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Influence of poultry manure and NPK fertilizer on yield and yield components of crops under different cropping systems in south west Nigeria

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Field experiments were conducted in two villages (Oniyo and Moloko Ashipa) representing two agro ecologies in the south west area of Nigeria during 2000 and 2001 cropping seasons. The objective was to determine the effects of NPK fertilizer and poultry manure on the yield and yield components in cassava/maize/melon systems. The factors were (1) cropping systems: cassava/maize/melon, sole cassava, sole maize and sole melon; and (2) fertilizers: no fertilizer, NPK 15-15-15 (400 kg/ha), poultry manure (5 t/ha), 2.5 t/ha poultry manure + 200 kg/ha NPK 15-15-15 and mineral fertilizer (NPK 15-15-15). Intercropping had no significant effect on cassava root yield but it reduced maize and melon seed yield compared to sole cropping. Land equivalent ratio (LER) values were however higher under intercropping than sole cropping. Crop yields were statistically the same under NPK alone and NPK + poultry manure but significantly higher than both poultry manure alone and control in both locations.

Key words: Poultry manure, NPK, Cropping system, intercrop.

INTRODUCTION

Bush fallowing has been an efficient, balanced and sustainable agricultural system for soil productivity and fertility restoration in the humid tropics. Its success, however, depends on unlimited availability of land and small farming population. The system is presently unsustainable due to high population pressure and other human activities which have resulted in reduced fallow period (Steiner, 1991). Intensive cropping is becoming more common and the primary function of soil productivity and fertility restoration through fallow has become less effective (Okigbo, 1982). Increased cropping intensity has however been found to accentuate such changes as erosion of top soil, degradation in soil physical condition, deteriorating nutrient status and changes in the number and composition of soil organisms (Okigbo, 1982). The judicious management and conservation of the soil to guide against these problems that eventually lead to decreased crop yield under intensive cropping have become major areas of agronomic research (Brechin and McDonald, 1994).

The use of inorganic fertilizer has not been helpful under intensive agriculture because it is often associated with reduced crop yield, soil acidity and nutrient imbalance (Kang and Joo, 1980; Obi and Ebo, 1995; Ojeniyi, 2000). Soil degradation which is brought about by loss of organic matter accompanying continuous cropping becomes aggravated when inorganic fertilizers are applied repeatedly. This is because crop response to applied fertilizer depends on soil organic matter (Agboola and Omueti, 1982). The quantity of soil organic matter in the soil has been found to depend on the quantity of organic material which can be introduced into the soil either by natural returns through roots, stubble, slough off roots nodules and root exudates or by artificial application in the form of organic manures which can otherwise be called organic fertilizers.

The need to use renewable forms of energy and reduce costs of fertilizing crops has revived the use of organic fertilizers worldwide. Improvement of environmental conditions and public health important reasons for advocating increased use of organic materials (Seifritz,
combined in either simple or complex mixtures. Complex
determine the effects of NPK fertilizer and poultry
the basis of differences in growth habits and can be
1990). In view of the foregoing, a study was conducted to
known to give higher financial and calorie returns (IITA,
and several leafy vegetables. The crops are selected on
short-duration crops such as maize, melon, cowpea, okra
important food crops widely grown in several countries in
sub-saharan Africa, is well suited to intercropping with
intercropping produces a stable and sustainable
agroecosystem in the humid tropics. Farmers in the
farm sites for the experiments have been previously cropped to crops such as maize, cassava and
cowpea with little or no mineral fertilizers application and
inconsistent fallow periods. The dominant soil of the experimental
areas in Oniyo and Moloko-Ashipa is Alfisol (USDA, 1975). The
soils are well to moderately well drained and have a low nutrient
status.

Before planting in 2000, surface soil samples (0-15 cm) were
collected from fifteen points from both sites and were then bulked
for routine analysis. The nutrient contents of the soils are presented
in Table 1. The poultry manure applied contained 1.98% N, 1.74% P,
5.25% Ca, 2.00% K and 4.79% Mg. The experiments were laid
out as a 4 x 4 factorial in randomized complete block design
(RCB) with four replications. The factors were (1) cropping
systems: cassava/maize/melon, sole cassava, sole maize and
melon; (2) fertilizer: no fertilizer, 5 t/ha poultry manure (PM), 2.5
t/ha poultry manure + 200 kg/ha NPK15-15-15 and 400 kg/ha
NPK15-15-15. The treatments comprised all possible combinations
of four cropping systems and fertilizer levels. The plot size was 4
m x 5 m. Sites were ploughed and harrowed, and the plots were
laid out according to the design of the study. Organic fertilizer was
applied a week before planting. It was uniformly spread on the plots
and lightly worked into the soil with hoe. Inorganic fertilizer was
applied 3 weeks after planting by ringing around maize plant.

