis stage of crop growth, were at par but produced significantly higher grain yield as compared to all other additive treatments and RDF tested in this experiment. The trends of grain yield contributing characters viz., no. of spike/m$^2$, length of spike, number and weight of grains spike$^{-1}$ also had similar trends to that recorded grain yield ha$^{-1}$ which might be held responsible for such results of grain yield ha$^{-1}$. All the additives along with RDF did not improve the harvest index significantly over RDF applied alone.

The maximum net income was obtained from normal sown crop with the application of RDF along with FYM @ 5 t ha$^{-1}$ + mulch @ 6 t ha$^{-1}$ + spray of $ZnSO_4$ @ 0.5% ($D_1T_5$) and the B:C ratio (2.64) was also highest in case of crop sown at normal date of sowing (Nov. 10$^{th}$) with the application of recommended dose of fertilizer only ($D_1T_1$). This might be due to low cost of Cultivation.

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