IMPACT OF ORGANIC AND INORGANIC SOURCES OF NITROGEN AND PHOSPHORUS FERTILIZERS ON GROWTH, YIELD AND QUALITY OF FORAGE OAT (Avena sativa L.)

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Received January 31, 2011

ABSTRACT. A field trial was carried out to examine the comparative efficacy of organic and inorganic sources of nitrogen and phosphorous fertilizers alone and in different combinations to find the yield and quality contributing factors of oat (Avena sativa L.) during 2008-09 at Agronomic Research Area, University of Agriculture Faisalabad. The treatments were tested under randomized complete block design using three replications. Significant result were found in respect of plant height (146.3 cm), number of leaves per plant (6.87), number of tillers per plant (8.02), number of tillers m⁻² (336), leaf area per plant (128 cm²), fresh weight per tiller (30.10g), dry weight per tiller (5.01g) and green fodder yield (74.67 t ha⁻¹) in contrast to organic manures and its combination with inorganic fertilizer (inorganic sources of manures). From the present study it can be concluded to meet the needs of fodder; it is better to use inorganic sources that are more effective and quick in response while organic sources are more environmental friendly than inorganic sources.

Key words: Oat; Organic; Inorganic; Fertilizer; Manure.

INTRODUCTION

Oat (Avena sativa L.) is one of the important cereal forages grown in winter throughout the Pakistan. It is adapted to a wide range of soil types, altitude and rainfall conditions. It can tolerate waterlogged conditions better than most of others cereals (Alemayehu, 1997). Fodder production in Pakistan is approximately 52-54 percent less than actual requirement (Bhatti, 1992). This unsatisfactory crop yield is due to many constrains, among those appropriate nutrient supply is the most important (Oad et al., 2004). Organic sources like farm yard manure (FYM), poultry manure (PM), green manuring and compost etc not supply

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the organic matters but also increase the fertility status of soil (Chang et al., 1991; Brady, 1996; Chung et al., 2000; Keupper and Gegner, 2004). Manures not only supply the important nutrients but also improve physical and chemical properties of the soil (Sharpley et al., 2004). Chemical fertilizers being crucial input for improving soil fertility have become an integral part of modern technology for crop production. There is no complete substitute of chemicals fertilizers (NFDC, 1997). The integration of organic and inorganic sources of nutrients not only supplied essential nutrients but also some positive interaction with chemical fertilizers to increase their efficiency and there by reduce environment hazards (Ahmad et al., 1996). For consistent cropping combined use of FYM and inorganic fertilizers is helpful (The World Bank, 1999).

Keeping in view the above fact and for further confirmation, the study was executed to evaluate the impact of organic and inorganic sources of fertilizers on growth, yield and quality of oat fodder under Faisalabad conditions.

**MATERIALS AND METHODS**

The study to estimate the effect of organic and inorganic sources of fertilizer on growth and yield of forage oat was carried out at the agronomic research area, University of Agriculture, Faisalabad. The experiment was laid out in 1.8 m x 3.0 m plot size with three replicates under Randomized Complete Block Design. Soil samples were taken before sowing of crop at a depth of 30 cm for physio-chemical analysis. Physiochemical characteristics showed that soil of the area was loamy having pH 7.8, total nitrogen contents 0.033 mg kg\(^{-1}\), available phosphorous 8.8 mg kg\(^{-1}\), available potassium 285 ppm and organic matter 0.65%.

The treatments were comprised of control (T\(_1\)), N: P\(_2\)O\(_5\) 150:60 kg ha\(^{-1}\) (T\(_2\)), farm yard manure 4000 kg ha\(^{-1}\) (T\(_3\)), poultry manure 3000 kg ha\(^{-1}\) (T\(_4\)), N: P\(_2\)O\(_5\) 112:45+ poultry manure 750 kg ha\(^{-1}\) (T\(_5\)), N: P\(_2\)O\(_5\) 112:45+ farm yard manure 1000 kg ha\(^{-1}\) (T\(_6\)), N: P\(_2\)O\(_5\) 37.5:15+ poultry manure 2250 kg ha\(^{-1}\) (T\(_7\)), N: P\(_2\)O\(_5\) 37.5:15+ farm yard manure 3000 kg ha\(^{-1}\) (T\(_8\)). Oat variety, Oat-2000 was sown at 20 cm apart rows with single row hand drill 60 kg of seed ha\(^{-1}\). Full dose of well rotted FYM and poultry manure were added three weeks before sowing and thoroughly mixed in the field. Full dose of phosphorus and half dose of nitrogen were added as urea and diammonium phosphate accordingly in respective plots before sowing and the remaining half nitrogen at the time of first irrigation. All other agronomic practices were kept normal and uniform for all the treatments.

