Effect of customized fertilizers on the growth and yield of wheat (*Triticum aestivum* L.) under eastern Uttar Pradesh

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**Abstract**

A field experiment was conducted at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.) during Rabi 2015-16 in randomized block design with four replications. The treatment consisted of T1 (control), T2 (RDF), T3 (Soil test-based recommendation), T4 (Indo-Gulf Customized Fertilizer), T5 (TCL Customized Fertilizer) and T6 (Farmer’s Practice). All the growth parameters viz. plant height (cm), number of tillers (m²), and yield attributes like number of grains spike⁻¹, test weight, grain and straw yield (q ha⁻¹), were maximum under T3 (Soil test based recommendation), which was at par with T4 (Indo-Gulf Customized Fertilizer) and T5 (TCL Customized Fertilizer) and significantly superior over T1 (control), T2 (RDF) and T6 (Farmer’s Practice). At harvest stage the tallest plants of 111.11 cm were recorded with T3 (Soil test based recommendation) followed by Indo-Gulf Customized Fertilizer (108.34cm) and TCL Customized Fertilizer (106.64cm) and the number of tillers meter⁻² at harvest (379.25) were found under T3 (Soil test based recommendation) which were 1.28% and 1.71% higher than the T5 (Indo-Gulf Customized Fertilizer) and T5 (TCL Customized Fertilizer) treatments respectively. The maximum grain yield of wheat (46.64 q ha⁻¹) was recorded with T3 (Soil test-based recommendation) which was significantly higher over than control (20.08 qha⁻¹), farmer’s practice (30.78 qha⁻¹) and RDF (38.10 qha⁻¹) while at par with TCL Customized Fertilizer (43.92 qha⁻¹) and Indo-Gulf Customized Fertilizer (44.97 qha⁻¹). The grain yield of wheat was increased with the treatment T3 (Soil test-based recommendation) 22.41% and 51.53% over RDF and farmer’s practise respectively. Similarly, 3.71% and 6.19% over Indo-Gulf Customized Fertilizer and TCL Customized Fertilizer respectively. The yield difference between both the customized fertilizers was not up to the level of significance.

**Keywords:** customized fertilizer, RDF, TCL, indo gulf fertilizers

**Introduction**

Wheat (*Triticum aestivum* L.) is the important cereal crop for most of the world's population belongs to family Poaceae (Gramineae). It is the most staple food of about two billion people (36% of the world population) provides nearly 55% of the carbohydrates and 20% of food calories consumed globally. Besides staple food for human beings, wheat straw is a good source of feed for a large population of cattle in our country. Wheat compares well with other important cereals in its nutritive value. Wheat grain contains about 8-15% protein, 65-70% carbohydrates, 1.5% fat, 0.8-2.0% minerals, 15% moisture, 2.0-2.5% fiber, 33% thiamine, 36% niacin.

The continuous mining of nutrients from soils coupled with inadequate and imbalanced fertilizer use has resulted in emergence of multi-nutrient deficiency. The deficiency of at least seven nutrients (N, P, K, S, Zn, Fe and B) is quite common in soils of U.P. An annual depletion of 36 million tonnes of nutrients (NPK) from soil, has been estimated while the replenishment through fertilizer is only 28 million tonnes, leaving ~ a net annual deficit of 8 million tonnes which keeps accumulating year after year depleting the soil fertility. The rice – wheat cropping system involving high yielding varieties even with recommended dose of N, P and K use, impoverishing soils in secondary and micro nutrients specially S, Zn, Mn, B and Fe. Use of high analysis fertilizers and inadequate addition of organic manures was resulting in wide spread deficiencies of Zn, S and other micronutrients. The universal deficiency of nitrogen and phosphorus is followed by Zn and nearly 50% of the world soils used for cereal production is Zn deficient (Gibbson, 2006) [5].
The results of large number of experiments clearly showed that even recommended rates of NPK application based on soil test basis, the yield of crops or of the cropping system could not be maintained at higher level continuously (Ananda and Patil, 2005) [1]. The deficiency of S, Zn and Fe or Mn started emerging and limiting crop yield after different periods (Rekhi et al., 2000) [10]. The decrease in productivity was observed to be associated with the new emerging problems of deficiency of micronutrients such as zinc (Zn) and of secondary nutrients such as sulphur (S). The balance nutrient supply to the crops resulted minimal deleterious effect on environment as well as soil (Hegde et al., 2007) [7]. The ‘Customized Fertilizer’ made up of mixing Nitrogen, Phosphorus, Potassium, Sulphur and Zinc has been tested for enhancing wheat yield. Customized fertilizers are unique and ready to use granulated fertilizers, formulated on sound scientific plant nutrition principles integrated with soil information, extensive laboratory studies and evaluated through field research (Rakshit et al., 2012) [13]. The Central Fertilizer Committee has included customized fertilizers in the Fertilizer (Control) Order (FCO) 1985, as a new category of fertilizers that are area, soil and crop specific. Customized fertilizers which are crop; soil and area specific show a good promise to maintained soil health by ensuring appropriate fertilization. Customized fertilizers facilitate the application of the complete range of plant nutrients in the right proportion and to suit the specific requirement of a crop at different stages of growth and are more relevant under site specific nutrient management practices. A large number of customized fertilizer grades proposed by a number of companies have included in fertilizer control order which are multi-nutrient carriers designed to contain primary, secondary and micro nutrients. These products are manufactured through a systematic process of granulation providing uniform quality and can meet crop nutritional needs which is specific to site, soil and stage of crop. Maintenance of proper soil fertility in Rice-wheat system is formidable challenge. Therefore the present study is proposed to study the effect of customized fertilizers on the growth parameters and yield of Wheat.

