Integrated Nitrogen Management Studies in Forage Maize

Asif Iqbal, Muhammad Aamir Iqbal, Ali Raza, Nadeem Akbar, Rana Nadeem Abbas and Haroon Zaman Khan

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Abstract: A research trial was conducted to examine the comparative efficacy of organic and inorganic sources of nitrogen fertilizers alone and in different combinations on the yield and quality contributing parameters of forage maize (Zea mays L.) during 2012. The experiment was laid out in randomized complete block design (RCBD) with three replications. The maximum green forage yield (47.51 t ha$^{-1}$), dry matter yield (10.36 t ha$^{-1}$) and crude protein (8.63 %) were recorded in case of T$_1$ (100 % recommended dose of nitrogen from urea) which were statistically at par with T$_2$ (75 % nitrogen from urea + 25 % nitrogen from poultry manure). This indicated that inorganic source of nitrogen also responded well for maximum growth and quality parameters. Results indicated that application of inorganic fertilizer alone and in combination with organic manure (75 % nitrogen from urea + 25 % nitrogen from poultry manure) have a significantly greater influence than other treatments.

Key words: Forage maize $\cdot$ Nitrogen $\cdot$ Poultry manure $\cdot$ Inorganic fertilizer $\cdot$ Forage yield and quality

INTRODUCTION

Maize is the most important multipurpose crop which is grown as food, feed and forage crop and provides the cheapest fodder for livestock, feed for poultry and most valuable food for human beings. Its fodder is highly relished by livestock due to its succulence and palatability. Farmers grow it as green forage due to its high productivity. Its green forage contains 7.2-8.5% protein, 32.52-33.49% fibre and 1-2.25% fat [1]. Forage maize is high in carbohydrates and low in protein like grain maize. Well dried corn forage has only about half protein than those of alfalfa hay and corn, while stover has even less protein contents. Maize has a surplus of potential for providing the energy rich forage for livestock feed and it can safely be utilized at all levels without any hazard of oxalic acid, prussic acid as in case of sorghum [2]. The potential of crop is not being exploited reasonably in Pakistan due to many restraints. Among those, imbalanced nutrient supplementation is imperative [3]. There is no doubt that the use of nitrogenous fertilizer has now become necessary for the higher crop harvest [4].

Integrated use of chemicals, organic fertilizers and improved management has revealed better results and it not only improves crop production, soil health but also decreases chemical fertilizer requirement [5]. Application of poultry manure alone and in combination with chemical fertilizer can be used for nutrient supplementation [6]. Use of organic and inorganic fertilizers together has many beneficial effects on crop and soil. Chemical fertilizers are the potential sources of high amounts of nutrient in easily available form so they cannot be avoided. Mostly crops give the quick response to chemical fertilizers and results in higher yield and maize is more responsive, but application of chemical fertilizers alone is not appropriate as it has been described to deteriorate soil health. It was reported that poultry manure improves soil chemical properties as compared to ammonium nitrate which is an inorganic source of nitrogen [7]. At the same time application of organic fertilizer alone do not give higher yield due to their low nutrient status. By the application of suitable combinations of organic and inorganic fertilizers a sustainable crop yield can be achieved [8]. So due to increasing trend of poultry farming in all around the world

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and in Pakistan too and increase in poultry litter the present study was therefore planned to determine the impact of poultry manure with or without combination of inorganic fertilizer (urea) on the productivity of forage maize.

MATERIALS AND METHODS

The present study aims to determine the effect of organic (poultry manure) and inorganic fertilizer alone and in different combinations to find the yield and quality contributing parameters of forage maize was conducted at Agronomic Research Area, University of Agriculture, Faisalabad. The experiment was laid out in randomized complete block design having 3 replications. Experimental soil was sandy clay loam with an initial fertility status of 0.043% N, 5.8 ppm P₂O₅ and 225 ppm K₂O with net plot area of 9 m × 3.6 m. The experiment was comprised of 6 treatments: The experimental treatments as T₀(Control), T₁ (100 % recommended dose of nitrogen from urea), T₂ (100 % recommended dose of nitrogen from poultry manure), T₃ (25 % nitrogen from urea + 75 % nitrogen from poultry manure), T₄ (50 % nitrogen from urea + 50 % nitrogen from poultry manure), T₅ (75 % nitrogen from urea + 25 % nitrogen from poultry manure) were laid out in randomized complete block design (RCBD) with three replications.

The pre-experiment soil analysis was conducted from the experimental area from two depths i.e. 0-15 cm and 15-30 cm. Poultry manure was also analyzed for various chemical properties showing that it contain nitrogen 2.03 %, phosphorus 0.74 % and potassium 1.26 %.

