Effects of Application Timing on Maize Production using Poultry Manure

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Abstract

Low soil fertility is identified as a major factor militating against crop production in many tropical cropping systems where fertilizer use is low and agricultural residues are not returned to the soil for its rejuvenation. As a result of this, the performance of maize (Zea mays) in response to application of a uniform rate of 30 t/ha of fresh poultry manure was studied on a loamy sand soil at Ilorin in the southern Guinea savannah of Nigeria to determine the effects of poultry manure application timing on maize production. The experimental design adopted for the study was Randomized Complete Block Design (RCBD) of four treatments with four replications each. The four treatments consist of applying uniform rate of fresh poultry manure on each plot at 6, 4, 2 and 0 months before planting (MBP), respectively. Results indicate that applying poultry manure 2 months before planting gave the highest cob weight per plot, 500 kernel weight and grain yield in the Guinea savannah zone. The maize variety used for the study was the Downy Mildew Resistant (DMR) type.

Keywords: maize, manure, poultry, timing, yield

1. Introduction

Maize (Zea mays L.,) is an important cereal crop grown in Nigeria. The greatest potential for maize production can only be fully realized with adequate fertilizer application (Norman et al., 1976) since most savannah soils are deficient of native soil nitrogen (Jones, 1973) and native phosphorus. Maize ranks among the world’s three most important cereals and is a major staple food in many tropical and sub-tropical countries of the world. Guinea savannah ecological zone has been reported to have the greatest potential for maize cultivation in this country (Kassam and Kowal, 1973).

Hegde (1998) reported that the use of costly chemical fertilizers can be minimized or replaced by the use of locally available organic manures. Furthermore, integrated use of organic and inorganic manures sustains the productivity of soil and crops in an integrated cropping system. This approach restores and sustains soil health and productivity in the long run, besides meeting the nutritional needs of crops (Satyajeet et al., 2007).

Maintenance of high crop yields under intensive cultivation is possible only through the use of fertilizer. However, the use of inorganic fertilizers alone has not been helpful under intensive agriculture because it aggravates soil degradation (Sharma and Mittra, 1991). The degradation is brought about by loss of organic matter which consequently results in soil acidity, nutrient imbalance and low crop yields.
Nutrients contained in organic manures are released more slowly and are stored for a longer time in the soil, thereby ensuring a long residual effect (Sharma and Mittra, 1991). Improvement of environmental conditions and public health concerns as well as the need to reduce cost of fertilizing crops are also important reasons for advocating increased use of organic materials (Seifritz, 1982). Application of organic manures also improves the soil physical and microbial properties (Belay et al., 2001).

Nitrogen (N) is typically the nutrient of most concern because it has a strong influence on cereal crop yields (Havlin et al., 2005). Plants take up N in the form of ammonium (NH$_4^+$), a result of mineralization and NO$_3^-$, a result of nitrification. In manure, between 50 and 75% of total N is organic (R-NH$_2$) and needs to undergo mineralization before it becomes available for plants. The remaining 25 to 50% is NH$_4^+$, which is highly susceptible to volatilization (Havlin et al., 2005). Mineralization and N recycling begin as soon as the manure is incorporated into the soil. The rate of mineralization varies among N sources, but the rate is highest at application and decreases with time (Havlin et al., 2005).

Application timing is a crucial component to maximizing N use efficiency in manures. Management of manure fertilizers is much more difficult than that of mineral fertilizers, primarily because manure and other organic fertilizers are affected by the handling during storage and application as well as the timing of incorporation and distribution (Thomsen, 2005). Autumn applications increase N loss through the soil system, in comparison with later applications that lead to increased crop utilization of N (Thomsen, 2005).

Low soil fertility has been recognized as one of the major production constraints affecting agriculture in Sub-Saharan Africa. Soil fertility depletion in small holder farms is the fundamental cause of declining per capital food production (Sanchez et al., 1996). This depletion is mainly due to intensive and continuous cropping with low application of fertilizer, causing a negative balance between nutrition supply and extraction from the soil. The need to take appropriate measures to check this decline in soil productivity is urgent. The rate of deterioration is on the increase and if not checked, will have serious implications for future food security.

The shortage and high cost of inorganic fertilizers have limited their use for crop production among the peasant farmers in Nigeria (Tanimu et al., 2007). There is therefore the tendency for increased dependence on the use of organic waste such as farmyard manure, crop residues and poultry manure. Poultry manure has been adjudged to be the most valuable of all manures produced by livestock (Omisore et al., 2009). Moreover, the nutrient contents of poultry manure are among the highest of all animal manures, and the use of poultry manure as soil amendment for agricultural crops will provide appreciable quantities of all the major plant nutrients. It also improves biological activities, soil tilth and soil chemical properties (Michael and George, 1998).