Materials and Methods
Site and experimental description
A Field experiment was carried out during Rabi season of 2015 - 2016 at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.). Geographically, this experimental site falls under semi-arid, sub-tropical climate of Indo-Gangatic alluvial plains (IGP) having alluvial calcareous soil and is located at 26°47’ N latitude and 82°12’ E longitude on an elevation of about 113 meters above mean sea level. The average annual precipitation is about 1150 mm of which 80-85 per cent is received during monsoon period i.e., between June to September. The total rainfall during course of experimentation was 4.8 mm. The experiment was laid out in randomized block design with four replications. The treatment consisted of T1 (control), T2 (RDF), T3 (Soil test based recommendation), T4 (Indo-Gulf Customized Fertilizer), T5 (TCL Customized Fertilizer) and T6 (Farmer’s Practice). The soil of experimental field was silt loam texture, low in organic carbon (0.38%) and low in available nitrogen (151.76 kg ha⁻¹), phosphorus (14.75 kg ha⁻¹) and medium in potassium (248.00 kg ha⁻¹) and low in sulphur (9.00 kg ha⁻¹), zinc (0.50ppm) and boron (0.46ppm). The crop was sown on 3 December 2015. The crop was fertilized according to treatments in which T1 was completely control, T2 with recommended dose of N:P:K (150:60:40), T3 (N:P:K 120:60:30, S:Zn:B 30:5:2), and T4, T5, and T6 (N:P:K 100:40:0). The half dose of N and full dose of P₂O₅ and K₂O with urea DAP and MOP were applied at time of sowing. In treatment T3 sulphur, zinc and boron were applied through gypsum, zinc sulphate and borax, respectively. The crop was harvested at 140 days after sowing and yield was recorded.

Growth attributes and yield of wheat
The growth attributing characters such as plant height and number of tillers (m²) was taken by selecting five plants randomly from each plots at 30, 60, 90 DAS and at harvest. Yield attributes like number of grain per spike and 1000-grain weight were measured by harvesting five plant samples per plot selected at random. At maturity the wheat crop was harvested and grain and straw yield was recorded.

Results and Discussion
Growth attributes
Plant height is not a yield component especially in grain crops but it indicates the influence of various nutrients on plant metabolism. A cursory glance over the data present in Table 1 revealed that maximum plant height was recorded with the treatment T3 (Soil test based recommendation) at all growth stages (30, 60, 90, DAS and at harvest). The plant height attained in T3 (Soil test based recommendation) was at par with T4 (Indo-Gulf Customized Fertilizer) and T5 (TCL Customized Fertilizer) and significantly higher over T1 (control), T2 (RDF) and T6 (Farmer’s Practice) at all growth stages. At harvest stage the tallest plants of 111.11 cm were recorded with T3 (Soil test based recommendation) followed by Indo-Gulf Customized Fertilizer (108.34cm) and TCL Customized Fertilizer (106.64cm). While minimum plant height was recorded with control at all growth stages. At harvest stage, application of STR, the plant height of wheat was increased 11.42% and 25.93% over T1 (RDF) and T6 (Farmer’s practices) respectively. Similarly, plant height were increased 2.55% and 4.19% over Indo Gulf customized fertilizer and TCL- Customized Fertilizer respectively. The plant height under the treatment T1 (Indo-Gulf Customized Fertilizer) were increased 36.68%, 8.64%, 1.59% and 22.79% as compared to the other treatments i.e. T1 (control), T2 (RDF), T5 (TCL Customized Fertilizer) and T6 (farmer’s practice), respectively. Similarly, with the application of treatment T3 (TCL Customized Fertilizer) an increased in plant height 34.54%, 6.93% and 20.86% over the treatments T1 (control), T2 (RDF) and T6 (farmer’s practice) respectively. The difference in plant height between both the customized fertilizers was not up to the level of significant at all growth stages in this regard. Plant height gradually increased up to 90 DAS during the growth period of crop while slightly decreased at harvest stage under all the treatments.

