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# Effect of sowing methods, NPK levels and zinc sulphate on grain yield and its attributing traits in wheat (*Triticum aestivum* L.)

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**Abstract:** For utilizing the full potential of wheat variety PBW 502, two consecutive experiments were carried out at Crop Research Station, Masodha of N. D. University of Agriculture and Technology, Faizabad (U.P.) during *rabi* season of 2012 and 2013 to study the effect of sowing methods, NPK levels and zinc sulphate on grain yield and its attributing traits in wheat (*Triticum aestivum* L.). The experimental field was laid out in Split Plot Design with three replications keeping two methods of sowing *viz.* $S_1$ (Ridge method) and $S_2$ (Flat method) in the main plot and three fertilizer doses *viz.* $F_1$ (Recommended dose of fertilizers), $F_2$ (RDF + 25% higher dose) and $F_3$ (RDF + 50% higher dose) in sub plot. The four levels of zinc sulphate (@ 10, 20, 30 and 40 kg $ha^{-1}$) were also applied in the sub plots. Periodical observations were recorded on growth, yield attributing characters and grain yield. The results revealed that various methods of sowing had significant effect on plant height at all the stage of crop growth (except at dough stage), days to 50% heading, yield attributing traits and grain yield. The varied doses of fertilizers had significant response on all the stages of crop growth as well as days to 50% heading. Increasing levels of NPK and zinc sulphate significantly influenced most of the yield components. Maximum yield potential can be obtained under ridge method of sowing along with the application of RDF + 25% higher dose and zinc sulphate @ 30 kg $ha^{-1}$ which also improved the yield attributing traits like number of productive tillers/plant, spike length (cm), number of spikelets/spike, number of grains/spike, test weight (g) and seed recovery (%).

**Keyword:** Wheat, NPK, Zinc, Showing methods, Grain yield

## Introduction

In India, wheat (*Triticum aestivum* L.), being second important staple food crop after rice, is a backbone of our food security and prosperity. Importance of wheat crop may be understood from the fact that it covers about 42% of total cropped area and 32% of total rice (*Oryza sativa* L.) area in rice-wheat system in South Asia (Iqbal *et al.*, 2002). India needs more food grain year ahead as the population is increasing unabated. Most of this increase in production will have to manage from increase in productivity as the land area under wheat cultivation is not expected to expand. Therefore, the best production techniques need to be followed. Of which, sowing methods, balanced fertilizer application and micronutrient applications are important factors in determining the yield of wheat. In India, wheat is planted through broadcasting on a large scale. Raised beds are widely used in developed countries as an improved system of productivity (Meisner *et al.*, 1992) which makes wheat-based cropping systems to be less resource intensive and more sustainable. This technique offers new and better weed control, water management and fertilizer management opportunities, along with less crop lodging and some reduction in tillage (Sayre, 2003). During the past three decades, intensive agriculture involving exhaustive high yielding varieties has led to heavy withdrawal of nutrients from the soil. Among different nutrient elements nitrogen, phosphorus and potassium are the most important plant nutrient needed to obtain high wheat yield as well as of other crops. In addition to NPK, zinc is an essential micronutrient for biological systems because of its role in protein synthesis and metabolism. Keeping the above points in view, the present investigation was carried out to compare the performance of wheat in various sowing methods with varied doses of NPK and zinc sulphate. Keeping all these factors in view present investigation was carried out with the objectives: 1) To analyse the comparative performance of ridge and flat bed methods, 2) To optimize the doses of NPK by increasing 25% and 50 % over its recommended doses *i.e.* 120:60:40 kg/ha, 3) To quantify the scheduling and dose of micronutrient *i.e.* Zn being deficient at experimental site.

## Materials and Methods

Two consecutive experiments were carried out at Crop Research Station, Masodha of N. D. University of Agriculture and Technology during *rabi* season of 2012 and 2013. The experimental field was laid out in Split Plot Design with three replications keeping two methods of sowing *viz.* $S_1$ (Ridge method) and $S_2$ (Flat method) in the main plot and three fertilizer doses *viz.* $F_1$ (Recommended dose of fertilizers), $F_2$ (RDF + 25% higher dose) and $F_3$ (RDF + 50% higher dose) in sub plot. The four levels of zinc sulphate (@ 10, 20, 30 and 40 kg $ha^{-1}$) were also applied in the sub plots. The soil of experimental field was suitable being neutral in reaction (pH 7.4) and weather conditions during crop period seemed to be favourable for successful outcome of the wheat crop. Periodical observations were taken in order to assess the effect of sowing methods, fertilizer doses and zinc sulphate on growth, yield attributing characters and grain yield which were analyzed statistically.

