Original Research Article

Effect of Different Nutrient Management Treatments on Growth, Yield Attributes, Yield and Quality of Wheat (*Triticum aestivum* L.)

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A B S T R A C T

A field experiment entitled “Yield maximization through nutrient management in irrigated wheat (*Triticum aestivum* L.)” was carried out at Instructional Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh during the rabi season of 2015-16. The experiment comprising ten treatments of nutrient management viz., *T*<sub>1</sub> (control), *T*<sub>2</sub> (RDF 120:60:60 NPK kg ha<sup>-1</sup>), *T*<sub>3</sub> (75% N from urea + 25% N from FYM), *T*<sub>4</sub> (FYM @ 10 t ha<sup>-1</sup>), *T*<sub>5</sub> [RDF + ZnSO<sub>4</sub> @ 25 kg ha<sup>-1</sup> (P from DAP)], *T*<sub>6</sub> [RDF + ZnSO<sub>4</sub> @ 25 kg ha<sup>-1</sup> (P from SSP)], *T*<sub>7</sub> [RDF (N from Zn coated urea + P from SSP)], *T*<sub>8</sub> (75% RDF + *Azotobacter* + PSB), *T*<sub>9</sub> [RDF (N from neem coated urea + P from SSP)] and *T*<sub>10</sub> (RDF 50% N from neem coated urea + 50% N from Zn coated urea + P from SSP) were evaluated in randomized block design with three replications. The experimental soil was clayey in texture, medium in available N, P, K and low in available zinc. Wheat variety ‘GW-336’ was sown at 22.5 cm row spacing. The experimental results revealed that significantly higher values of growth parameters viz., plant height, dry matter per plant, number of total tillers and effective tillers, and yield attributes viz., length of spike, number of grains per spike, grain weight per spike and 1000-seed weight, higher grain yield (4227 kg ha<sup>-1</sup>) and straw yield (5792 kg ha<sup>-1</sup>), quality parameters viz., protein content and protein yield were recorded significantly higher under the treatment RDF (120-60-60 kg N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O ha<sup>-1</sup>) + ZnSO<sub>4</sub> @ 25 kg ha<sup>-1</sup> (P from DAP), being at par with treatments RDF, RDF + ZnSO<sub>4</sub> @ 25 kg ha<sup>-1</sup> (P from SSP), RDF (N from Zn coated urea + P from SSP), 75% RDF + *Azotobacter* + PSB, RDF (N from neem coated urea + P from SSP) and RDF (50% N from neem coated urea + 50% N from Zn coated urea) + P from SSP.

**Keywords**
Wheat, Nutrient management, biofertilizers, growth, yield

Introduction

Wheat, *Triticum aestivum* L., a native of South West Asia, is one of the most important staple food crop that has been labelled as ‘king of cereals’. India is the second largest wheat producer country in the world. It is the second most important crop in India after rice, both in terms of area and production. In the world, wheat is grown on an area of 226.60 million ha with 716.1 million tonnes production and 3.2 tonnes ha<sup>-1</sup> productivity (Anon., 2014). India occupied wheat area of 30.23 million ha with production of 93.50 million tonnes and average productivity of 3093 kg ha<sup>-1</sup> (Anon., 2016).

The major wheat producing states are Uttar Pradesh, Madhya Pradesh, Punjab, Rajasthan, Haryana and Bihar which occupy 33%, 18%, 12%, 10%, 9% and 8% area of total wheat cultivation in the country, respectively. In India, the highest
productivity of wheat is recorded in Punjab, whereas Gujarat stands 6th rank with productivity of 2919 kg ha⁻¹.