The increase in plant height in response to application of nutrients through soil test based recommendation and customized fertilizers are might be due to enhanced availability of macro nutrients (N, P, K and S) as well as micro nutrients (Zn and B). This result is supported by the finding of Sarwer et al. (2008) [10], and Chopra et al. (2016) [2]. Significantly highest plant height was observed with the application of 150% dose of CF (89.4 cm) which was on par with the level of 125% CF on mean basis Dwivedi et al. (2014) [4]. The NPK and Zn is important growth nutrient for efficient growth and production Zeidan et al. (2010) [22]. Similar findings were also reported by Sharma et al. (2013) [13].
The number of tillers are closely related to yield of wheat. More number of tillers especially effective tillers, the more will be the yield. The periodical data on number of tillers meter\(^{-2}\) has been presented in Table 1 showed that at harvest stage, the minimum number of tillers meter\(^{-2}\) (270.85) were recorded in control while, maximum number of tillers (379.25) were in T3 (Soil test based recommendation). At harvest stage, the number of tillers meter\(^{-2}\) (379.25) were found under T3 (Soil test based recommendation) which were 1.28% and 1.71% higher than the T1 (Indo-Gulf Customized Fertilizer) and T3 (TCL Customized Fertilizer) treatments respectively. The number of tillers meter\(^{-2}\) under the treatment T1 (Indo-Gulf Customized Fertilizer) were increased 38.24%, 7.51%, 42% and 20.37% as compared to the other treatments i.e. T1 (control), T2 (RDF), T3 (TCL Customized Fertilizer) and T6 (farmer’s practice) respectively. Similarly, with the application of treatment T3 (TCL Customized Fertilizer) an increased in number of tillers meter\(^{-2}\) 37.66%, 7.06% and 19.86% over the treatments T1 (control), T2 (RDF) and T6 (farmer’s practice) respectively. An increased in number of tillers meter\(^{-2}\) 14.84% were calculated in treatment T6 (farmer’s practice) over the control. Singh et al. (2011) reported that increase in number of tillers in wheat crop due to influence of different fertilizer combinations. The higher number of tillers associated with soil test based recommendation and customized fertilizers. At later stages of growth, the number of tillers meter\(^{-2}\) were increased due to enhanced cell expansion and various metabolic processes in the presence of abundant supply of nutrients (Laghari et al. 2010) [10]. Similar results were also reported by Khan et al. (2008) [9], Nadim et al. (2012) [12] and Chopra et al. (2016) [2]. The maximum number of effective tillers/m2 was also obtained under the treatment of 150% dose of CF which was statistically significant over all other treatments by Dwivedi et al. (2014) [4].

### Yield and yield attribute

Yield is the result of cumulative response of yield contributing characters which are determine from the growth and development traits. The data presented in Table 1 revealed that the maximum (48.98) number of grains spike\(^{-1}\) was found with T3 (Soil test based recommendation) which was significantly higher over all the treatments except T1 (Indo-Gulf Customized Fertilizer) and T3 (TCL Customized Fertilizer). Application of fertilizers according to T3 (Soil test based recommendation), the number of grains spike\(^{-1}\) were increased significantly over T1 (control), T6 (farmer’s practice) and T2 (RDF) respectively. Application of T3 (Soil test based recommendation), the number of grains spike\(^{-1}\) of wheat was increased 21.38% and 29.40% over T2 (RDF) and T6 (farmer’s practice) respectively. Similarity, 3.83% and 8.33% over T4 (Indo-Gulf Customized Fertilizer) and TCL Customized Fertilizer respectively. The number of grains spike\(^{-1}\) under the treatment T4 (Indo-Gulf Customized Fertilizer) were increased 38.32%, 16.90%, 4.33% and 24.54% as compared to the treatments that is T1 (control), T2 (RDF), T3 (TCL Customized Fertilizer) and T6 (farmer’s practice) respectively. Similarly, with the application of treatment T3 (TCL Customized Fertilizer) an increased in number of grains spike\(^{-1}\) 32.58%, 12.04%, and 19.44% over the treatments T1 (control), T2 (RDF), T6 (farmer’s practice), respectively. The increase in above characters was found probably due to optimum availability of phosphorus, potassium, sulphur and micro nutrients, which might increase the utilization of other nutrients also. The applied nutrients increased the source capacity such as number and size of leaves, photosynthesis efficiency and translocation of photosynthates from source to sink, its utilization towards yield contributing characters. The more number of grains per spike was found with the application of NPK with combination of micro nutrients under soil test based recommendation and application of customized fertilizers. The effect of boron and zinc in soil test based recommendation and customized fertilizers are clearly seen. The results were partially agreed with the results of Khan et al. (2008) [9], Kallesh et al. (2012) [13], Meena et al. (2013), Samimand Thomas (2016) [15], Chopra et al. (2016) [2] and Dwivedi et al. (2014) [4].