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and lightly worked into the soil with hoe. Inorganic fertilizer was
applied 3 weeks after planting by ringing around maize plant.

### Table 1. Initial soil test values of sites used for field studies at Oniyo and Moloko-Ashipa.

<table>
<thead>
<tr>
<th>Soil parameter</th>
<th>Oniyo</th>
<th>Moloko-Ashipa</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Clay</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>% Silt</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>%Sand</td>
<td>82</td>
<td>82</td>
</tr>
<tr>
<td>PH</td>
<td>5.2</td>
<td>5.7</td>
</tr>
<tr>
<td>Organic C (g/kg)</td>
<td>4.74</td>
<td>6.24</td>
</tr>
<tr>
<td>Total N (g/kg)</td>
<td>0.84</td>
<td>0.92</td>
</tr>
<tr>
<td>Ca (cmol/kg)</td>
<td>1.48</td>
<td>2.14</td>
</tr>
<tr>
<td>Mg (cmol/kg)</td>
<td>1.12</td>
<td>1.30</td>
</tr>
<tr>
<td>K (cmol/kg)</td>
<td>0.16</td>
<td>0.18</td>
</tr>
<tr>
<td>Na (cmol/kg)</td>
<td>0.50</td>
<td>0.27</td>
</tr>
<tr>
<td>CEC (cmol/kg)</td>
<td>3.14</td>
<td>4.00</td>
</tr>
<tr>
<td>Available P (mg/kg)</td>
<td>7.48</td>
<td>4.71</td>
</tr>
</tbody>
</table>

1982; Ojeniyi, 2000; Maritus and Vleel, 2001). The
benefits derivable from the use of organic materials
have, however, not been fully utilized in the humid tropics
partly due to the huge quantities required in order to
satisfy the nutritional needs of crops, transportation as
well as the handling costs which constitute major
constraints. Complementary use of organic manures and
mineral fertilizers has been proved to be a sound soil
fertility management strategy in many countries of the
world (Lombin et al., 1991). High and sustained crop
yield can be obtained with judicious and balanced NPK
fertilization combined with organic matter amendment
(Kang and Balasubramanian, 1990). A system
integrating different practices of soil fertility maintenance
is required and this will include the use of mineral
fertilizer, organic manures and intercropping which
provides a fast and good ground cover and also allows
the roots to exploit soil nutrients at various depths
(Steiner, 1991). The traditional farmers seem to have
unconsciously designed their cropping system with a
view of maintaining the fertility status of the soil because
intercropping produces a stable and sustainable
agroecosystem in the humid tropics. Farmers in the
southwestern part of Nigeria practice intercropping with
a wide range of crops consisting usually of a major crop
and other minor crops. Crops like cassava, maize, yam
and plantain are planted as major crops while melon,
cowpea and vegetables are minor crops in various parts
of the region (IITA, 1990). Cassava, one of the most
important food crops widely grown in several countries in
sub-saharan Africa, is well suited to intercropping with
short-duration crops such as maize, melon, cowpea, okra
and several leafy vegetables. The crops are selected on
the basis of differences in growth habits and can be
combined in either simple or complex mixtures. Complex
mixtures consisting of three or more crop species are
known to give higher financial and calorie returns (IITA,
1990). In view of the foregoing, a study was conducted to
determine the effects of NPK fertilizer and poultry
manure on the yield and yield components of cassava,
maize and melon under sole and inter cropping systems.

### MATERIALS AND METHODS

Field experiments were conducted during the 2000 and 2001
cropping seasons in the adopted villages (Oniyo and Moloko-
Ashipa) of the Institute of Agricultural Research and Training
(IAR&T). Oniyo (latitude 8° 20'N; longitude 4° 20'E) is in the
derived savanna agro-ecological zone of Southwestern Nigeria.
The average annual rainfall varies from 1000 to 1150 mm and
distributed over seven months with a short dry spell in August.
Moloko-Ashipa (latitude 7° 01'N; longitude 3° 33'E) is in the
lowland rainforest agro ecological zone of Southwestern Nigeria.
The average annual rainfall varies from 1000 to 1350 mm and has
a bimodal distribution. The farm sites for the experiments have
been previously cropped to crops such as maize, cassava and
cowpea with little or no mineral fertilizers application and
inconsistent fallow periods. The dominant soil of the experimental
areas in Oniyo and Moloko-Ashipa is Alfisol (USDA, 1975). The
soils are well to moderately well drained and have a low nutrient
status.