Physico-chemical analysis of soil showed that it contained organic matter 0.73%, nitrogen 0.043%, available phosphorus 5.8ppm and available potassium 155ppm. Seeds of maize (cv. Akbar) were sown during 3rd week of July, 2012 in 30 cm spaced rows for all the treatments using seed rates @ 100 kg ha⁻¹ for maize and harvesting was done after 60 days of sowing. As poultry manure besides urea contains some amount of phosphorus therefore the remaining phosphorus dose was applied through inorganic fertilizer source of Phosphorus i.e. Single Super Phosphate. Poultry manure and Single Super Phosphate were applied to the soil at seed bed preparation in one split whereas urea was added to the soil in two splits, half at seed bed preparation and half 20 days after sowing. All other agronomic practices were kept normal and uniform for all treatments. The data related to crop yield and quality parameters were recorded using standard procedures. Collected data was analyzed statistically by using Fisher’s analysis of variance technique. The differences among treatment means were compared by using least significance difference (LSD) test at 5 % probability level [4].

RESULTS AND DISCUSSION

Plant height is generally considered as plant growth parameter. Forage yield is directly related with the plant height and it has prime importance in the green forage studies. Examination of the data showed significant differences among treatment means. It is clear from the Table (1) that maximum plant height of 181.67 cm was recorded in case of those plots where T₅ (75 % N from

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Plant height (cm)</th>
<th>No. of Leaves Plant⁻¹</th>
<th>Leaf Area Plant⁻¹(cm²)</th>
<th>Green Forage Yield (t ha⁻¹)</th>
<th>Total Dry Matter yield (t ha⁻¹)</th>
<th>Crude Protein (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₀ (no application of nitrogen)</td>
<td>159.47 E</td>
<td>8.73 D</td>
<td>2396.0 F</td>
<td>34.62 E</td>
<td>7.14 F</td>
<td>6.81 D</td>
</tr>
<tr>
<td>T₁ (100 % recommended dose of N from urea)</td>
<td>180.47 A</td>
<td>11.80 A</td>
<td>2771.7 A</td>
<td>47.51 A</td>
<td>10.36 A</td>
<td>8.63 A</td>
</tr>
<tr>
<td>T₂ (100 % N from poultry manure)</td>
<td>170.40 D</td>
<td>9.80 C</td>
<td>2534.7 E</td>
<td>38.87 D</td>
<td>8.34 E</td>
<td>6.91 D</td>
</tr>
<tr>
<td>T₃ (25 % N from urea + 75 % N from poultry manure)</td>
<td>173.57 C</td>
<td>10.67 B</td>
<td>2604.3 D</td>
<td>41.34 C</td>
<td>8.86 D</td>
<td>7.49 C</td>
</tr>
<tr>
<td>T₄ (50 % N from urea + 50 % N from poultry manure)</td>
<td>176.83 B</td>
<td>11.13 B</td>
<td>2711.3 C</td>
<td>44.68 B</td>
<td>9.55 C</td>
<td>7.86 B</td>
</tr>
<tr>
<td>T₅ (75 % N from urea + 25 % N from poultry manure)</td>
<td>181.67 A</td>
<td>12.00 A</td>
<td>2752.0 B</td>
<td>47.20 A</td>
<td>10.01 B</td>
<td>8.46 A</td>
</tr>
</tbody>
</table>

Table I: Effect of organic and inorganic sources of nitrogen on the yield and quality of forage maize.
urea + 25 % N from poultry manure) was applied. It was statistically at par with T₁ (100 % recommended dose of N from urea) giving plant height of 180.47 cm. The minimum plant height of 159.47 cm was recorded in case of T₆ (no application of nitrogen). Similar results were found by Ahmad [9] and Ayub et al. [10], who stated that plant height and other growth attributes of maize increased significantly by the application of nitrogen over control.

Leaves are the major source of the total dry matter accumulation in which a plant accumulates during the course of its development through various physiological processes. Leaves also play a positive role in the fodder quantity and quality of the crop. Results showed the maximum numbers of leaves plant⁻¹ were recorded in T₁ (75 % N from urea + 25 % N from poultry manure) that were 12 leaves per plant and it was statistically at par with T₁ (100 % recommended dose of N from urea) with total number of leaves per plant 11.8. The minimum numbers of leaves per plant 8.7 were observed in T₆ (no application of nitrogen). These results are in contrast with Ahmad [2] and Cheema [11], who stated that number of leaves per plant increases with increase in nitrogen levels. Among various yield contributing parameters leaf area per plant plays a remarkable role in the formation of final fodder yield per hectare. Data recorded revealed that the sources of nitrogen and combinations were significantly affected the leaf area of forage maize presented in the Table I. The maximum leaf area was recorded in T₁ (100 % recommended dose of N from urea) that was 2771.7 cm² and it was followed by T₁ (75 % N from urea + 25 % N from poultry manure) with leaf area 2752.0 cm². The minimum leaf area was recorded in T₆ (no application of nitrogen) that was 2396.0 cm². Similar results were found by Ayub et al. [10] who observed that minimum leaf area was attained in those plots where no nitrogen was applied. Adeniyan and Ojeniyi [12] observed that application of poultry manure and combination of Poultry manure with NPK results higher leaf area and plant height of maize significantly.