## Results and Discussion

The findings of the present investigation have been elaborated and discussed under following heads.

**Effect of sowing methods:** The selection of suitable method of planting plays an important role in the placement of seed at proper depth, which ensures better emergence and subsequent crop growth. Irrespective of treatments, plant height was lower at CRI stage which further increased continuously increased at tillering stage, jointing stage, flowering stage and dough stage. The results over two years (table-1) revealed that plant height was significantly affected by the various methods of sowing at all the stage of crop growth (except at dough stage). Higher plant height was recorded under ridge method of sowing than flat method of sowing during both the year. This might be due to better water utilization efficiency and development of extensive root system in the crop plants sown on ridges. Non-significant effects of method of sowing on plant height at dough stage may be in support of Shahzad *et al.* (2007) who stated that height of the crop is mainly controlled by the genetic makeup of a genotype and it can also be affected by the environmental factors. The present findings are in line of Dixit and Gupta (2004), Phogat *et al.* (2007) and Sangwan *et al.* (2008) who reported significant effect of various methods of sowing on plant height. Dagash *et al.* (2014) suggested that higher plant height could be achieved by planting on ridges than flat and other method of sowing. The results over two years showed that the crop sown on ridge beds reached about 2-3 days early to 50% heading than flat bed method (Table-1). This might have been due to better growth performance which led to early entry of reproductive stage in the plants sown on ridges than flat method.

Yield attributing characters which determine yield, are the resultant of the vegetative development of plant. The highest values of yield and its components *viz.*, number of productive tillers/plant, spike length (cm), number of spikelets /spike, number of grains/spike, test weight (g) and grain recovery (%) were recorded under ridge method of sowing during both the years (Table 2). Similar results had been observed by Dixit and Gupta (2004), Kataria and Sharma (2007), Wesolowski and Cierpiala (2011). The grain yield is a function of the integrated effect of the yield components which were influenced differently by growing conditions. The data revealed that grain yield was affected significantly due to sowing methods during both the years. Higher grain yield of 54.77 q $ha^{-1}$ and 56.41 q $ha^{-1}$ was obtained under ridge method of sowing, which significantly produced 11.45% and 12.63% more yield than flat method during 2012-13 and 2013-14, respectively (Table 2). Sayre (2003) stated that ridged bed sowing helps to control soil erosion, reducing soil compaction and bettering soil physical structure over time. Improvement in grain yield over flat method may coincide with preceding statement. Khan *et al.* (2000) reported that sowing method greatly affected grain yield. Siddiqui *et al.* (2006), El-Lattief (2011) and Dagash *et al.* (2014) obtained maximum grain yield of wheat with ridge sowing over other methods.

**Effect of NPK fertilizers:** Among the nutrients; the nitrogen, phosphorus and potassium are prerequisite to crop plants. These can play a vital role enabling the wheat crop to achieve their full genetic potential. Generally the seed crop have additional requirement of plant nutrients in place of recommended dose of fertilizer for better growth and development. The varied doses of fertilizers had significant response on all the stages of crop growth as well as heading. The maximum plant height (cm) at CRI stage, tillering stage, jointing stage, flowering stage and dough stage was recorded in the plots applied with RDF + 50% higher dose but this treatment delayed 50% heading by 2 days (Table-1). The plant height increased linearly with each successive increase in dose of

**Table-1:** Mean values for plant height (cm) at different critical stages of growth and days to 50% heading in wheat cv. PBW 502 during 2012-13 and 2013-14