Before planting in 2000, surface soil samples (0-15 cm) were
collected from fifteen points from both sites and were then bulked
for routine analysis. The nutrient contents of the soils are presented
in Table 1. The poultry manure applied contained 1.98% N, 1.74% P,
5.25% Ca, 2.00% K and 4.79% Mg. The experiments were laid
out as a 4 x 4 factorial in randomized complete block design
(RCB) with four replications. The factors were (1) cropping
systems: cassava/maize/melon, sole cassava, sole maize and
melon; (2) fertilizer: no fertilizer, 5 t/ha poultry manure (PM), 2.5
t/ha poultry manure + 200 kg/ha NPK15-15-15 and 400 kg/ha
NPK15-15-15. The treatments comprised all possible combinations
of four cropping systems and fertilizer levels. The plot size was 4
m x 5 m. Sites were ploughed and harrowed, and the plots were
laid out according to the design of the study. Organic fertilizer was
applied a week before planting. It was uniformly spread on the plots
and lightly worked into the soil with hoe. Inorganic fertilizer was
applied 3 weeks after planting by ringing around maize plant.

Cassava (Manihot esculenta Crantz) variety TMS 30572, a popular
improved variety among local farmers was planted. Maize (Zea
mays L.) variety planted was DMR-LSR-W while a local variety of
melon (Colocynthis citrullus L) was used. Planting was done on the
flat in May of each year at Oniyo and Moloko-Ashipa. Cassava,
maize and melon were planted at the same time. Cassava was pla-
Table 2. Effect of cropping systems, NPK and poultry manure on yield and yield components of maize in at Oniyo.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Grain yield (t/ha) 2000</th>
<th>Cob weight (g) 2000</th>
<th>Cob length (cm) 2000</th>
<th>Weight of 1000 grains (g) 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cropping systems</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sole cropping</td>
<td>2.13a</td>
<td>59.53a</td>
<td>13.31a</td>
<td>147.8a</td>
</tr>
<tr>
<td>Intercropping</td>
<td>1.99b</td>
<td>56.99b</td>
<td>12.33b</td>
<td>149.2a</td>
</tr>
<tr>
<td>Fertilizers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No fertilizer</td>
<td>0.93c</td>
<td>50.06d</td>
<td>9.450d</td>
<td>120.8d</td>
</tr>
<tr>
<td>NPK</td>
<td>2.61a</td>
<td>62.85b</td>
<td>13.84b</td>
<td>160.9b</td>
</tr>
<tr>
<td>Poultry manure</td>
<td>1.99b</td>
<td>54.33c</td>
<td>12.40c</td>
<td>150.7c</td>
</tr>
<tr>
<td>NPK + Poultry manure</td>
<td>2.79a</td>
<td>65.81a</td>
<td>15.58a</td>
<td>165.6a</td>
</tr>
</tbody>
</table>

Values followed by the same letter(s) in a column are not significantly different at P=0.05 (DMRT).

Table 3. Effect of cropping systems, NPK and poultry manure on yield and yield components of maize at Moloko-ashipa.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Grain yield (t/ha) 2000</th>
<th>Cob weight (g) 2000</th>
<th>Cob length (cm) 2000</th>
<th>Weight of 1000 grains (g) 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cropping systems</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sole cropping</td>
<td>2.12a</td>
<td>58.36a</td>
<td>14.04a</td>
<td>148.5a</td>
</tr>
<tr>
<td>Intercropping</td>
<td>1.91b</td>
<td>56.98b</td>
<td>12.80b</td>
<td>143.9a</td>
</tr>
<tr>
<td>Fertilizers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No fertilizer</td>
<td>0.85c</td>
<td>49.83d</td>
<td>10.04d</td>
<td>116.2d</td>
</tr>
<tr>
<td>NPK</td>
<td>2.50a</td>
<td>62.24b</td>
<td>14.31b</td>
<td>155.1b</td>
</tr>
<tr>
<td>Poultry manure</td>
<td>2.04b</td>
<td>53.98c</td>
<td>13.46c</td>
<td>149.6c</td>
</tr>
<tr>
<td>NPK + Poultry manure</td>
<td>2.66a</td>
<td>64.64a</td>
<td>15.88a</td>
<td>163.9a</td>
</tr>
</tbody>
</table>

Values followed by the same letter(s) in a column are not significantly different at P=0.05 (DMRT).

