Effect of dates of sowing and fertilizer on growth and yield of wheat (*Triticum aestivum*) in an Inceptisol of Varanasi

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ABSTRACT

A field experiment was conducted during the winter (rabi) season 2010–11 at Agricultural Research Farm, BHU, Varanasi, Uttar Pradesh, to study the effect of sowing dates and fertilizer levels on growth and yield of wheat (*Triticum aestivum* (L.) emend. Fiori & Paol.). Sowing dates and fertilizer levels significantly affected the number of tillers, plant height, dry-matter accumulation, ear weight, ear length, grains/ear, 1,000-grain weight, grain and straw yield. Grain yield decreased with delay in the sowing dates. Maximum grain yield (3.66 t/ha) was recorded when the crop was sown on 20 November and the minimum (3.17 t/ha) when sown on 23 December.

Key words : Crop production, Fertilizer, Sowing dates, Wheat

Wheat is the most important cereal crop because it is the staple food of the people of India. Weather is one of the key factor influencing agricultural production and productivity. In weather factors, temperature is the driving force of plant development; day length and vernalization moderate its effect. Consequently, different varieties with different genetic make-up mature at different rates but the difference is greater when sown early. In spite of cultivation of high-yielding varieties, improved cultural practices and plant-protection measures, favourable weather is must for good harvests (Rao *et al*., 1999). Fertilizers constitute an integral part of improved crop-production technology. Proper amount of fertilizer application is considered a key to the bumper crop production (Tariq *et al*., 2007). Inorganic fertilizers hold the key to desired increase in yield of food-grain. Studies showed a direct relationship between increased balanced fertilizer uses for higher crop yields. Past many years have shown a significant change in temperature and rainfall pattern. Therefore, it was realized to study the effect of different sowing dates and fertilizer levels to cope up with the changing weather pattern of the region. During the last 8 years, variability in onset of monsoon, decreased rainfall and slight increase in temperature has prompted to study the effect of sowing dates and fertilizer levels on growth and yield of wheat.

A field experiment was conducted during the winter of rabi season of 2010–11 at the Agricultural Research Farm, Institute of Agricultural Sciences, BHU, Varanasi (25° 18' N, 83° 03' E and 128.93 m above mean sea-level). District Varanasi is in semi-arid to sub humid climate zone, mean maximum temperature ranged from 39 to 42°C, while minimum temperature from 9 to 10°C. The mean annual rainfall is about 1,100 mm. The weekly mean maximum and minimum temperature during the experiment ranged from 14.2 to 37.3°C and 4.8 to 21.8°C, respectively. The soil belongs to Inceptisol, had sandy loam texture, particle density 2.68 Mg/m³, bulk density 1.35 Mg/m³, pH (1:2.5, soil: water) 7.3; electrical conductivity 0.27 dS/m; organic carbon 4.3 g/kg and available nitrogen 184.6 kg, phosphorus 14.2 kg and potassium 153.7 kg/ha. The experiment comprised 9 treatment combinations (3 dates of sowing: 20 November, 6 December, 23 December 2010 and 3 levels of fertilizer: 120, 60 and 60; 80, 40 and 40; 80, 40 and 00 kg N, P₂O₅ and K₂O/ha) with 3 replications under split-plot design. Date of sowing was kept in main plot and fertility levels in subplot with plot size of 5m × 3.5 m. Full dose of phosphorous and potassium and one-third nitrogen was applied at the time of sowing through diammonium phosphate, muriate of potash (MOP) and urea. Remaining nitrogen was applied in 2 equal splits at first and second irrigation.

The crop sown on 20 November achieved highest plant height, number of tillers, dry-matter accumulation/plant, being significantly higher than that sown on 6 and 23 De-
cember (Table 1). This might be attributed to maximum
length of growing period available to 20 November sown
crop in comparison to 6 and 23 December sown crop. Cell
division and cell expansion are more sensitive to low tem-
perature than is photosynthesis. Temperature increase
tends to stimulate growth which in turn results in a dilution
of carbohydrates and chlorophyll. Thus the findings con-
firm those of Baloch et al. (2010). At 90 days after sowing,
plant height was maximum with application of 120, 60 and
60 kg/ha N, P₂O₅ and K₂O and at this dose number of
tillers and dry-matter accumulation was maximum. Plant
height increased with an increase in fertilizer dose. Similar
responses were also recorded by Niamatullah et al.
(2011).