Integrated nutrient management is vital for sustaining food production. Use of organic, bio-fertilizers and green manures along with inorganic fertilizers has been found effective in improving and maintaining soil fertility, increasing nutrient use efficiency for maximizing productivity in different cropping systems. Verma et al., (2005) reported that the integration of inorganic fertilizers with organic manures will not only sustain the crop production but also effective in improving soil health and enhancing the nutrient use efficiency. Use of bio-fertilizers provide primary nutrients to the plants and maintains good soil health. Neem coated urea is a special formulation of natural neem oil and humic acid which contains high quantity of Triterpenes, the denitrifying factors. The integrated use of concentrate organic materials and inorganic fertilizers has received considerable attention in the past with a hope of meeting the farmer’s economic need as well as maintaining favorable ecological conditions on long-term basis (Kumar et al., 2007). A balanced fertilizer means not only the use of major and secondary nutrients, but also other essential micronutrients in correct proportions. Nutrients affected all most growth and yield attributing characters and yields through its doses as well as sources. Keeping in view the importance of these factors, the present study was designed to investigate the Effect of different nutrient management treatments on growth, yield and quality of wheat (Triticum aestivum L.)

Materials and Methods

A field experiment entitled “Yield maximization through nutrient management in irrigated wheat (Triticum aestivum L.)” was carried out at College of Agriculture, Junagadh Agricultural University, Junagadh during the rabi season of 2015-16. The experiment comprising ten treatments of nutrient management viz., T₁ (control), T₂ (RDF 120:60:60 NPK kg ha⁻¹), T₃ (75% N from urea + 25% N from FYM), T₄ (FYM @ 10 t ha⁻¹), T₅ [RDF + ZnSO₄ @ 25 kg ha⁻¹ (P from DAP)], T₆ [RDF + ZnSO₄ @ 25 kg ha⁻¹ (P from SSP)], T₇ [RDF (N from neem coated urea + P from SSP)], T₈ (75% RDF + Azotobacter + PSB), T₉ [RDF (N from neem coated urea + P from SSP)] and T₁₀ (RDF 50% N from neem coated urea + 50% N from Zn coated urea + P from SSP) were evaluated in randomized block design with three replications. The soil of the experimental plot was clayey in texture and slightly alkaline in reaction (pH 7.9 and EC 0.33 dS/m). The soil (0-15 cm depth) was low in zinc (0.41 mg kg⁻¹), medium in available nitrogen (254-269 kg/ha), available phosphorus (28.4-30.7 kg/ha) and available potassium (183-185 kg/ha). Wheat variety ‘GW-336’ was sown at 22.5 cm row spacing with 120 kg seed ha⁻¹ in last week of November. The recommended dose of fertilizers @ 120:60:60 kg NPKha⁻¹ was considered as 100% RDF. The crop was fertilized as per treatments at the time of sowing, while well decomposed FYM containing 0.5% N, 0.2% P₂O₅, and 0.5% K₂O and vermicompost containing 1.5% N, 1.0% P₂O₅ and 1.5% K₂O were applied based on the nutrient equivalent basis of wheat nutrient requirement at preparation of soil. The seeds were treated with Azotobacter (A. chroococcum) and PSB (Bacillus coagulans) @ 10 ml kg⁻¹ seed as per the treatments, shade dried before sowing. Other cultural operations were done as per recommendation and crop requirements. Regularly biometric observations were recorded at specific time intervals by selecting randomly five plants in each treatment. Finally the crop was
harvested and produce were dried, threshed, cleaned and weighed. The yield data was subjected to statistical analysis.

Results and Discussion

Growth attributes

Wheat growth parameters viz., plant height at harvest, dry matter accumulation plant$^{-1}$ at harvest, number of total tillers per metre$^{-1}$ row length at harvest, effective tillers metre$^{-1}$ row length at harvest were significantly influenced by different treatments (Table 1).

Application of RDF (120-60-60 kg N-P$_2$O$_5$-K$_2$O ha$^{-1}$) + ZnSO$_4$ @ 25 kg ha$^{-1}$ (P from DAP) (T$_3$) recorded significantly taller plants at harvest, higher dry matter accumulation plant$^{-1}$, maximum number of total tillers m$^{-1}$ row length, more number of effective tillers metre$^{-1}$ row length compared to control (T$_1$), it was remained at par with the treatments T$_2$, T$_6$, T$_7$, T$_8$, T$_9$ and T$_{10}$.