RESULTS

Cropping systems significantly affected all the characters investigated except the weight of 1000 grains from both locations. Intercropping reduced maize growth, yields and yield components relative to sole cropping over two seasons for both locations (Table 2). Application of NPK and poultry manure significantly increased grain yields and other parameters investigated. Complementary application gave the highest values. Maize grain yield followed the same trend in both location for the planting seasons and the trend was NPK + poultry manure > NPK > poultry manure > no fertilizer. Grain yields were not statistically different under complementary application of NPK and poultry manure fertilizer and application of NPK fertilizer alone (Tables 2 and 3).

Melon when planted sole gave significantly higher seed yield and average ball weight than when intercropped with cassava and maize. At both locations, no fertilizer (control) gave the least seed yield. Seed yield was not significantly different between the application of NPK fertilizer alone and complementary application of NPK fertilizer and poultry manure.

Data on cassava fresh tuber yield and average number of tubers per plot are shown in Table 4. Cropping system effect was not significant for fresh tuber and average number of tubers per plot at 2000 and 2001 from both stations. There were significant differences among the fertilizers applied for fresh tuber yield and average number of tubers per plot. Averaged across cassava fresh tuber yield from both stations in 2000 and 2001, comple-
<table>
<thead>
<tr>
<th>Treatments</th>
<th>Cropping system</th>
<th>Oniyo</th>
<th>Moloko-Ashipa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Melon seed yield (kg/ha)</td>
<td>2000</td>
<td>2001</td>
</tr>
<tr>
<td>Sole cropping</td>
<td>193.5a</td>
<td>208.1a</td>
<td>710.1a</td>
</tr>
<tr>
<td>Intercropping</td>
<td>101.7b</td>
<td>94.96b</td>
<td>627.9b</td>
</tr>
<tr>
<td></td>
<td>Fertilizers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No fertilizer</td>
<td>101.7c</td>
<td>101.2c</td>
<td>485.7c</td>
</tr>
<tr>
<td>NPK</td>
<td>163.2a</td>
<td>177.3a</td>
<td>715.5b</td>
</tr>
<tr>
<td>Poultry manure</td>
<td>157.1b</td>
<td>155.9b</td>
<td>704.9b</td>
</tr>
<tr>
<td>NPK + Poultry manure</td>
<td>167.9a</td>
<td>171.3a</td>
<td>770.0a</td>
</tr>
</tbody>
</table>

Values followed by the same letter(s) in a column are not significantly different at P=0.05 (DMRT).
Table 5. Fresh root yield and average number of tubers of cassava as affected by cropping systems, NPK and poultry manure.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Oniyo</th>
<th></th>
<th>Moloko-Ashipa</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cassava tuber yield (t/ha)</td>
<td>Average wt of tubers/plant (g)</td>
<td>Cassava tuber yield (t/ha)</td>
<td>Average wt of tubers/plant (g)</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>2001</td>
<td>2000</td>
<td>2001</td>
</tr>
<tr>
<td>Cropping system</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sole cropping</td>
<td>21.34a</td>
<td>22.70a</td>
<td>137.4a</td>
<td>138.3a</td>
</tr>
<tr>
<td>Intercropping</td>
<td>20.40a</td>
<td>20.92a</td>
<td>135.2a</td>
<td>133.0a</td>
</tr>
<tr>
<td>Fertilizers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No fertilizer</td>
<td>13.99c</td>
<td>14.44c</td>
<td>110.2c</td>
<td>112.3d</td>
</tr>
<tr>
<td>NPK</td>
<td>23.95b</td>
<td>23.58b</td>
<td>132.4ab</td>
<td>142.4b</td>
</tr>
<tr>
<td>Poultry manure</td>
<td>20.29b</td>
<td>23.09b</td>
<td>129.1b</td>
<td>127.4c</td>
</tr>
<tr>
<td>NPK + Poultry manure</td>
<td>25.25a</td>
<td>26.14a</td>
<td>135.7a</td>
<td>160.6a</td>
</tr>
</tbody>
</table>

Values followed by the same letter(s) in a column are not significantly different at P=0.05 (DMRT).

Table 6. Mean values of Land Equivalent Ratio (LER) for the two years.

