Effect of different levels of nitrogen and phosphorus on performance of wheat (Triticum aestivum L.)

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Abstract
An experiment to study the effect of different levels of nitrogen and phosphorus on performance of wheat (Triticum aestivum L.) was conducted at ITM University, Gwalior during Rabi season 2015-2016. The combination of three nitrogen levels (50, 100 and 150kg ha⁻¹) and three levels of phosphorus (40, 60 and 80 kg ha⁻¹) were tested in Randomized Block Design with three replications. Significant improvement in plant height, number of tillers, number of leaves and yield attributes were recorded with increase in N application from 50 to 100 and 150 kg ha⁻¹. Increase in levels of Phosphorus from 40 to 60 and 80 kg ha⁻¹ has increased the leaf number per culm, tiller number, number of ear head m⁻², spike length, grain number, grain, straw and biological yield. The maximum grain, straw and biological yield was recorded with the application of 150kg N ha⁻¹ 80 kg P₂O₅ ha⁻¹ which was followed by 150 kg N ha⁻¹ 60 kg P₂O₅ ha⁻¹ while, the minimum yield was observed in 50 kg N ha⁻¹ 40 kg P₂O₅ ha⁻¹.

Keywords: Nitrogen, phosphorus, performance, Triticum aestivum L.

Introduction
Wheat (Triticum aestivum (L.) is the second most important food grain crop in India ranking next to rice (Oryza sativa L.) contributing about 35% of the food grain production. India occupies second position next to China in the world with regard to area (27.7 million hectares) and production (77.6 million tones) of wheat. Although wheat is cultivated in a large area in India but the average yield of wheat is very low (3.0 tons/ha⁻¹) (USDA-2014). The area of wheat in Madhya Pradesh is 5792 thousand ha with the production of 13928 thousand tons and productivity 2405 kg ha⁻¹ (Anonymous, 2014). Balance use of fertilizers and agronomic measures are needed to raise production of wheat crop. The role of macro and micro nutrients is crucial in crop nutrition for achieving higher yields (Raun and Jhonson, 1995). The soils of India are deficient in N and are supplemented with chemical fertilizers for enhancing crop productivity. For the major processes of plant development and yield formation, the presence of nutrients like N, P, K, S and Mg etc. in balance form is essential (Randhawa and Arora 2000) [11]. Nitrogen and phosphorus are the major factors in achieving higher yield because it promotes vegetative growth of plant. Nitrogen is one of the basic elements required for obtaining higher wheat yield. It is largely used in the synthesis of protein, chlorophyll and other vital compounds which are attributed to all physiological and biochemical processes of plants. The response to N fertilization varies according to location, climate, crops and their varieties, type and characteristics of the soil, rate, time of fertilizer application and its placement (Mengel and Kirkby, 1978) [8]. Phosphorus is one of the essential nutrients for plant growth and crop production. Higher P levels increased the yield and nitrogen use efficiency (Zubillaga et al., 2002) [18]. Phosphorus is also essential for cellular respiration, metabolism of starch and fats which has been investigated by many researchers. Appropriate and balanced fertilization on wheat and rice not only causes yield enhancement but also has good impact on phosphorus uptake by these crop plants (Rehman et al. 2006) [13]. Keeping these facts in view present study was conducted to determine the growth and yield response of wheat to different nitrogen and phosphorus role the levels.
Material and Methods
An experiment was conducted at ITM University, Gwalior, Madhya Pradesh on the effect of different levels of nitrogen on phosphorus in performance of wheat (*Triticum aestivum* L.) during rabi season of 2015-16. The experiment comprises of three levels of nitrogen (50, 100 and 150 kg/ha) and three levels of phosphorus (40, 60 and 80 kg ha\(^{-1}\)). The experiment was laid out in Factorial Randomized block design with three replications.

The experiment site falls under humid sub-tropical climate and located in between 23° 10’ N latitude and 79° 54’ E longitudes at an elevation of 411.98 meters above mean sea level. The soil type of experimental field was sandy loam in nature with pH of 7.4 and EC 0.29 dsm\(^{-1}\), having 242 kg available nitrogen, 20.5 kg available phosphorus, 456 kg available potassium, 8.1 kg available sulphur per hectare. During the crop growth period, the maximum temperature varied between 18.9 °C in January third week to 40.1 °C in April first week and minimum temperature ranged from 3.9 °C in third week of December to 23 °C in second week of April.