The data on growth yield and quality parameters was recorded by adopting standard procedure. The data collected was analyzed by using Fisher’s analysis of variance technique. Individual comparison of treatments’ means will be made by using least significant difference (LSD) test at 5 % probability level (Steel et al., 1997).

**RESULTS AND DISCUSSION**

**Germination count (m\(^{-2}\)).** Data regarding germination count m\(^{-2}\) of oat are presented in Table 1 revealed that the germination count was not
influenced by the application of different organic and inorganic sources of fertilizers. The means for germination count m⁻² was in the range of 190 to 196. These results are quite in line with Theodora et al. (2003) who concluded that application of farmyard manure had no effect on seed germination. Similarly Loecke et al. (2004) and Harris (1996) also endorsed that adding manure did not affect seedling emergence, but resulted in enhanced growth.

**Number of tillers per plant**

Number of tillers per plant greatly contributes towards fodder yield. Significant effects of fertilizers were recorded on number of tillers per plant presented in Table 1. Maximum number of tillers per plant (8.02) was observed in T₂ where nitrogen and phosphorous was applied 150 and 60 kg ha⁻¹ followed by T₅ (N: P₂O₅ 112:45+ Poultry manure 750 kg ha⁻¹) and T₆ (N: P₂O₅ 112:45+ Farm yard manure 1000 kg ha⁻¹) having 7.89 and 7.53 respectively which were statistically at par with T₂ treatment. While the minimum number of tillers 5.94 were observed in T₁ where no fertilizers were applied. These results coindsides with the findings of Hasan and Shah (2000) who concluded that increase in nitrogen levels increased the number of tillers per plant in oat (*Avena sativa* L). While Chellamuthu et al. (2000) reported that combined application of biofertilizers together with N and P fertilizers increased number of tillers per plant in bajra-napier hybrid grass.

Number of tillers per m² is one of the important yield contributing factors which was significantly affected by the application of different fertilizer sources as shown in Table 1. Nitrogen and phosphorous applied 150: 60 kg ha⁻¹ (T₂) produced maximum number of tillers 338 than others. Combination of inorganic N and P sources with poultry and farm yard manure (T₅ and T₆) recorded significantly less number of tillers m⁻² (320) than T₂ (338), however, have higher number of tillers m⁻² compared to rest of treatments. These results are in contrast with the findings of Sasireka et al. (1998) who reported that organic and inorganic manures increased the number of tillers in bajra-napier. Similarly Jayanthi et al. (2002) also revealed that the application of combined source of organic and inorganic fertilizers recorded higher number of tillers m⁻² in oat.