| Treatment | At CRI stage | | At tillering stage | | At jointing stage | | At flowering stage | | At dough stage | | Days to 50% heading | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2012-13 | 2013-14 | 2012-13 | 2013-14 | 2012-13 | 2013-14 | 2012-13 | 2013-14 | 2012-13 | 2013-14 | 2012-13 | 2013-14 |
| **Method of sowing** | | | | | | | | | | | | |
| Ridge method | 22.38 | 22.88 | 45.27 | 46.55 | 73.14 | 73.86 | 79.31 | 79.32 | 83.47 | 85.08 | 77.65 | 76.68 |
| Flat method | 21.27 | 21.19 | 42.45 | 43.25 | 70.78 | 72.69 | 75.19 | 76.53 | 81.91 | 84.02 | 80.04 | 78.24 |
| Sem (±) | 0.189 | 0.119 | 0.206 | 0.032 | 0.059 | 0.387 | 0.114 | 0.192 | 0.261 | 0.951 | 0.089 | 0.373 |
| C.D. (p=0.05) | NS | 0.72 | 1.25 | 0.20 | 0.36 | NS | 0.70 | 1.17 | NS | NS | 0.54 | NS |
| **Fertilizer doses (NPK kg $ha^{-1}$)** | | | | | | | | | | | | |
| RDF (120:60:40) | 21.11 | 20.95 | 42.32 | 44.19 | 71.08 | 72.35 | 75.10 | 76.94 | 81.71 | 83.62 | 78.06 | 76.55 |
| RDF+25% higher dose (150:75:50) | 21.87 | 22.07 | 43.83 | 44.28 | 71.70 | 73.38 | 76.49 | 76.76 | 82.31 | 83.95 | 78.50 | 77.11 |
| RDF+50% higher dose (180:90:60) | 22.49 | 23.08 | 45.43 | 46.24 | 73.09 | 74.10 | 80.14 | 80.08 | 84.05 | 86.08 | 79.97 | 78.72 |
| Sem (±) | 0.102 | 0.114 | 0.181 | 0.204 | 0.250 | 0.348 | 0.156 | 0.133 | 0.308 | 0.253 | 0.282 | 0.159 |
| C.D. (p=0.05) | 0.29 | 0.33 | 0.52 | 0.58 | 0.71 | 0.99 | 0.44 | 0.38 | 0.88 | 0.72 | 0.80 | 0.45 |
| **Zinc sulphate (kg $ha^{-1}$)** | | | | | | | | | | | | |
| 10 kg $ha^{-1}$ | 21.04 | 21.42 | 43.25 | 44.29 | 71.40 | 72.92 | 76.92 | 77.66 | 82.09 | 84.27 | 78.18 | 76.68 |
| 20 kg $ha^{-1}$ | 21.94 | 21.94 | 43.78 | 44.70 | 71.84 | 73.13 | 77.30 | 77.78 | 82.43 | 84.17 | 78.60 | 77.39 |
| 30 kg $ha^{-1}$ | 22.05 | 22.17 | 44.02 | 45.20 | 72.11 | 73.44 | 77.59 | 77.94 | 82.86 | 84.68 | 78.96 | 77.43 |
| 40 kg $ha^{-1}$ | 22.26 | 22.61 | 44.38 | 45.43 | 72.48 | 73.60 | 77.17 | 78.33 | 83.38 | 85.07 | 79.64 | 78.35 |
| Sem (±) | 0.118 | 0.132 | 0.209 | 0.235 | 0.289 | 0.402 | 0.180 | 0.154 | 0.356 | 0.292 | 0.326 | 0.183 |
| C.D. (p=0.05) | 0.34 | 0.38 | 0.60 | 0.67 | NS | NS | NS | 0.44 | NS | NS | 0.93 | 0.52 |
| Interaction (S×F) | NS | NS | Sig. | Sig. | Sig. | NS | Sig. | NS | NS | Sign. | NS | NS |
| Interaction (S×Z) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| Interaction (F×Z) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| Interaction (S×F×Z) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