Wheat variety GW-322 was sown in well prepared soil on Nov 11, 2015 by nari plough with 20 cm row to row distance at the rate of 100 kg seed ha\(^{-1}\) and harvested on April 5, 2016. First weeding was done at 20 days after sowing with the help of khurpi, hand hoe and second at 35 days after sowing.

Fertilizers containing half dose of nitrogen, full dose of phosphorus and potash were drilled 8 cm deep in every plot before sowing and rest dose of nitrogen was top dressed after first irrigation. The potassium was applied @ 40 kg K\(_2\)O ha\(^{-1}\) through Muriate of Potash (60% K\(_2\)O). Nitrogen and Phosphorus were applied as per treatment to each plot, in the form of urea and single super phosphate respectively.

All the agronomic management practices were done uniformly in all the treatments. Six irrigations were given during the entire period of crop, besides pre sowing irrigation. The data on plant height was recorded on five plants which were tagged randomly in each treatment and in each replication. The observations on numbers of tiller per meter row length and yield attributes number of effective tiller per meter row length, ear head length (cm), number of grains per ear head, 1000 grain weight, biological, grain and straw yield were recorded. The grain and straw yields were recorded as per standard procedure.

The Harvest Index, the ratio of economic yield to the biological yield was calculated and expressed in per cent age as given below:

Harvest Index (%) = \(\frac{\text{Economic yield (grain yield)}}{\text{Biological yield (grain + straw)}} \times 100\)

The data obtained on various observations were subjected to statistical analysis by using the techniques of the analysis of variance (ANOVA) and the treatment was tested by F test and Critical difference (CD) at 5% level of significance (Panse and Sukhatme, 1989)\(^9\) for each character to compare the differences among treatment means.

Results and Discussion
Nitrogen levels
The germination and plant stand, was uniform at all the levels of nitrogen and phosphorus. At harvest, with increase in N level from 50 to 100 and 150 kg ha\(^{-1}\) the plant height, leaf number and tiller number per m\(^2\) increased. Application of 150 kg N ha\(^{-1}\) resulted in significantly more days to ear head emergence as compared to 50 and 100 kg N ha\(^{-1}\). The days taken to ear head emergence under latter two levels of N was comparable. The ear head number m\(^{-2}\) increased significantly with increase in phosphorus levels from 40 to 60 and 80 kg ha\(^{-1}\). Increase in nitrogen levels from 50 to 100 and 150 kg ha\(^{-1}\) significantly increased the number of ear head m\(^{-2}\), ear head length. Application of nitrogen at 150 kg ha\(^{-1}\) resulted in significantly higher weight of ear head as compared to 100 and 50 kg ha\(^{-1}\)and these two parameters under latter two treatments was comparable with each other. The number of grains per ear head, grain, straw and biological yield increased with increment in nitrogen dose from 50 to 100 and 150 kg ha\(^{-1}\).

Phosphorus levels
At harvest, the plant height, leaf number and tiller number increased significantly with increase in P\(_2\)O\(_5\) level from 40 to 60 and 80 kg ha\(^{-1}\). The number of days taken for ear head emergence increased significantly with increase in phosphorus level from 40 to 60 and 80 kg ha\(^{-1}\). The ear head length, ear head weight, number of grains per ear head and 1000 grain weight increased significantly with increase in phosphorus level from 40 to 60 and 80 kg ha\(^{-1}\). The grain, straw and biological yield yield increased significantly with increase in phosphorus levels from 40 to 60 and 80 kg ha\(^{-1}\).