**Plant height (cm).** The results regarding plant height as presented in Table 1 showed significant affect of organic and inorganic fertilizer application. Maximum plant height 146.3 cm was observed in T₂ (N: P₂O₅ 150:60 kg ha⁻¹) followed by T₅ (N: P₂O₅ 112:45+ Poultry manure 750 kg ha⁻¹) and T₆ (N: P₂O₅ 112:45+ Farm yard manure 1000 kg ha⁻¹) where 141.7 and 140 cm plant height was recorded respectively. While in case of control T₁ (no fertilizer), showed minimum plant height of 116.6 cm.
Table 1 - Impact of organic and inorganic sources of nitrogen and phosphorus fertilizers on germination count, No. of tillers per plant, No. of tillers m$^2$, plant height, No. of leaves per plant and leaf area per plant of forage oat (Avena sativa L.)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Germination count (m$^2$)</th>
<th>No. of tillers per plant</th>
<th>No. of tillers per m$^2$</th>
<th>Plant Height (cm)</th>
<th>No. of leaves per plant</th>
<th>Leaf area per plant (cm$^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_1 = \text{Control (no fertilizer)}$</td>
<td>189.83</td>
<td>5.94 e</td>
<td>277 e</td>
<td>116.6 e</td>
<td>4.83 g</td>
<td>105.2 f</td>
</tr>
<tr>
<td>$T_2 = N: P_2O_5 \cdot 150:60 \text{ kg ha}^{-1}$</td>
<td>195.47</td>
<td>8.02 a</td>
<td>338 a</td>
<td>146.3 a</td>
<td>6.87 a</td>
<td>128.0 a</td>
</tr>
<tr>
<td>$T_3 = \text{Farm yard manure - 4000 kg ha}^{-1}$</td>
<td>192.64</td>
<td>6.35 de</td>
<td>290 d</td>
<td>122.4 d</td>
<td>5.80 cd</td>
<td>109.8 de</td>
</tr>
<tr>
<td>$T_4 = \text{Poultry manure - 3000 kg ha}^{-1}$</td>
<td>190.70</td>
<td>6.50 cd</td>
<td>294 d</td>
<td>120.2 de</td>
<td>5.47 de</td>
<td>107.2 ef</td>
</tr>
<tr>
<td>$T_5 = N: P_2O_5 \cdot 112.45+ \text{ Poultry manure @ 750 kg ha}^{-1}$</td>
<td>193.30</td>
<td>7.89 a</td>
<td>320 b</td>
<td>141.7 b</td>
<td>6.27 b</td>
<td>123.7 b</td>
</tr>
<tr>
<td>$T_6 = N: P_2O_5 \cdot 112.45+ \text{ Farm yard manure - 1000 kg ha}^{-1}$</td>
<td>190.23</td>
<td>7.53 ab</td>
<td>317 b</td>
<td>140.0 b</td>
<td>6.00 bc</td>
<td>116.6 c</td>
</tr>
<tr>
<td>$T_7 = N: P_2O_5 \cdot 37.5:15+ \text{ Poultry manure - 2250 kg ha}^{-1}$</td>
<td>191.86</td>
<td>7.03 bc</td>
<td>308 c</td>
<td>132.0 c</td>
<td>5.23 ef</td>
<td>113.5 cd</td>
</tr>
<tr>
<td>$T_8 = N: P_2O_5 \cdot 37.5:15+ \text{ Farm yard manure - 3000 kg ha}^{-1}$</td>
<td>194.69</td>
<td>6.87 cd</td>
<td>306 c</td>
<td>131.4 c</td>
<td>5.00 fg</td>
<td>114.7 c</td>
</tr>
<tr>
<td><strong>F-value</strong></td>
<td>1.84$^{\text{NS}}$</td>
<td>17.08$^{**}$</td>
<td>279.36$^{**}$</td>
<td>68.33$^{**}$</td>
<td>36.76$^{**}$</td>
<td>35.40$^{**}$</td>
</tr>
<tr>
<td><strong>LSD value</strong></td>
<td>--</td>
<td>0.5482</td>
<td>2.892</td>
<td>3.997</td>
<td>0.3414</td>
<td>4.009</td>
</tr>
</tbody>
</table>