The ear length, grains/ear, ear weight and test weight
were influenced significantly by the dates of sowing. The
highest ear length, grains/ear, ear weight and test weight
were recorded in 20 November sown wheat, followed by
6 December. All these attributes significantly decreased
with delay in date of sowing. It might be due to longer and
favourable period of ear formation resulting more
spikelet’s development and greater chances of producing
long ears containing a large number of grains. Shirpurkar
et al. (2008) also reported such results. Among the levels
of fertilizer, 120, 60 and 60 kg/ha N, P₂O₅ and K₂O gave
the highest ear length, grains/ear, ear weight and test
weight, closely followed by 80, 40, 40 kg/ha and both
were significantly higher than 80, 40 and 00 kg N, P₂O₅
and K₂O application. Potassium ion has a beneficial influ-
ence on the development of endosperm cells and hence on
the single grain weight of cereals. The differences in ear
length might be attributed to their difference in supply of
available nutrients. Singh et al. (2011) also reported that
the yield attributes are mainly controlled by the fertilizer
dose.

The highest yield of grain 3.66 and straw 4.95 t/ha and
harvest index were recorded in 20 November sown wheat
(Table 1), followed by 6 and 23 December sown crop. A
significant decrease in grain yield was recorded with suc-
cessive delay in date of sowing, but its effect on the har-
vest index was found non-significant. Lower grain yield in
late-sown wheat could be due to less favourable period for
maturity. High temperature and hot winds forced maturity
of the crop and maturation period is shortened; this can
also occur if the crop is deficient of N and other nutrients,
which results in decrease in grain and straw yield. The early-sown crop, on the other hand, having favourable
weather conditions for longer duration recorded better
growth. These results are in close conformity with the
observation of Shivani et al. (2001). Among the fertilizer
doses, the highest grain and straw yield and harvest index
were recorded with application of N, P₂O₅ and K₂O @
120, 60 and 60 kg/ha. It was significantly superior to 80,
40 and 40 kg/ha and 80, 40 and 00 kg/ha N, P₂O₅ and K₂O
application. The differences in grain yield might be attrib-
uted to difference in doses of N, P and K. The lower level
of N nutrition during the grain-filling period resulted in
yield reduction, which was largely accounted by the
smaller grains, obtained in this condition. Yadav et al.
(2005) found that the grain yield is mainly controlled by
the fertilizer dose.

Changing the sowing time influenced the amount of
total protein and leaf chlorophyll content (Table 1), prob-
ably driven by the differential thermal conditions prevail-
ing during the grain filling period. The crop sown on 20
November recorded highest protein and chlorophyll con-
tent, which was significantly higher than the crop sown on
the other dates. The high temperature during growth pe-
riod of 20 November sown crop induced increase in nitro-
gen accumulation than dry matter accumulation leading to

Table 1. Effect of dates of sowing and fertilizer levels on growth and yield parameters of wheat

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant height (cm)</th>
<th>Tillers/ running m</th>
<th>DM accumulation/ plant (g)</th>
<th>Ear length (cm)</th>
<th>Grains/ ear</th>
<th>Ear weight (g)</th>
<th>Test weight (g)</th>
<th>Yield (t/ha)</th>
<th>Harvest index (%)</th>
<th>Protein content (%)</th>
<th>Chlorophyll content at 60 DAS (SPAD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of sowing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>20 Nov.</td>
<td>83.0</td>
<td>124.0</td>
<td>9.89</td>
<td>8.88</td>
<td>52.4</td>
<td>2.32</td>
<td>36.06</td>
<td>3.66</td>
<td>4.95</td>
<td>34.17</td>
<td>9.43</td>
</tr>
<tr>
<td>6 Dec.</td>
<td>80.0</td>
<td>119.0</td>
<td>9.61</td>
<td>8.26</td>
<td>49.5</td>
<td>2.25</td>
<td>34.88</td>
<td>3.40</td>
<td>4.59</td>
<td>33.58</td>
<td>9.01</td>
</tr>
<tr>
<td>23 Dec.</td>
<td>77.6</td>
<td>108.2</td>
<td>9.32</td>
<td>8.33</td>
<td>45.4</td>
<td>2.10</td>
<td>31.94</td>
<td>3.17</td>
<td>4.29</td>
<td>32.56</td>
<td>8.59</td>
</tr>
</tbody>
</table>