Superiority of poultry manure was also reported by Chandrashekara et al. (2000). Saranappa (2002) showed 7.62 per cent increase in seed yield of maize with the application of poultry manure. Mehta and Shaktawat (2002) reported that application of farm yard manure at 10 t/ha recorded higher grain yield and was economical.

In Nigeria, the shortage and high cost of inorganic fertilizer has put the commodity out of reach of most peasant farmers, leaving them with no other option than to look
for cheaper alternatives of fertilizing their maize and other crops. The need for a cheap alternative to mineral fertilizer culminated in the choice of organic manure, such as poultry manure, for crop production.

Therefore, this study was conceived to investigate the performance of maize in response to uniform application rate of fresh poultry manure using four different treatments in order to determine the most appropriate application timing for manure in the Guinea savannah agro-ecological zone. The main objective of this experiment is to examine the effects of poultry manure application on maize production.

2. Materials and Methods

The study was carried out at the Research Farm of the National Centre for Agricultural Mechanization, Ilorin, Nigeria (Longitude 4°, 30 East and Latitude 8°, 26 North). Soil samples were taken from soil depths of 0 – 15 cm to determine the soil physical and chemical properties before the application of poultry manure. A sample of the poultry manure was also taken to determine its chemical composition and other characteristics.

A uniform rate of 30 tons/ha of fresh poultry manure was applied to each treatment. Treatments consisted of manure application 6 months before planting (in December, 2007) which was followed immediately by ploughing to cover up the manure applied, the second treatment was the application of fresh poultry manure in February 2008 while subsequent applications of fresh poultry manure were in April and June, 2008 respectively. There was an interval of two months between each time of fresh poultry manure application. The experiment was laid out in a randomized complete block design (RCBD) with four treatments and four replications. On the 3rd of July, 2008, all the plots were harrowed and planted with maize. Downy mildew resistant (DMR) variety obtained from the National Seed Service, Ilorin was planted at two seeds per hole at a spacing of 75 cm x 25 cm. The plants were thinned to one plant per stand two weeks after planting. The size of a plot was 10 m by 3 m. Weeding was carried out twice at 3 and 6 weeks after planting (WAP) by using traditional weeding hoe.

The treatments consisted of fresh manure application at four different times, starting with post-harvest application in December 2007 and ending up with a pre-planting manure application in June 2008. Among plant parameters recorded were stand count after thinning, weight of weeds per square metre, plant height at 3, 6 and 9 weeks after planting (WAP), date of 50% tasselling and silking, weight of 500 kernel, yield of cobs/plot, number of ears/plot and grain yield. All data collected were analysed using Analysis of Variance (ANOVA) technique and means were separated using the Least Significant Difference (LSD) method.

3. Results and Discussion

Table 1 presents the soil characteristics and chemical composition of the poultry manure utilized for the experiment, while Table 2, present the effect of application timing on maize production components using poultry manure. The poultry manure used was generally average in its content of the major nutrients as compared to values obtained in earlier experiments carried out by Sridhar et al. (1985) and Ademoroti (1996).
3.1 500 Kernel weight

There was no significant difference in the weight of 500 kernel of maize among the four times of manure application (Table 2). However, the highest weight of 500 seeds was obtained at plots where manure was applied 2 months before planting.

3.2 Grain yield

There was significant difference in the grain yield of maize among the four times of manure application (Table 2). Highest grain yield of 1.6 t/ha was obtained from the plots to which poultry manure was applied 2 months before planting while the lowest yield of 0.91 t/ha was obtained from plots to which poultry manure was applied 6 months before planting (Table 2). Grain yield of plots to which poultry manure was applied 2 months before planting was higher than plots treated 6 months before planting by 76%. This could be explained by the fact that between 50 to 75% of total N contained in manure is organic and needs to undergo mineralization before it becomes available for plants, the remaining 25 to 50% is ammonium (NH$_4^+$), which is highly susceptible to volatilization (Havlin et al. 2005). The inorganic form (NH$_4^+$) is immobilized in the soil upon application to the soil surface. This implies that manure in plots where poultry manure was applied 6 months before planting had started decomposing and mineralizing almost 6 months before maize crop was planted and may have lost the higher percentage of its nitrogen to volatilization, compared to plots where manure was applied only 2 months before planting (MBP).

