Maize Growth and Yield as Influences by Different Organic and Inorganic Fertilizers at Swabi, Pakistan

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Abstract: The current study was designed to evaluate the effect of organic and inorganic fertilizers on maize growth and yield at Agricultural Research Station Swabi, Khyber Pakhtunkhwa, Pakistan during summer season 2014. According to statistical analysis of the data, plant height (cm), biological yield (kg ha⁻¹), 1000 grains weight (g) and grain yield (kg ha⁻¹) showed significant differences for applied treatments, while leaf area (cm²) and ears plant⁻¹ were non-significantly affected. The maximum plant height (92.20 cm) and leaf area (378.05 cm²) were recorded in compost and Farm Yard Manure treatments, respectively. The highest 1000-grain weight (226.67 g) and grain yield (1511.1 kg ha⁻¹) were confirmed for Diammonium Phosphate. Similarly, the maximum biological yield (6830 kg ha⁻¹) was noted in Diammonium Phosphate and compost treatments. It can be concluded that maize crop showed valuable response to organic fertilizers along with commercial fertilizer and in case of biological yield, compost can replace commercial fertilizers.

Key words: Maize • Organic fertilizers • Diammonium phosphate • Grain yield (kg ha⁻¹)

INTRODUCTION

Maize, the highest yielding cereal in the world is considered vitally important for developing countries like Pakistan, to feed the rapidly increasing population. Maize is the staple food and third important cereal of Pakistan after wheat and rice [1]. In the last 50 years, maize economic yield has markedly increased especially in temperate regions of the globe [2]. Although, this crops is grown extensively in Pakistan as a fodder, but its grain yield is below the average. Though, the climatic and soil conditions of the country are suitable for its production, but poor nutrition management is the key factor responsible for low productivity. The maize production is largely dependent on proper nutrients management, particularly of nitrogen, phosphorus and potassium [3]. While, practicing intensive agriculture, using inorganic fertilizers alone is not useful as it leads to aggravates soil degradation [4]. In addition, organic fertilizers are comprised of all the essential nutrients. And also contains carbon, the energy source for soil biota to regulate nutrient cycling [5]. Applying organic fertilizers alone or in combination with inorganic fertilizers is essential for proper nutrient management and maintaining the soil fertility [6]. Though, organic fertilization in combination with inorganic fertilization for crop nutrient management is not an easy task, because of the complex and variable chemical nature of the different organic materials. However, in many cases combined application of organic and inorganic fertilizer have resulted in maximum yields than alone [7]. In the current study, efforts were made to evaluate the efficiency of organic and inorganic fertilizers on growth and yield of maize at Swabi region of Khyber Pakhtunkhwa, Pakistan.

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MATERIALS AND METHODS

To evaluate the effect of phosphorus (110 kg ha$^{-1}$) using different organic and inorganic fertilizers on the yield and yield components of maize a study was conducted at Agricultural Research Station Swabi, Khyber Pakhtunkhwa, Pakistan using randomized complete block design (RCBD) with three replications. The fertilizers tested were diammonium phosphate (DAP), compost, poultry manure and farm yard manure. One treatment was kept as control for comparison. Net plot size was 3m x 4m (12 m$^2$) having row to row and plant to plant distances of 30 and 75 cm, respectively. Different fertilizers were applied to the respective plots and incorporated in the soil before sowing. Maize variety (Bahar) was sown on 7th August 2014. Sowing was done by dibbling method (by placing 2 seeds manually hill$^{-1}$). After germination of seeds, one plant hill$^{-1}$ was maintained in order to achieve proper plant population. Manual weed control was practiced to keep the field weed free. A total of seven irrigations were applied to the crop. First irrigation was applied five days after sowing, while subsequent irrigation were applied as when required by crop. Data were recorded on plant height (cm), leaf area (cm$^2$), ears plant$^{-1}$, Biological yield (kg ha$^{-1}$), 1000 grains weight (g) and grain yield (kg ha$^{-1}$). To record plant height data, heights of randomly selected plants in each treatment were measured from the soil surface to the tip of panicles and averaged. The formula “Leaf area (cm$^2$) = Leaf length x leaf width x factor” was used measure leaf area of five randomly selected plants and then averaged. Number of ears plants$^{-1}$ were recorded by counting the numbers of ears in five plants randomly selected in each subplot and then their means were worked out. Biological yield data were recorded by harvesting all material in each subplot. The harvested material was sun dried, weighted and converted to kg ha$^{-1}$ according to the following formula:

\[
\text{Biological yield (kg ha}^{-1} ) = \frac{\text{Biological yield (kg)}}{\text{Area harvested (m}^2\text{)}} \times 10000
\]

RESULTS AND DISCUSSION

Plant Height (cm): Plant height (cm) data of maize as affected by different treatments are shown in Table 1. Statistical analysis of the data showed a significant (P < 0.05) effect of treatments on plant height (cm) of maize crop. The longest plants of 92.20 cm were noted in compost treatments followed DAP with 89.53 cm plant height, while the shortest plants of 79.53 cm were noted in control. Our results are in line with the findings of Oad et al. [8]. The taller and fast maize growth might be due to increased soil moisture content and optimum temperature as a result of compost treatment which provides favorable conditions for root development in the earlier stage as reported by Khurshid et al. [9] and Fan et al. [10].