Means sharing same letter are non-significant at 5% level of probability.  
NS = non-significant, ** = highly significant
<table>
<thead>
<tr>
<th>Treatment</th>
<th>Fresh weight per tiller (g)</th>
<th>Dry weight per tiller (g)</th>
<th>Green fodder yield (t ha⁻¹)</th>
<th>Crude protein (%)</th>
<th>Crude fiber (%)</th>
<th>Total ash (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_1 = \text{Control (no fertilizer)}$</td>
<td>17.87 g</td>
<td>2.98 f</td>
<td>38.13 e</td>
<td>7.86 d</td>
<td>30.10 c</td>
<td>10.17 d</td>
</tr>
<tr>
<td>$T_2 = \text{N: P}_2\text{O}_5 - 150:60 \text{ kg ha}^{-1}$</td>
<td>30.10 a</td>
<td>5.01 a</td>
<td>74.67 a</td>
<td>10.76 a</td>
<td>37.00 a</td>
<td>15.14 a</td>
</tr>
<tr>
<td>$T_3 = \text{Farm yard manure - 4000 kg ha}^{-1}$</td>
<td>24.33 d</td>
<td>4.05 cd</td>
<td>61.03 c</td>
<td>8.93 c</td>
<td>34.83 ab</td>
<td>11.07 d</td>
</tr>
<tr>
<td>$T_4 = \text{Poultry manure - 3000 kg ha}^{-1}$</td>
<td>23.33 e</td>
<td>3.89 d</td>
<td>63.47 c</td>
<td>8.90 c</td>
<td>34.83 ab</td>
<td>11.13 d</td>
</tr>
<tr>
<td>$T_5 = \text{N: P}_2\text{O}_5 - 112.45 + \text{ Poultry manure - 750 kg ha}^{-1}$</td>
<td>27.30 b</td>
<td>4.55 b</td>
<td>69.00 b</td>
<td>9.84 b</td>
<td>35.24 ab</td>
<td>13.67 b</td>
</tr>
<tr>
<td>$T_6 = \text{N: P}_2\text{O}_5 - 112.45 + \text{ Farm yard manure - 1000 kg ha}^{-1}$</td>
<td>26.16 c</td>
<td>4.36 bc</td>
<td>70.00 b</td>
<td>9.83 b</td>
<td>35.20 ab</td>
<td>13.67 b</td>
</tr>
<tr>
<td>$T_7 = \text{N: P}_2\text{O}_5 - 37.5:15 + \text{ Poultry manure - 2250 kg ha}^{-1}$</td>
<td>20.40 f</td>
<td>3.40 e</td>
<td>49.53 d</td>
<td>7.74 d</td>
<td>33.33 b</td>
<td>12.84 bc</td>
</tr>
<tr>
<td>$T_8 = \text{N: P}_2\text{O}_5 - 37.5:15 + \text{ Farm yard manure - 3000 kg ha}^{-1}$</td>
<td>20.30 f</td>
<td>3.38 e</td>
<td>51.70 d</td>
<td>8.01 d</td>
<td>33.33 b</td>
<td>12.50 c</td>
</tr>
</tbody>
</table>

| F-value                                      | 415.09**                  | 27.83**                   | 263.80**                    | 35.38**           | 8.11**         | 26.03**       |
| LSD value                                    | 0.6092                    | 0.3916                    | 0.5593                      | 0.5593            | 2.16           | 0.9750        |

Means sharing same letter are non-significant at 5% level of probability.  
NS = non-significant; ** = highly significant
These findings are in contrast with the results of Zada et al. (2000), who reported that plant height increases with the increase in farmyard manure and nitrogen doses. Similarly Oad et al. (2004) also reported that maximum plant height 150.82 cm of maize fodder was recorded with application of 120 kg nitrogen + 3000 kg FYM ha⁻¹ and Chellamuthu et al. (2000) that the combine application of biofertilizer together with 75% of recommended NP increase plant height compare with 100% NP alone.

Number of leaves per plant. There was a significant effect of organic and inorganic sources of fertilizers used alone or in combination on number of leaves per plant at harvest as shown in Table 1. Maximum number of leaves per plant (6.87) were observed in the treatment T₂ where only inorganic fertilizers N and P were applied at the rate of 150 and 60 kg ha⁻¹ followed by T₅ (N: P₂O₅ 112:45+ Poultry manure 750 kg ha⁻¹) having (6.27) number of leaves per plant but was statistically at par with the treatment T₆ (N: P₂O₅ 112:45+ Farm yard manure 1000 kg ha⁻¹) produced 6.00 number of leaves per plant. The rest of treatments in respect to number of leaves per plant intermediated. The variation in number of leaves per plant may be due to the timely availability of nutrients from inorganic and organic source of fertilizers. These results are not in line with the findings of Oad et al. (2004) who found that number of leaves per plant were affected significantly by using varying combinations of farmyard manure and inorganic fertilizers. Similar results were also reported by Chaudhary and Khade (1991) and Randhawa et al. (1994).

Leaf area per plant (cm²). Application of inorganic fertilizer N:P at the rate of 150:60 kg ha⁻¹ produced maximum leaf area plant⁻¹ (128 cm²) than the rest of the treatments as shown in Table 1. While the treatment T₅ where combination of inorganic and organic fertilizers were applied (N: P₂O₅ 112:45+ Poultry manure 750 kg ha⁻¹) recorded significantly lower leaf area of 123.7 cm² per plant than treatment T₂ but higher than T₆, T₇, and T₈ with leaf area of 116.6 cm², 113.5 cm² and 114.7 cm² respectively which were also statistically at par with each other but higher the control treatment which have 105.2 cm² leaf area per plant. The increase or decrease in leaf area per plant in different treatments may be a result of less or more number of leaves per plant and availability flow of nutrients from inorganic and organic sources of fertilizers. These results are in accordance with the findings of Ayub et al. (2002) who reported that application of NP fertilizer significantly affected the leaf area per plant of maize fodder while Haq and Jan (2001) concluded that leaf area increased with progressive increase in fertilizer level.