Application of 150 kg N and 80 kg P\(_2\)O\(_5\) ha\(^{-1}\) produced higher grain, straw and biological yield over all other treatment combinations except that under 150 kg N with 60 Kg P\(_2\)O\(_5\) ha\(^{-1}\) and 100 kg N with 80 Kg P\(_2\)O\(_5\) ha\(^{-1}\) (Table- 3). The grain, straw and biological yield in latter two treatments was comparable with that under former treatment. Significantly lower grain yield was observed less than 50 kg N and 40 kg P\(_2\)O\(_5\) ha\(^{-1}\) as compared to all other treatments.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant population m(^{-2})</th>
<th>Plant height at harvest, cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen level, kg ha(^{-1})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>120.7</td>
<td>70.22</td>
</tr>
<tr>
<td>100</td>
<td>120.0</td>
<td>73.89</td>
</tr>
<tr>
<td>150</td>
<td>119.5</td>
<td>80.22</td>
</tr>
<tr>
<td>S.E.m(^{-1})</td>
<td>0.86</td>
<td>1.02</td>
</tr>
<tr>
<td>CD at 5%</td>
<td>2.58</td>
<td>3.04</td>
</tr>
<tr>
<td>Phosphorus levels, kg ha(^{-1})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>120.7</td>
<td>69.44</td>
</tr>
<tr>
<td>60</td>
<td>120.0</td>
<td>74.00</td>
</tr>
<tr>
<td>80</td>
<td>119.5</td>
<td>80.89</td>
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<tr>
<td>Interaction P(^{2})N</td>
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</tbody>
</table>
Different nitrogen levels significantly influenced days to ear head emergence, number of ear head m\(^2\), spike length, number of spikelet per spike, grain, straw and biological yield of wheat. The better growth and higher biological yield with increasing N levels can be attributed to the most important functions of the N, in enhancing the vegetative growth (Ma et al. 2004). The increase in yield attributes with mostly helped in increasing the yield of the crop. There was increase in these parameters and with increase in N level.

**Phosphorus levels**

Different growth characters of wheat were significantly influenced due to application of Phosphorus levels (40, 60 and 80 kg ha\(^{-1}\)). The higher values of growth were recorded with application of higher P rates and it decreased in treatments receiving lower P rates. These results are in confirmation with the findings of Islam and Patel (1991) [4] who recorded maximum growth with application of higher P rates and it decreased in treatments receiving lower P rates. The increase in level of phosphorus increased different yield parameters and with increase in N level.

**Discussion**

**Nitrogen levels**

The growth attributes, i.e. plant height, tiller number and the number of leaves significantly increased with increasing levels of nitrogen (50 to 150 kg ha\(^{-1}\)). The increase in these parameters in response to application of N fertilizers is probably due to enhanced availability of nitrogen which enhanced more leaf area resulting in higher photo assimilates and rapid conversion of synthesized carbohydrates into protein and consequent to increase in the number and size of growing cells, resulting ultimately in increased number of tillers (Singh and Agarwal, 2001).

Different nitrogen levels significantly influenced days to ear head emergence, number of ear head m\(^2\), spike length, number of spikelet per spike, grain, straw and biological yield of wheat. The better growth and higher biological yield with increasing N levels can be attributed to the most important functions of the N, in enhancing the vegetative growth (Ma et al. 2004). The increase in yield attributes with mostly helped in increasing the yield of the crop. There was increase in these parameters and with increase in N level.
straw yield) and yield of wheat. The maximum values of these characters were recorded in 80 kg ha⁻¹ application and minimum were observed at 40 kg ha⁻¹. Phosphorus seems to have an additive effect on crop growth provided it is supplied in a balanced proportion to that of N (Bhatti et al., 1988 and Brink, 2001) [2, 3]. Maximum grain yield at highest level of P₂O₅ may be due to proper nutrient availability during seed filling which resulted in the development of reproductive part especially in seed when large quantity of phosphorus was available.

**Interaction effect of Nitrogen and Phosphorus level**

The length of ear head (cm), number of ear head per m² and grain, straw and biological yield (kg ha⁻¹) were significantly influenced due to different combinations of nitrogen and phosphorus levels. Successive increase in P₂O₅ at each level of N showed a tendency to increase the number of grains per ear head indicating the effectiveness of P₂O₅ towards seed formation and grain filling (Kaishtha and Marwahs, 1977). Singh and Singh 1991 and Vaughan et al., (1990), have also reported similar findings, which suggested that N and P₂O₅ in appropriate proportion are vital for formation and development of grains. The better growth and higher biological yield with increasing N levels can be attributed to the most important functions of the N in enhancing the vegetative growth (Ma et al. 2004). Phosphorus has an additive effect on crop growth as it is supplied in a balanced proportion to that of applied N (Bhatti et al., 1988 and Brink, 2001) [2, 3]. Since the test cultivar produced maximum yield (kg ha⁻¹) at 150 kg N and 80 kg P₂O₅ ha⁻¹, which the crop requirements (Villar-Mir, et al. 2002 and Bhatti et al. 1988) [2]. Hence level can be considered as a balanced and economical dose for wheat in this region.

From the results of present experiment, it can be concluded that application of 150 kg ha⁻¹ N and 80 kg P₂O₅ha⁻¹ to wheat crop results in higher growth and grain yield, gross and net returns in Gwalior region of Madhya Pradesh.

**References**