The maximum green forage yield of maize (47.20 t ha⁻¹) was attained in those plots where T₁ (75 % N from urea + 25 % N from poultry manure) was applied and it was statistically at par with T₁ (100 % recommended dose of N from urea) with forage yield of maize 47.51 t ha⁻¹. The minimum green fodder yield (34.62 t ha⁻¹) was observed in T₆ (no application of nitrogen). These results are in accordance with findings of Vasanthi and Kumaraswamy [13] who described that the combine use of organic poultry manure and inorganic fertilizer resulted in higher maize fodder yield than all other treatments.

Dry matter production is basically a measure of photosynthetic efficiency of assimilatory system in plants. Data regarding dry matter yield showed that maximum dry matter yield of maize (10.36 t ha⁻¹) was attained in those plots where T₁ (100 % recommended dose of N from urea) was applied and it was followed by T₁ (75 % N from urea + 25 % N from poultry manure) with dry matter yield of maize 10.00 t ha⁻¹. The minimum dry matter yield of maize was observed in T₆ (no application of nitrogen) that was 7.14 t ha⁻¹. The same results were recorded by Adeniyan and Ojeniyi [12] who found that application of poultry manure and combination of Poultry manure with chemical fertilizer gave higher vegetative growth and dry matter yield of maize.

Crude protein contents have a major role in increasing the quality of fodder crops. The protein contents of maize can be improved by integrated use of organic and inorganic fertilizers. The maximum crude protein (%) of maize (8.63) was attained in T₁ (100 % recommended dose of N from urea) and it was statistically at par with T₁ (75 % N from urea + 25 % N from poultry manure) with crude protein 8.46 %. The minimum crude

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Total expenditures (Rs. ha⁻¹)</th>
<th>Gross income (Rs. ha⁻¹)</th>
<th>Net income (Rs. ha⁻¹)</th>
<th>Benefit cost ratio (BCR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₀ (no application of nitrogen)</td>
<td>86300</td>
<td>173100</td>
<td>86800</td>
<td>2.00</td>
</tr>
<tr>
<td>T₁ (100 % recommended dose of N from urea)</td>
<td>96788</td>
<td>237550</td>
<td>140762</td>
<td>2.45</td>
</tr>
<tr>
<td>T₂ (100 % N from poultry manure)</td>
<td>83492</td>
<td>194350</td>
<td>110858</td>
<td>2.32</td>
</tr>
<tr>
<td>T₃ (25 % N from urea + 75 % N from poultry manure)</td>
<td>86882</td>
<td>206700</td>
<td>119818</td>
<td>2.37</td>
</tr>
<tr>
<td>T₄ (50 % N from urea + 50 % N from poultry manure)</td>
<td>89930</td>
<td>223400</td>
<td>133470</td>
<td>2.48</td>
</tr>
<tr>
<td>T₅ (75 % N from urea + 25 % N from poultry manure)</td>
<td>93620</td>
<td>236000</td>
<td>142380</td>
<td>2.52</td>
</tr>
</tbody>
</table>
protein contents (6.81 and 6.91 %) were observed in T₄ (no application of nitrogen) and T₅ (100 % N from poultry manure). Ayub et al. [1] reported that application of nitrogen to maize increase the nutritive value by increasing crude protein and by reducing ash fiber concentration of crude protein.

Economic analysis is the criteria for basic determination of net benefits. It also helps the researcher to make recommendations to the farmers and to plan for further investigation. The economic analysis of different sources and combinations of nitrogen on maize is essential to look at the results from a farmer point of view as they are more interested in net return or benefits. In Table 2, the maximum benefit cost ratio (BCR) of 2.51 was found in T₁ (75 % N from urea + 25 % N from poultry manure). This was due to its less cost of production and more gross income as compare to other treatments.

CONCLUSION

It is concluded that T₁ (100 % recommended dose of N from urea) and T₃ (75 % N from urea + 25 % N from poultry manure) showed best performance then all the other treatments in increasing the yield and quality of forage maize. The maximum benefit cost ratio of 2.52 was recorded in T₃ and this was due to its less cost of production and more gross income as compare to other treatments.

REFERENCES