Note: Sig. denotes significance of treatments and NS for non-significant

**Table-2:** Mean values for yield component and grain yield in wheat cv. PBW 502 during 2012-13 and 2013-14

| Treatment | No. of productive tillers/plant | | Spike length (cm) | | No. of spikelets /spike | | No. of grains /spike | | Test weight (g) | | Grain recovery (%) | | Grain yield (q ha$^{-1}$) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2012-13 | 2013-14 | 2012-13 | 2013-14 | 2012-13 | 2013-14 | 2012-13 | 2013-14 | 2012-13 | 2013-14 | 2012-13 | 2013-14 | 2012-13 | 2013-14 |
| **Method of sowing** | | | | | | | | | | | | | | |
| Ridge method | 9.13 | 9.48 | 8.62 | 8.80 | 41.96 | 42.35 | 40.56 | 41.30 | 42.80 | 41.74 | 93.70 | 94.54 | 54.77 | 56.41 |
| Flat method | 7.42 | 6.98 | 6.97 | 6.58 | 38.50 | 39.13 | 37.80 | 37.92 | 40.03 | 40.40 | 90.26 | 90.86 | 49.41 | 50.08 |
| Sem (±) | 0.110 | 0.107 | 0.063 | 0.026 | 0.090 | 0.283 | 0.219 | 0.338 | 0.171 | 0.181 | 0.340 | 0.375 | 0.174 | 0.376 |
| C.D. (p=0.05) | 0.67 | 0.65 | 0.38 | 0.16 | 0.55 | 1.72 | 1.33 | 2.06 | 1.04 | 1.10 | 2.07 | 2.28 | 1.06 | 2.29 |
| **Fertilizer doses (NPK kg ha$^{-1}$)** | | | | | | | | | | | | | | |
| RDF (120:60:40) | 7.69 | 7.77 | 7.23 | 7.00 | 39.05 | 39.71 | 38.03 | 38.36 | 40.37 | 39.79 | 91.26 | 92.13 | 51.12 | 52.47 |
| RDF+25% higher dose (150:75:50) | 8.05 | 8.16 | 7.63 | 7.53 | 39.82 | 40.57 | 39.32 | 39.86 | 41.50 | 40.99 | 92.04 | 92.68 | 52.22 | 53.14 |
| RDF+50% higher dose (180:90:60) | 9.10 | 8.76 | 8.52 | 8.53 | 41.81 | 41.95 | 40.21 | 40.60 | 42.38 | 42.42 | 92.64 | 93.28 | 52.92 | 54.12 |
| Sem (±) | 0.064 | 0.088 | 0.045 | 0.049 | 0.120 | 0.054 | 0.085 | 0.089 | 0.158 | 0.167 | 0.252 | 0.246 | 0.284 | 0.236 |
| C.D. (p=0.05) | 0.18 | 0.25 | 0.13 | 0.14 | 0.34 | 0.15 | 0.24 | 0.25 | 0.45 | 0.48 | 0.72 | 0.70 | 0.81 | 0.67 |
| **Zinc sulphate (kg ha$^{-1}$)** | | | | | | | | | | | | | | |
| 10 kg ha$^{-1}$ | 6.88 | 7.19 | 7.58 | 7.47 | 39.43 | 40.25 | 38.67 | 39.28 | 41.10 | 40.79 | 91.62 | 92.24 | 51.84 | 53.00 |
| 20 kg ha$^{-1}$ | 7.86 | 7.72 | 7.70 | 7.58 | 39.82 | 40.52 | 39.07 | 39.60 | 41.33 | 40.96 | 91.95 | 92.55 | 52.08 | 53.18 |
| 30 kg ha$^{-1}$ | 8.78 | 8.78 | 7.86 | 7.76 | 40.23 | 40.99 | 39.39 | 39.70 | 41.48 | 41.23 | 92.05 | 92.91 | 52.12 | 53.30 |
| 40 kg ha$^{-1}$ | 9.59 | 9.23 | 8.04 | 7.94 | 41.42 | 41.21 | 39.61 | 39.85 | 41.75 | 41.30 | 92.30 | 93.09 | 52.31 | 53.48 |
| Sem (±) | 0.074 | 0.102 | 0.052 | 0.057 | 0.139 | 0.062 | 0.098 | 0.103 | 0.182 | 0.193 | 0.291 | 0.284 | 0.328 | 0.272 |
| C.D. (p=0.05) | 0.21 | 0.29 | 0.15 | 0.16 | 0.39 | 0.18 | 0.28 | 0.29 | NS | NS | NS | NS | NS | NS |
| Interaction (S×F) | Sig. | NS | Sig. | Sig. | Sig. | NS | Sig. | Sig. | Sig. | Sig. | NS | NS | NS | NS |
| Interaction (S×Z) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| Interaction (F×Z) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| Interaction (S×F×Z) | NS | NS | Sig, | Sig. | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

Note: Sig. denotes significance of treatments and NS for non-significant

NPK fertilizers which was attributed to the gradual increase in plant height. In addition, increased fertilizer doses helped greater root establishment due to increased meristematic activates which contributed to rapid cell division and cell elongation and thus led to taller plants under the treatments. The present findings may be supported by Dagash *et al.* (2014). The results over two years revealed that days to 50% heading significantly responded to varied fertilizer doses. The crop under lower fertility was nutrient stressed and flowered earlier causing hastened grain filling resulting in poor yields. Increasing levels of NPK fertilizer up to 50% higher dose over RDF took about 80 days to 50% heading (Table-1).

All the yield components were significantly influenced by the application of varied doses of fertilizers during both the years. The highest values of number of productive tillers/plant, spike length (cm), number of spikelets/spike, number of grains/spike, test weight (g) and seed recovery (%) were recorded under the treatment of RDF + 50% higher dose (Table-2), which was followed by RDF + 25% higher dose and RDF. This may be due to sufficient availability of nutrients in plant at all the critical stages of growth and development might have resulted in higher photosynthetic activities of leaves which increased the translocation of photosynthates from source to sink. RDF gave the lowest indices of all yield components as the low availability of nutrient to poor growth performance under this treatment, which resulted lowest yield attributes. Similar results were obtained by Singh and Uttam (1994), Ragasits *et al.* (2000) and Dagash *et al.* (2014) with the increased rates of fertilizers.