Fresh weight per tiller (g). It was evident from the data presented in Table 2 that fresh weight per tiller was affected significantly by the
application of organic and inorganic fertilizers. Statistically the maximum fresh weight per tiller (30.10 g) was recorded in treatment T2 fertilized with inorganic source (N: P₂O₅ 150:60 kg ha⁻¹) followed by T5 (27.30 g) where combination of inorganic and organic sources of fertilizer were used at the rate of (N: P₂O₅ 112:45+ Poultry manure 750 kg ha⁻¹). The minimum fresh weight per tiller (17.87 g) was recorded in T1 where no source of fertilizer was used. The increase in fresh weight per tiller in the treatments other than control treatment with organic and inorganic fertilizers application alone and in combinations was probably due to higher number of leaves per plant, plant height and leaf area per plant. These results are not in accordance with the findings of Naterchera and Salagae (2002) who reported that fodder yield per plant of fodder maize increased with the application of cattle and chicken manure.

**Dry matter per tiller (g).** Among the sources, recommended dose of inorganic fertilizers T2 (N: P₂O₅ 150:60 kg ha⁻¹) produced significantly the highest dry matter per tiller (5.01 g) which was followed by T5 (N: P₂O₅ 112:45+ Poultry manure 750 kg ha⁻¹) and T6 (N: P₂O₅ 112:45+ Farm yard manure 1000 kg ha⁻¹) producing 4.55 and 4.36 g dry weight per tiller, respectively (Table 2). The treatment T3 fertilized with organic manure alone (farm yard manure 4000 kg ha⁻¹) and T4 (poultry manure 3000 kg ha⁻¹) yielded 4.05 and 3.89 g dry weight per tiller were statistically at par with each other but higher than the combination of inorganic and organic sources. The minimum dry weight 2.98 g per tiller was recorded in control. These results are in agreement with Karki et al. (2005) who revealed that recommended dose of fertilizer on maize gave statistically highest dry weight per plant than different combinations of fertilizer and FYM while Ogboghodo et al. (2004) contradicly reported that maize dry matter per plant was increased with the application of poultry manure and fertilizer.

**Green fodder yield (t ha⁻¹).** Fodder yield is a function of genetic as well as the environmental factors, which plays a vital role in plant growth and development and ultimately contributed to fodder yield. Statistically the maximum green forage yield (74.67 t ha⁻¹) was observed in T2 (N: P₂O₅ 150:60 kg ha⁻¹) while the minimum green forage yield of (38.13 t ha⁻¹) in untreated treatment T1 (control). Next to the treatment T2; T6 (N: P₂O₅ 112:45+ Farm yard manure 1000 kg ha⁻¹) and T5 (N: P₂O₅ 112:45+ Poultry manure 750 kg ha⁻¹) were statistically at par with each other and gave significantly higher green forage yield of 70 and 69 t ha⁻¹ respectively compared to all other treatments (Table 2). The green forage yield of other treatments was intermediated. These results are quite in line with the Ayub et al. (2002), who reported that NP produced significantly higher fodder yield of maize than control. Similarly Devi
A.H. AHMAD, A. WAHID, F. KHALID, N. FIAZ, M.S.I. ZAMIR (2002) also reported that fodder maize variety “African Tall” produced significantly higher green fodder yield at higher dose of nitrogen while biofertilizers produced lower yield. Green fodder yield increased significantly up to 120 kg N ha\(^{-1}\). In contrast Reiad et al. (1992) and Lakoo et al. (2004) reported that organic manures and inorganic fertilizer increase the maize fodder yield.