The improvement in growth parameters with application of RDF (120-60-60 kg N-P$_2$O$_5$-K$_2$O ha$^{-1}$) + ZnSO$_4$ @ 25 kg ha$^{-1}$ (P from DAP), treatments (T$_3$). T$_2$ (RDF 120:60:60 NPK kg ha$^{-1}$), T$_6$ [RDF + ZnSO$_4$ @ 25 kg ha$^{-1}$ (P from SSP)], T$_7$ [RDF (N from Zn coated urea + P from SSP)], T$_8$ (75% RDF + Azotobacter + PSB), T$_9$ [RDF (N from neem coated urea + P from SSP)] and T$_{10}$ [RDF (50% N from neem coated urea + 50% N from Zn coated urea) + P from SSP]. Fertilizer provides all the essential growth promoting elements for shoot growth, root development, photosynthesis, cell division and cell enlargement as a result meristematic activity increased which favors the growth of wheat. Beneficial effect of chemical fertilizer on increasing growth and superior yield attributes were also reported by Jat et al., (2013), Singh and Kushwaha (2013) and Kumar et al., (2016). Inorganic nutrient application with zinc plays a pivotal role in regulating the auxin concentration in plant and nitrogen metabolism and might have improved the growth parameters. The nitrogen from fertilizer helped in the promotion of growth during the early stages and it is considered to be a vitally important plant nutrient. Further, an adequate supply of phosphorous early in the life cycle of plant through chemical fertilizer is important in laying down the primordia of its reproductive parts. While, micronutrient fertilization with zinc indicate the importance of Zn to plants, being involved in many enzymatic reactions and consequently for better growth and development.

Zn play a major role in the shoots and roots elongation due to auxin hormones activation in the wheat crop plant, higher dry matter production with the application of zinc might be due to reduced leaf senescence and it helps in increasing inter nodal length. These results are in accordance with the findings of Behera et al., (2007), Khan et al., (2007), Dhaliwal et al., (2012), Shivay and Prasad (2012), Kumar et al., (2016) and Nazir et al., (2016).

Yield attributes

Wheat yield attributes such as length of spike, number of spikelets spike$^{-1}$, 1000-grain weight at harvest (Table-1) were improved by integrated nutrient management treatments of T$_3$ [RDF (120-60-60 kg N-P$_2$O$_5$-K$_2$O ha$^{-1}$) + ZnSO$_4$ @ 25 kg ha$^{-1}$ (P from DAP)] which was remained statistically equivalent to the treatments T$_2$, T$_6$, T$_8$, T$_9$ and T$_{10}$ in respect of length of spike, number of spikelets spike$^{-1}$, number of grains spike$^{-1}$ at harvest, treatments T$_2$, T$_6$ and T$_8$ in respect of grain weight spike$^{-1}$ and T$_2$, T$_6$, T$_7$, T$_8$, T$_9$ and T$_{10}$ in respect of 1000-grain weight.
Table 1 Effect of different nutrient management treatments on growth and yield attributes of wheat