Leaf Area (cm$^2$): Statistical analysis of the data showed a non-significant (P > 0.05) effect of different treatments on leaf area (cm$^2$) of maize crop. However, the maximum leaf area of (378.05 cm$^2$) was verified for farm yard manure followed by poultry manure (377.20 cm$^2$) as compared to lowest leaf area of 341.68 from compost. Organic amendments to soil have been stated to buffer soils and improve its water holding capacity ability to produce vigorous plant growth [11]. Farm yard manure may supply potassium directly to the crop and can also mobilize native soil potassium and nitrogen application trough farm yard manure or fertilizers applications to accelerate crop growth [12].

Ears Plant$^{-1}$: Data on ears plant$^{-1}$ of maize as influenced by different organic and inorganic treatments are shown in Table 1. Statistical analysis of the data showed a non-significant (P > 0.05) effect of the applied treatments on ears plant$^{-1}$ of maize crop. The maximum ears plant$^{-1}$ of 1.20 were noted for DAP, compost and farm yard manure followed by poultry manure with 1.07 ears plant$^{-1}$, while the minimum ears plant$^{-1}$ of 1.00 were noted in control. The final grain yield is directly related with number of ears plant$^{-1}$. In our case the higher number of ears palant$^{-1}$ in inorganic and organic treatments over control might be the outcome of adequate and balanced supplementation of plant nutrients as reported by Shah and Arif [13] and Tasneem et al. [14].

Grain yield (kg ha$^{-1}$) = \[
\frac{\text{Grain yield (kg)}}{\text{Area harvested (m}^2\text{)}} \times 10000
\]
Table 1: Growth and yield traits of maize as affected by different organic and inorganic fertilizers.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Plant height (cm)</th>
<th>Leaf area (cm²)</th>
<th>Ears plant⁻¹</th>
<th>Biological yield (kg ha⁻¹)</th>
<th>1000 grains weight (g)</th>
<th>Grain yield (kg ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diammonium Phosphate</td>
<td>89.53 a</td>
<td>366.45</td>
<td>1.20</td>
<td>6830 a</td>
<td>226.67 a</td>
<td>1511.1 a</td>
</tr>
<tr>
<td>Compost</td>
<td>92.20 a</td>
<td>341.68</td>
<td>1.20</td>
<td>6830 a</td>
<td>190.00 b</td>
<td>888.8 b</td>
</tr>
<tr>
<td>Poultry Manure</td>
<td>80.33 b</td>
<td>377.20</td>
<td>1.07</td>
<td>6000 ab</td>
<td>140.00 c</td>
<td>956.4 b</td>
</tr>
<tr>
<td>Farm Yard Manure</td>
<td>88.27 ab</td>
<td>378.05</td>
<td>1.20</td>
<td>5330 b</td>
<td>156.67 bc</td>
<td>702.8 b</td>
</tr>
<tr>
<td>Control</td>
<td>79.53 b</td>
<td>377.13</td>
<td>1.00</td>
<td>4830 b</td>
<td>135.72</td>
<td>423.38</td>
</tr>
<tr>
<td>LSD (P = 0.05)</td>
<td>9.06 NS</td>
<td>NS</td>
<td>1.32</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3 Mean values of the same category followed by different letters are significant at P≤0.05 level

**Biological Yield (kg ha⁻¹):** Mean values of the data (Table 1) showed that biological yield was significantly (P≤0.05) affected by various organic and inorganic fertilizers. The maximum biological yield (6830 kg ha⁻¹) was noted for DAP and compost followed by poultry manure with 6000 kg ha⁻¹ biological yield as compared to minimum biological yield of 4830 kg ha⁻¹ from control. This is similar with the findings of Shafi et al. [15]. Our results are also in agreement with those obtained by Abiola and Aiyelaagbe [16].

**1000 Grains Weight (g):** Mean values of the data (Table 1) of the data revealed that various organic and inorganic treatments had significantly (P≤0.05) affected 1000 grains weight of maize crop. The maximum 1000 grains weight of 226.67 g was confirmed for DAP, followed by compost (190.00 g), when compared with minimum 1000 grains weight of 140.00 g from farm yard manure. Our results are supported by Shafi et al. [15]. The increased grain weight in treatments with inorganic fertilization over control and organic fertilizers treatments might be due to reasonable sufficient nutrients supply during the grain filling and development stages.

**Grain Yield (kg ha⁻¹):** Statistical analysis of the data showed a significant (P≤0.05) effect of various organic and inorganic treatments on grain yield of maize crop. The maximum grain yield of 1511.1 kg ha⁻¹ was noted for DAP followed poultry manure (1077.4 kg ha⁻¹), while the minimum grain yield of 702.8 kg ha⁻¹ was noted in control. Inorganic fertilization was observed more efficient as compared to organic fertilizers due to readily supply of nutrients as concluded by Tasneem et al. [14]. The higher grain yield in inorganic treatment was mainly due to increased ears palant⁻¹ and highest grains weight. This finding is also in agreement with those reported by Tamayo et al. [17].

**Conclusions and Recommendations:** The following conclusions can be drawn from the study:

- Different organic and inorganic treatments significantly affected plant height (cm), biological yield, grain yield and 1000-grain weight of maize crop.
- In case of biological yield, compost can replace commercial fertilizers.

**REFERENCES**