**Crude protein (%)**. Protein content is one of the most important parameters affecting the nutritional value of fodder crops. It was evident from the data that crude protein was affected significantly by different source of fertilizers. Statistically the maximum crude protein (10.76 %) was produced in treatment T\(_2\) fertilized with inorganic sources (N: P\(_2\)O\(_5\) 150:60 kg ha\(^{-1}\)) followed by T\(_3\) and T\(_6\) treatments where combination of inorganic and organic sources of fertilizer were used N: P\(_2\)O\(_5\) 112:45+ Poultry manure 750 kg ha\(^{-1}\) and N: P\(_2\)O\(_5\) 112:45+ Farm yard manure 1000 kg ha\(^{-1}\) respectively (Table 2). Minimum crude protein of 7.74 and 8.01 % were recorded in T\(_7\) and T\(_8\) treatments where inorganic and organic sources of fertilizers were applied N: P\(_2\)O\(_5\) , 37.5:15+ Poultry manure 2250 kg ha\(^{-1}\) and N: P\(_2\)O\(_5\) , 37.5:15+ Farm yard manure 3000 kg ha\(^{-1}\) and were also statistically at par with control treatment having 7.86% crude protein. The results are in line with the findings of Safdar (1997) and Tariq (1998) reported that in fodder maize, by increasing nitrogen levels; crude protein, crude fiber and ash contents were increased. Similarly, Ahmad (1999) also reported that crude protein percentage increased with the increase of nitrogen fertilizer.

**Crude fiber (%)** is another parameter influencing the quality of fodder crops. The higher is the fiber percentage in the feeding material the lower will be its quality. Data regarding the crude fiber % age in Table 2 exhibited that all the treatments have highly significant effect on crude fiber %age. Statistically the maximum crude fiber (37.00%) was observed in T\(_2\) (N: P\(_2\)O\(_5\) 150:60 kg ha\(^{-1}\)) followed by T\(_3\) (Farm yard manure 4000 kg ha\(^{-1}\)), T\(_4\) (Poultry manure 3000 kg ha\(^{-1}\)), T\(_5\) (N: P\(_2\)O\(_5\) 112:45+ Poultry manure 750 kg ha\(^{-1}\)) and T\(_6\) (N: P\(_2\)O\(_5\) 112:45+ Farm yard manure 1000 kg ha\(^{-1}\)) produced crude fiber % age of 34.83, 34.83, 35.24 and 35.2 respectively and were statistically same with each other. Minimum crude fiber 30.1 % was observed in T\(_1\) where no source of fertilizers was applied. The results are similar with the findings of Rafiq et al. (1996) who checked the effect of nitrogen application on growth, green fodder yield and quality of maize cv. Neelum. Similarly, Safdar (1997) reported that green fodder yield; protein, fiber and total ash contents were increased with nitrogen rates in maize and in the same way Tariq (1998) also reported that in fodder maize, by increasing nitrogen levels; crude protein, crude fiber and ash contents were increased.

**Total ash (%).** The higher value of total ash of 15.14 % was observed
in the treatment T₂ (N: P₂O₅ 150:60 kg ha⁻¹) which differed significantly with all the other treatments (Table 2). The treatment T₅ (N: P₂O₅ 112:45+ Poultry manure 750 kg ha⁻¹) and T₆ (N: P₂O₅ 112:45+ Farm yard manure 1000 kg ha⁻¹) have same values 13.67 % and were statistically at par with treatment T₇ (12.84 %). The minimum ash percentage was recorded in the treatments T₁ (control) with ash %age of 10.17 which was found to be at par with T₃ (Farm yard manure 4000 kg ha⁻¹) and T₄ (Poultry manure 3000 kg ha⁻¹) with an ash %age of 11.07 and 11.13, respectively. The results are inconsonance with the findings of Safdar (1997) who reported that green fodder yield; protein, fiber and total ash contents were increased with various nitrogen rates in maize and in the same way Tariq (1998) observed that in fodder maize, by increasing nitrogen levels; crude protein, crude fiber and ash contents were also increased.

CONCLUSIONS

Application of organic and inorganic fertilizers contributed greatly towards the growth and yield contributing attributes of the oat. Nevertheless, the application of inorganic fertilizers surpassed in enhancing growth, yield and quality attributes then the organic fertilizer application. While organic fertilizers are more environmental friendly and reduce the risk of pollution then the inorganic ones. A combination of inorganic and organic fertilizers with application of N:P 112:45 + poultry manure 750 kg ha⁻¹ can be a better alternative to the most responsive inorganic application of N:P 150:60 kg ha⁻¹.

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