It is obvious from the table that maximum test weight (39.97g) was obtained with T3 (STR) which was at par over all the treatments i.e. T1 -control (38.96g), T6 -Farmer’s Practice (39.00g), T2 -RDF (39.11g), T4 -Indo-Gulf customized fertilizer (39.47g) and T5 -TCL customized fertilizer (39.40g). Higher value of test weight was found under those treatments where S, Zn and B supplied along with NPK while lower value of test weight was found in control (no fertilizer) and farmer’s practice where only nitrogen and phosphorus applied.

The application of nutrients according to T3 (Soil test based recommendation) showed that the maximum grain yield of wheat (46.64 qha\(^{-1}\)) was obtained which was significantly superior over control (20.08 qha\(^{-1}\)), farmer’s Practice (30.78 qha\(^{-1}\)) and RDF (38.10 qha\(^{-1}\) while, at par with Indo-Gulf Customized Fertilizer (44.97 qha\(^{-1}\) and TCL Customized Fertilizer (43.92 qha\(^{-1}\)). The treatments T1 (Soil test based recommendation), T4 (Indo Gulf customized fertilizer) and T6 (TCL- customized fertilizer) where NPK and micro nutrients were used jointly gave the grain yield of wheat 46.64 qha\(^{-1}\), 44.97 qha\(^{-1}\), and 43.92 qha\(^{-1}\) respectively. Under the treatment T3 (STR), the grain yield of wheat was increased 22.41%, 51.53% and 132.27% over T2 (RDF), T6 (farmer’s practices) and T1 (control) respectively. Similarly the grain yield was increased 3.71% and 6.91% over T4 (Indo Gulf customized fertilizer) and T3 (TCL- customized fertilizer) respectively. The grain yield under the treatment T4 (Indo-Gulf Customized Fertilizer) was increased 123.95%, 18.03%, 2.39% and 46.10% over T1 (control), T2 (RDF), T3 (TCL- customized fertilizer) and T6 (farmer’s practice) respectively. Similarly, with the application of treatment T3 (TCL- customized fertilizer), the grain yield of wheat was increased 118.72%, 15.27% and 42.69% over the treatments T1 (control), T2 (RDF) and T6 (farmer’s practice) respectively. The yield difference between both the customized fertilizers was not up to the level of significant in this regard.

A cursory glance over the data presented in Table-2 revealed that straw yield was significantly affected by different treatment practices. The maximum straw yield (73.30 qha\(^{-1}\)) of wheat was obtained under the treatment T1 (Soil test based recommendation) which was significantly superior over all the treatments except T4 -Indo-Gulf Customized Fertilizer (70.96 qha\(^{-1}\)) and T5 -TCL Customized Fertilizer (68.86 qha\(^{-1}\)), which was registered an increase of 3.29% and 6.44% over T4 (Indo-Gulf Customized Fertilizer) and T5 (TCL Customized Fertilizer), respectively. The straw yield under the treatment T4 (Indo-Gulf Customized Fertilizer) were increased 114.57%, 16.27%, 3.04% and 42.60% as compared to the other treatments i.e. T1 (control), T2 (RDF), T3 (TCL- Customized Fertilizer) and T6 (farmer’s practice) respectively. Similarly, with the application of treatment T1 (TCL- Customized Fertilizer) an increased in straw yield 108.22%,
12.82% and 38.38% over the treatments T₁ (control), T₂ (RDF) and T₆ (farmer’s practice) respectively. An increased in the straw yield 50.46% with treatment T₆ (farmer’s practice) than the control. The higher grain yield may be owing to the application of sufficient nutrients in combination which resulted to greater availability of essential nutrients to plants, improvement of soil environment which facilitate in better root proliferation leading to higher absorption of water and nutrients and ultimately resulting in higher yield. The extent of increase in grain and straw yield may be dependent on the effect of soil test based recommendation and use of customized fertilizers. Shekhon et al. (2012) [18] also reported that application of higher dose of customized fertilizer produced additional grain and straw yields. Goswami (2007) [6] and Singh et al. (2012) [19] reported that addition of micronutrient and secondary nutrient increased wheat yield. Reddy et al. (2009) and Mandal et al. (2004) [11] also reported superiority of combined application of N, P, K, Zn and FYM over recommended fertilizer application. Similar results were also reported by Dwivedi et al. (2014) [4], Meena et al. (2013), Khan et al. (2008) [8], Chopra et al. (2016) [3] and Chauhan et al. (2013) [3]. The highest harvest index (38.94%) was calculated with T₆ (TCL-Customized Fertilizer). However, minimum harvest index (37.77%) with control. Harvest index is a function of economic yield to biological yield (Black and Watson, 1960). Application of soil test based recommendation and customized fertilizers failed to bring remarkable difference in the harvest index.