3.3 Plant height

Table 2 presents the summary of the results obtained for average plant height and other yield components of maize in the experiment. Plant height was lowest (103 cm) at plots where fresh poultry manure was applied 6 months before planting and it increased linearly to obtain the highest height of 118 cm at planting (0 month after planting). There was no significant difference among the plant heights.

3.4 Cob weight per plot

There was significant difference in cob weights among the four times of manure applications (Table 2). The lowest cob weight per plot (4.45 kg) was obtained from plots where poultry manure was applied 6 months before planting and this increased progressively and reached the maximum in plots where manure was applied 2 months before planting which recorded highest cob weight of 7.68 kg. Second best cob weight was obtained from plots where manure was applied at planting.

3.5 Water holding capacity of the soil

Manure application 6 months before planting resulted in higher amount of moisture along the soil depth than the plots to which manure was applied 2 months before planting. This implies that there was high water percolation (low water holding capacity of the soil) in the 6-months-before-planting plots than the 2-months-before-planting treatment. This means nutrient loss due to leaching would be higher in the former treatment and less nutrient would be available for maize to utilize, which finally resulted in the low yield obtained from this treatment.
4. Conclusion

At the Research Farm of the National Centre for Agricultural Mechanization, Ilorin, a study was carried out to investigate the performance of maize production when fresh poultry manure was applied to the soil at four different times before planting. This is in order to determine the most appropriate application time for manure in the study area.

Results obtained during the study showed that cob weight per plot, 500 kernel weight and grain yield recorded their highest values at 2 months before planting (MBP).

Results of grain yield and yield components obtained from the experiment suggest that the best period to apply poultry manure in maize production is 2 months before planting or at planting, termed 0 months before planting.

References


Table 1.  Soil characteristics and chemical composition of the poultry manure

<table>
<thead>
<tr>
<th>Planting</th>
<th>Soil Characteristics</th>
<th>Poultry Manure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ph (H₂O)</td>
<td>5.8</td>
<td>5.6</td>
</tr>
<tr>
<td>Organic Matter (%)</td>
<td>1.0</td>
<td>2.9</td>
</tr>
<tr>
<td>Organic Carbon (%)</td>
<td>0.7</td>
<td>1.7</td>
</tr>
<tr>
<td>Total N (%)</td>
<td>0.45</td>
<td>1.33</td>
</tr>
<tr>
<td>Available P (%)</td>
<td>0.13</td>
<td>0.58</td>
</tr>
<tr>
<td>Exchangeable K (%)</td>
<td>0.76</td>
<td>1.02</td>
</tr>
<tr>
<td>Exchangeable Acidity</td>
<td>0.80</td>
<td>N.A.</td>
</tr>
<tr>
<td>Moisture Content (%)</td>
<td>10.87</td>
<td>36.79</td>
</tr>
<tr>
<td>Water Holding Capacity (%)</td>
<td>39.78</td>
<td>42.32</td>
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<tr>
<td>Sand (%)</td>
<td>82.52</td>
<td>N.A.</td>
</tr>
<tr>
<td>Silt (%)</td>
<td>8.00</td>
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</tr>
<tr>
<td>Clay (%)</td>
<td>9.48</td>
<td>N.A.</td>
</tr>
</tbody>
</table>

Textural Class: Loamy Sand  N.A. Not applicable

Table 2.  Effects of application timing on maize production components using poultry manure

<table>
<thead>
<tr>
<th>Application Time of Manure (*MBP)</th>
<th>Plant height 6 WAP* (cm)</th>
<th>Cob weight per plot (kg)</th>
<th>500 Kernel Weight (g)</th>
<th>Grain yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>102.50</td>
<td>4.45</td>
<td>126.83</td>
<td>0.91</td>
</tr>
<tr>
<td>4</td>
<td>107.75</td>
<td>4.48</td>
<td>127.88</td>
<td>0.99</td>
</tr>
<tr>
<td>2</td>
<td>112.40</td>
<td>7.68</td>
<td>128.65</td>
<td>1.60</td>
</tr>
<tr>
<td>0</td>
<td>117.95</td>
<td>5.98</td>
<td>122.03</td>
<td>1.33</td>
</tr>
<tr>
<td>Mean</td>
<td>110.15</td>
<td>5.65</td>
<td>126.35</td>
<td>1.21</td>
</tr>
<tr>
<td>L. S. D. 0.05</td>
<td>N. S.</td>
<td><strong>1.82</strong></td>
<td>N. S.</td>
<td><strong>0.42</strong></td>
</tr>
</tbody>
</table>

*MBP Months before planting; WAP* Weeks after planting; N. S. Not significant at 5% level