The different fertilizer levels had shown significant influence on grain yield during both the years of study. The highest grain yield (52.92 q ha$^{-1}$ and 54.12 q ha$^{-1}$) was recorded under RDF + 50% higher dose (Table-2), which was statistically *at par* with RDF + 25% higher dose in 2012-13 and significantly superior to RDF and 25% higher dose of fertilizers in 2013-14. The increasing grain yield under this treatment was mainly due to production of more number of productive tillers/plant in association with improvement in yield attributes, which had direct effect on grain yield. The lowest grain yield was obtained under RDF application which was possibly due to reduced translocation of carbohydrates from source to sink and less exploitation of the crop in lack of nutrients. Similar findings were reported by Hossain *et al.* (2009), Sumer *et al.* (2010), Alam (2012) and Dagash *et al.* (2014).

**Effect of zinc sulphate:** Application of zinc sulphate had significant effect on plant height at CRI and tillering stage. The maximum plant height was recorded with higher dose of zinc sulphate @ 40 kg ha$^{-1}$ (Table 1). The plant height at jointing, flowering and dough stage did not respond to zinc sulphate in both the years of study that showed the key role of zinc to active vegetative growth in development of meristematic cells whereas in later stages of growth, wheat crop enter the reproductive phase thereby neutralizing the effects of zinc sulphates. Rajput (2006) recorded the highest plant height with the application of $ZnSO_4$ @ 25 kg ha$^{-1}$. The plots treated comparatively at lower doses of zinc sulphate resulted significantly early 50% heading during both the years (Table-1). This has pronounced the translocation of zinc to increase vegetative growth as shown in case of plant height.

A significant increase in most of the yield components *viz*. number of productive tillers/plant, length of spike and number of spikelets/spike was recorded with increasing levels of zinc sulphate. In case of number of grains/spike, maximum values recorded under zinc sulphate @ 40 kg $ha^{-1}$ were found *at par* with zinc sulphate @ 20 kg $ha^{-1}$ and 30 kg $ha^{-1}$ (Table-2). However, non-significant effects of zinc sulphate were recorded for test weight (g), grain yield (q $ha^{-1}$) and grain recovery (%). Keram *et al.* (2013) reported that higher doses of zinc sulphate up to 20 kg $ha^{-1}$ (put under test) with 100% NPK on wheat crop enhanced the quality of produce and its chemical composition. However, non-significant effect of zinc sulphate on grain yield might be due no significant increase in test weight (g) and grain recovery (%) with the increasing levels of zinc sulphate (Table-2). Tiwari *et al.* (2006), Ramkala *et al.* (2008), Khan *et al.* (2008) and Aslam and Yadav (2009) recorded greater grain yield in wheat with the lower Zn rates. Asadi *et al.* (2013) observed that soil application could not supply the plant needs to zinc, lonely. The suggested at least one time supplemental foliar spray to achieve full yield potential of wheat crop.

**Interaction effects:** Sowing of seed on ridged beds increases crop yield by 10-20% with the proper variety, saves 30-40% irrigation water, reduces seed rate, promotes higher nitrogen use efficiency, reduces production cost over the conventional system (BARI, 2006). There are indications that yields of wheat on ridged beds can be further increased through applications of higher doses of fertilizers because of the reduced loss of lodging. Eventually, yield is the contribution of many growths and yield attributes. The results over two years (Table-1 and 2) revealed that significant interactions between sowing methods and fertilizer doses have been registered for plant height at tillering stage, plant height at jointing stage, plant height at flowering stage, plant height at dough stage; number of productive tillers/plant, spike length, number of spikelets/spike, number of grains/spike and test weight. Interaction effects among sowing method, fertilizer doses and zinc sulphate significantly influenced the spike length (cm) of wheat. Other possible interaction effects were found to be non-significant for most of the characters.

From the findings of present investigation, it can be concluded that wheat crop should be sown on ridges and the plant nutrients namely nitrogen, phosphorus and potassium be applied in the ratio of 150:75:60 kg $ha^{-1}$ along with zinc sulphate @ 20 kg $ha^{-1}$ for obtaining high grain yield potential of the variety PBW 502.

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