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Plant height (cm)</th>
<th>Dry matter plant⁻¹ (g)</th>
<th>Number of total tillers m⁻¹ row length</th>
<th>Number of effective tillers m⁻¹ row length</th>
<th>Length of spike (cm)</th>
<th>Number of spikelets spike⁻¹</th>
<th>1000-grain weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁  Control</td>
<td>68.33</td>
<td>22.33</td>
<td>71.67</td>
<td>52.33</td>
<td>7.11</td>
<td>11.80</td>
<td>39.73</td>
</tr>
<tr>
<td>T₂  RDF (120:60:60 NPK kg ha⁻¹)</td>
<td>85.67</td>
<td>26.88</td>
<td>88.78</td>
<td>72.00</td>
<td>8.43</td>
<td>14.25</td>
<td>44.00</td>
</tr>
<tr>
<td>T₃  75% N from urea + 25% N from FYM</td>
<td>77.19</td>
<td>24.13</td>
<td>80.00</td>
<td>62.81</td>
<td>7.60</td>
<td>13.34</td>
<td>41.04</td>
</tr>
<tr>
<td>T₄  FYM @ 10 t ha⁻¹</td>
<td>75.57</td>
<td>23.87</td>
<td>78.67</td>
<td>62.51</td>
<td>7.50</td>
<td>12.87</td>
<td>40.71</td>
</tr>
<tr>
<td>T₅  RDF + ZnSO₄ @ 25 kg ha⁻¹ (P from DAP)</td>
<td>87.53</td>
<td>27.83</td>
<td>91.67</td>
<td>75.33</td>
<td>8.70</td>
<td>15.45</td>
<td>46.36</td>
</tr>
<tr>
<td>T₆  RDF + ZnSO₄ @ 25 kg ha⁻¹ (P from SSP)</td>
<td>86.67</td>
<td>27.62</td>
<td>90.87</td>
<td>74.67</td>
<td>8.65</td>
<td>14.79</td>
<td>45.70</td>
</tr>
<tr>
<td>T₇  RDF (N from Zn coated urea+ P from SSP)</td>
<td>77.67</td>
<td>24.41</td>
<td>83.33</td>
<td>63.37</td>
<td>7.70</td>
<td>13.52</td>
<td>42.60</td>
</tr>
<tr>
<td>T₈  75% RDF + Azotobacter + PSB</td>
<td>84.22</td>
<td>26.99</td>
<td>88.24</td>
<td>71.43</td>
<td>8.35</td>
<td>14.14</td>
<td>43.23</td>
</tr>
<tr>
<td>T₉  RDF (N from neem coated urea + P from SSP)</td>
<td>83.90</td>
<td>26.17</td>
<td>84.93</td>
<td>69.67</td>
<td>8.27</td>
<td>14.05</td>
<td>43.00</td>
</tr>
<tr>
<td>T₁₀ RDF (50% N from neem coated urea + 50% N from Zn coated urea) + P from SSP</td>
<td>83.50</td>
<td>25.77</td>
<td>84.50</td>
<td>69.12</td>
<td>8.10</td>
<td>13.93</td>
<td>42.68</td>
</tr>
</tbody>
</table>

S.Em. ± 3.39 1.14 3.90 4.11 0.33 0.63 1.29
C.D. (P = 0.05) 10.07 3.40 11.60 12.21 0.98 1.88 3.83
C. V. % 7.25 7.75 8.03 10.57 7.13 7.94 5.21

Table 2 Effect of different nutrient management treatments on yield and quality of wheat