| SEm± CD (P=0.05) | 0.7 | 1.0 | 0.06 | 0.05 | 0.6 | 0.04 | 0.81 | 0.08 | 0.12 | 0.44 | 0.09 | 0.36 |

| Fertilizer level (N, P₂O₅ and K₂O kg/ha) | 82.9 | 123.2 | 9.97 | 8.80 | 51.2 | 2.35 | 36.09 | 3.72 | 5.02 | 34.07 | 9.40 | 36.53 |
| 80,40,40 | 80.2 | 116.4 | 9.68 | 8.64 | 49.4 | 2.25 | 34.13 | 3.41 | 4.60 | 33.49 | 9.01 | 34.80 |
| 80,40,00 | 77.6 | 111.5 | 9.17 | 8.39 | 46.7 | 2.08 | 32.72 | 3.11 | 4.20 | 32.76 | 8.63 | 30.67 |
| SEm± CD (P=0.05) | 1.0 | 2.4 | 0.08 | 0.10 | 1.0 | 0.04 | 0.85 | 0.05 | 0.07 | 0.23 | 0.17 | 0.95 |

The differences in ear length might be attributed to change in supply of available nutrients. Singh et al. (2011) also reported that the yield attributes are mainly controlled by the fertilizer dose.
higher protein and chlorophyll content. This was particularly evident when compared with 6 and 23 December sown crops. Similar results were also reported by El-Gizawy (2009) and Guixia (2010). Protein and leaf chlorophyll content increased significantly with increase in application of fertilizer especially nitrogen. The maximum protein and chlorophyll content were observed with treatment having higher application of N, P\(_2\)O\(_5\) and K\(_2\)O @ 120, 60 and 60 kg/ha and this value was significantly higher than the treatment supplied with 80, 40 and 00 kg/ha N, P\(_2\)O\(_5\) and K\(_2\)O. Amin et al. (2011) also reported significantly higher protein content with higher fertilizer application.

The nutrients uptake by grain and straw (Table 2) decreased significantly with delayed sowing. The highest N, P and K uptake by grain 55.48, 13.55 and 17.93 kg/ha and in straw 38.94, 2.67 and 111.42 kg/ha, respectively, was recorded in the wheat sown on 20 November. The uptake of nutrients by crop is mainly a function of yield of that plant material and efficient development of root system. With the delay in sowing, the growth and yield of crop reduced, resulting low uptake of nutrients. El-Gizawy (2009) also found that the nutrients uptake by grain and straw decreased with delay in sowing. Among the doses of fertilizer, the highest amount of N, P\(_2\)O\(_5\) and K\(_2\)O uptake by grain and straw was observed with N, P\(_2\)O\(_5\) and K\(_2\)O @ 120, 60 and 60 kg/ha. The new high-yielding varieties required higher amount of fertilizers and higher nutrient removal by plants. Similar results were reported by Amin et al. (2011).

Post harvest soil (Table 2) of wheat did not show any significant change in pH and electrical conductivity with respect to dates of sowing. However, organic carbon content of soil decreased significantly with the delay in sowing date, as plant vegetative growth decreased due to reduced growing period of crop, which produced less roots and leaves biomass that determined organic carbon status of soil. Maximum organic carbon content was recorded in earliest sown crop. This was statistically at par with 6 December and significantly higher than the 23 December sown crop. Usually organic carbon is mainly controlled by added organic manures and humus content of soil but it was also affected by added fertilizers as it affects the production of crop residue and root biomass. The available nitrogen, phosphorus and potassium contents in post harvested soil (Table 2) were not significantly influenced by the dates of sowing. The level of available nutrients increased significantly with each successive increase in fertilizer levels in soil. The higher content of available N, P and K, was observed with 120, 60 and 60 as compared with application @ 80, 40 and 00 kg of N, P\(_2\)O\(_5\) and K\(_2\)O/ha. Amount of added fertilizers determines the availability of nutrients to the crop and its content in post harvest soil.

The study revealed that crop sown on 20 November with application of 120, 60 and 60 kg/ha of N, P\(_2\)O\(_5\) and K\(_2\)O had maximum height, number of tillers, dry matter/plant, grain and straw yield, nutrients, chlorophyll, protein content and nutrient uptake by wheat in Varanasi region of eastern Uttar Pradesh.

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