Table 1: Effect of various treatments on growth parameters and yields attributes of wheat.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Treatments</th>
<th>Plant Height</th>
<th>Number of tillers per meter²</th>
<th>Grains spike</th>
<th>Test weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>Control</td>
<td>79.26</td>
<td>270.85</td>
<td>34.10</td>
<td>38.96</td>
</tr>
<tr>
<td>T₂</td>
<td>Recommended dose of Fertilizer</td>
<td>99.72</td>
<td>348.26</td>
<td>40.35</td>
<td>39.11</td>
</tr>
<tr>
<td>T₃</td>
<td>Soil test- based recommendation(N, P, K, S, Zn and B)</td>
<td>111.11</td>
<td>379.25</td>
<td>48.98</td>
<td>39.97</td>
</tr>
<tr>
<td>T₄</td>
<td>Indo Gulf-Customized Fertilizer- Vardan</td>
<td>108.34</td>
<td>374.43</td>
<td>47.17</td>
<td>39.47</td>
</tr>
<tr>
<td>T₅</td>
<td>TCL-Customized Fertilizer-Paras</td>
<td>106.64</td>
<td>372.86</td>
<td>45.21</td>
<td>39.40</td>
</tr>
<tr>
<td>T₆</td>
<td>Farmer’s Practice</td>
<td>88.23</td>
<td>311.06</td>
<td>37.85</td>
<td>39.00</td>
</tr>
<tr>
<td>C.D. (P=0.05)</td>
<td></td>
<td>8.76</td>
<td>25.31</td>
<td>3.74</td>
<td>2.93</td>
</tr>
</tbody>
</table>

Table 2: Effect of various treatments on grain yield, straw yield and harvest index of wheat.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Grain yield (q ha⁻¹)</th>
<th>Straw yield (q ha⁻¹)</th>
<th>Harvest index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>Control</td>
<td>20.08</td>
<td>33.07</td>
</tr>
<tr>
<td>T₂</td>
<td>Recommended dose of Fertilizer</td>
<td>38.10</td>
<td>61.03</td>
</tr>
<tr>
<td>T₃</td>
<td>Soil test- based recommendation(N, P, K, S, Zn and B)</td>
<td>46.64</td>
<td>73.30</td>
</tr>
<tr>
<td>T₄</td>
<td>Indo Gulf-Customized Fertilizer- Vardan</td>
<td>44.97</td>
<td>70.96</td>
</tr>
<tr>
<td>T₅</td>
<td>TCL-Customized Fertilizer-Paras</td>
<td>43.92</td>
<td>68.86</td>
</tr>
<tr>
<td>T₆</td>
<td>Farmer’s Practice</td>
<td>30.78</td>
<td>49.76</td>
</tr>
<tr>
<td>C.D. (P=0.05)</td>
<td></td>
<td>2.13</td>
<td>3.16</td>
</tr>
</tbody>
</table>

Conclusion
The study on use of customized fertilizers which is the combination of macro and micro nutrients indicated its usefulness. The application of both the customized fertilizers i.e. Indo-Gulf Customized Fertilizer and TCL Customized Fertilizer helps in increasing the plant height, number of tillers meter⁻² and grains spike⁻¹which was significantly superior over control, RDF and Farmer’s Practices. The grain and straw yield were directly affected by fertilizers applied through soil test based recommendation and customized fertilizers. The grain and straw yield of wheat were obtained under the treatments Indo-Gulf Customized Fertilizer and TCL Customized Fertilizer was significantly superior over control, RDF and Farmer’s Practices.

References