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Grain yield (kg ha⁻¹)</th>
<th>Straw yield (kg ha⁻¹)</th>
<th>Harvest index (%)</th>
<th>Grain protein content (%)</th>
<th>Protein yield (kg ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁  Control</td>
<td>2699</td>
<td>3913</td>
<td>40.80</td>
<td>9.55</td>
<td>257.33</td>
</tr>
<tr>
<td>T₂  RDF (120:60:60 NPK kg ha⁻¹)</td>
<td>4019</td>
<td>5482</td>
<td>42.97</td>
<td>12.37</td>
<td>497.33</td>
</tr>
<tr>
<td>T₃  75% N from urea + 25% N from FYM</td>
<td>3330</td>
<td>4692</td>
<td>41.44</td>
<td>11.12</td>
<td>370.00</td>
</tr>
<tr>
<td>T₄  FYM @ 10 t ha⁻¹</td>
<td>3278</td>
<td>4367</td>
<td>41.16</td>
<td>10.83</td>
<td>355.33</td>
</tr>
<tr>
<td>T₅  RDF + ZnSO₄ @ 25 kg ha⁻¹ (P from DAP)</td>
<td>4227</td>
<td>5792</td>
<td>42.87</td>
<td>13.62</td>
<td>576.00</td>
</tr>
<tr>
<td>T₆  RDF + ZnSO₄ @ 25 kg ha⁻¹ (P from SSP)</td>
<td>4192</td>
<td>5613</td>
<td>42.62</td>
<td>12.69</td>
<td>532.00</td>
</tr>
<tr>
<td>T₇  RDF (N from Zn coated urea+ P from SSP)</td>
<td>3413</td>
<td>4724</td>
<td>41.93</td>
<td>11.25</td>
<td>385.33</td>
</tr>
<tr>
<td>T₈  75% RDF + Azotobacter + PSB</td>
<td>3925</td>
<td>5162</td>
<td>42.61</td>
<td>11.94</td>
<td>468.64</td>
</tr>
<tr>
<td>T₉  RDF (N from neem coated urea + P from SSP)</td>
<td>3774</td>
<td>5037</td>
<td>42.19</td>
<td>11.75</td>
<td>445.67</td>
</tr>
<tr>
<td>T₁₀ RDF (50% N from neem coated urea + 50% N from Zn coated urea) + P from SSP</td>
<td>3643</td>
<td>4941</td>
<td>42.44</td>
<td>11.15</td>
<td>406.33</td>
</tr>
</tbody>
</table>

S.Em. ± 300.61 331.29 1.97 0.500 29.734
C.D. (P = 0.05) 893.17 984.32 NS 1.487 88.343
C. V. % 14.24 11.49 8.08 7.46 11.97
It was emphasized that use of chemical fertilizer and zinc source, use of fertilizers did bring about significant improvement in overall growth of the crop by providing needed nutrients from initial stage. Chemical fertilizer provided initial nutrient needed by crop, while Zn increased membrane-integrity, heat-tolerance, synthesis of carbohydrates, cytochrome and nucleotide synthesis, auxin-synthesis, chlorophyll synthesis and metabolism of N thereby enhancing photo-synthesis, photosynthates, their translocation to grain and finally crop yield increased in these treatments. Similar results related to increase in grain yield due to synergistic effect of NPK and Zn by soil application of Zn have been reported by Jan et al., (2013), Shivay et al., (2015) and Kumar et al., (2016).

**Yield**

A perusal of data (Table-2) revealed that different treatments of nutrient management exerted their significant effect on grain yield and straw yield at harvest. Significantly the highest grain yield of 4227 kg ha$^{-1}$ and straw yield of 5792 kg ha$^{-1}$ at harvest were recorded under treatment RDF (120-60-60 kg N-P$_2$O$_5$-K$_2$O ha$^{-1}$) + ZnSO$_4$ @ 25 kg ha$^{-1}$ (P from DAP) which was found statistically equivalent to treatments T$_2$ and T$_6$. The increased in protein content in wheat grain is influenced by nitrogen and micronutrient availability at the grain formation stage and other environmental conditions.

Significant improvement in grain protein content might be due to its dependence on nitrogen content. While higher protein yield is due to protein content and grain yield. This could explained on the basis of better availability of required nutrients in the crop root zone and enhanced photosynthetic and metabolic activity resulted in better partitioning of photosynthates to sinks, which reflected in quality enhancement in terms of protein content and protein yield. These findings are in close conformity with those reported by Kharub and Chander (2008), Keram et al., (2012), Gajanand et al., (2013), Kadlag et al., (2013), Seema et al., (2014), Sharma et al., (2013), Kumar et al., (2015), Singh et al., (2015).
Based on field experimentation, it can be concluded that, higher growth, yield attributes, yield and quality from wheat can be secured by application of RDF (120-60-60 kg N-P$_2$O$_5$-K$_2$O ha$^{-1}$) + ZnSO$_4$ @ 25 kg ha$^{-1}$ in which P supplied through DAP on calcareous clayey soil of South Saurashtra Agro-climatic Zone of Gujarat.

References