<table>
<thead>
<tr>
<th>Location</th>
<th>Sole cropping</th>
<th>Intercropping</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maize</td>
<td>Melon</td>
</tr>
<tr>
<td>Oniyo</td>
<td>0.75</td>
<td>0.69</td>
</tr>
<tr>
<td>Moloko-Ashipa</td>
<td>0.70</td>
<td>0.68</td>
</tr>
<tr>
<td>Mean LER</td>
<td>0.73</td>
<td>0.69</td>
</tr>
</tbody>
</table>

DISCUSSION

The results have indicated that regardless of agroecology and fertilizer application, the yield of maize was reduced by the associated cassava and melon, as reported by other workers (Okpara and Omaliko, 1995; Muoneke and Asiegbu, 1997). The reduction was attributed to inter-specific competition for nutrients, moisture and/or space. The poor performance of melon when intercropped with maize and cassava has been attributed mainly to shading by the taller maize and cassava. Ikeorgu (1984) observed that yields from melon grown in mixtures are often lower than 50% of those from sole crops. It was also noted in a trial conducted in IITA (1974) that melon component in a cassava/maize/melon mixture performed poorly because of shading effect of higher component crops. In traditional agriculture, melon is rarely planted solely; it is often intercropped with cassava, maize, yam and other food crops where it performs the role of a cover crop and it helps to smother weeds early in the growing season (Ikeorgu, 1984). It also reduces soil temperature and evaporation, thus conserving soil moisture. Ghuman and Lal (1987) observed that soil surface remained moist in the intercrop during an unexpected dry spell of 6-8 days when compared to situations under monoculture of maize and yam. They also found that maize intercropped with melon never showed any sign of even temporary wilting on hot afternoons, in contrast with monoculture check.

Intercropping had no significant effect on cassava yields. The fact that cassava is a long duration crop and has an initial slow growth rate allows it to recover from the earlier competition effects when intercropped with maize and melon. Some studies have shown that cassava yield was reduced by intercropping while other reports did not indicate any significant reduction in yield in comparison with sole crop. Sinthuprama (1978) reported that cassava growth was initially retarded when intercropped with maize but it was possible to get a high proportion of its sole crop yield. CIAT (1980) also found that the yield of cassava intercropped with groundnut was similar to sole crop yield. CIAT (1977) reported low
Cassava yields in studies evaluating the performance of cassava in cassava/maize, cassava/sweet potato and cassava/cocoyam associations. The cassava crop also gave 78% of its sole crop yield giving a land equivalent ratio (LER) of 1.71 in trials carried out in central America. In some situations the total LER was as high as 2.00. Yield advantages of between 58 and 77 percent were also recorded in cassava/maize association in southern Nigeria (IITA, 1982).

Cassava, maize and melon performed best in terms of growth and yield under poultry manure + NPK fertilizer treatments in both years. This is in agreement with the findings of Titiloye (1982) who reported that the most satisfactory method of increasing maize yield was by judicious combination of organic wastes and inorganic fertilizers. Agboola (1970) advocated for better farming systems which employ a combination of fertility building practices appropriate to local conditions for crop production in south west Nigeria. It has been observed that addition of manure increases soil water holding capacity and this means that nutrient would be made available to crops where manure has been added to the soil (Costa et al., 1991). Fuchs et al. (1970) also reported that nutrients from mineral fertilizers enhance the establishment of crops while those from mineralization of organic manure promoted yield when both fertilizers were combined. Munwira and Kirchman (1993) observed that nutrient use efficiency might be increased through the combination of manure and mineral fertilizer. The yield of maize and melon under NPK fertilizer treatment was comparable to that form NPK + poultry manure treatment because nutrients are readily released form inorganic fertilizer and these crops were able to utilize it for growth and yield. Crop yield were lower under poultry manure probably because of low mineralization of nutrient from this source. Titiloye (1982) found that organic waste / fertilizer alone could hardly be depended upon as the sole source of nutrient for a short duration crop like maize. On the average, the combined application of NPK fertilizer and poultry manure appeared satisfactory for obtaining high grain yield of maize, seed yield of melon and fresh tuber yield of cassava. The trend of cassava yield was NPK + poultry manure>NPK alone>poultry manure > no fertilizer. This indicates that cassava was still able to utilize residual nutrients from both NPK and poultry manure to produce bigger tubers in the fertilized plots after early season maize and melon had been harvested. The choice of crops for this study was based mainly on the popularity of the crops among farmers in the south west area of Nigeria. Cassava is particularly suitable for intercropping because it is a long duration crop. The faster growing maize exploits the microenvironment early in the growing season while melon, a low canopy crop served a dual purpose of protecting the soil against erosion and soil loss. This study has shown that intensification of cropping with complementary use of organic and inorganic fertilizer is a good way of making judicious and efficient use of applied nutrients.

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