GROWTH AND DEVELOPMENT COMPONENTS OF PEARL MILLET VARIETIES + GROUNDNUT INTERCROP IN SUDAN SAVANNA OF NIGERIA

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ABSTRACT
Field trials were conducted in 2010 and 2011 at Department of Crop Production Faculty of Agriculture University of Maiduguri, Nigeria to determine the growth and development components of pearl millet varieties + groundnut intercrop. Four pearl millet varieties SOSAT-C-88, ZATIP, LACRI-9707-C and EX-BORNO were assigned to the sub plot, while groundnut (samnut-14) was allocated to the main plots which were filled into RCBD design in factorial split arrangement replicated three times. Pearl millet and groundnut agronomic parameters, Number of tillers/plant, number of leaves/plant, plant height, number of days to 50% flowering were superior for sole millet compared to intercrop. Pearl millet vegetative and reproductive parameters were significantly greater for ZATIP and EX-BORNO than SOSAT-C-88 and LACR-9702-IC. The number of tillers/plant, plant height and grain yield/ha were significantly least for LACRI-9702-IC which was the shortest and earliest flowering variety but significantly produced superior (P<0.01) groundnut grain yield. Superior grain yields were realized for SOSAT-C88, ZATIP and EX-BORNO in both the intercropping and sole cropping system. Groundnut yield and yield components were greater when grown in association with LACRI-9702-IC than taller and late flowering varieties, except LACRI-9702-IC, all the varieties were competitive than the groundnut. Although both the grain yield and cash returns were higher for SOSAT-C-88 and groundnut combinations which was the most suitable in the Sudan Savanna.

INTRODUCTION
Millet/groundnut intercropping is the most predominant cropping system in the Sudan and Sahelain zones of West Africa Baker,(1978) and Dugje,(2009) . Millet (pennisetum glaucum (L.) R.Br.) is a staple diet while groundnut serves as a source of vegetable oil and protein. Although improved millet varieties have been developed which do not only provide grain for human but also straw for livestock and stalks for fencing. Groundnut plays a key role in food security, income generation and maintenance of the environment for smallholder farmers in the Sudan and Sahelian zones. The traditional groundnut cultivars, which are still widely in use in the zones, are spreading type, late maturing and low yielding for intercropping ICRISAT,(2011).An important consideration in millet/groundnut intercropping is the choice of appropriate millet variety and agronomic practices given the fast growth rate of millet/groundnut intercrop. In millet/groundnut intercropping in the Sudan Savanna- early flowering pearl millet varieties have been shown to yield higher than the tall and late maturing varieties Mkamilo.(2008). In contrast, Okigbo and Greenland, (2004) found that in the Sahelien Zones short and early flowering varieties produced higher grain yield than the tall late flowering varieties when intercropping with groundnut. However, the late flowering varieties caused greater groundnut yield reduction than the early short varieties, indicating that selection of pearl millet varieties and groundnut cultivar for intercropping should be based on compitability of their growth and development components of companion crops. Few reports on the growth and development of pearl millet varieties intercropping with groundnut in the Sudan Savanna. Henrich, (2013) observed that intercropping short pearl millet varieties with groundnut in 1:1 alternate row arrangement was superior to intercropping. IIPPS, (2007) reported superior yield of pearl/groundnut intercrop when dwarf pearl millet varieties was grown in associations with groundnut. There appears to be opportunities for increasing pearl millet and system productivity by using suitable pearl millet varieties and manipulating cultural practices. The objective of this study therefore was to assess the growth and
development components of some newly improved pearl millet varieties in increasing the productivity of cereal - legume intercrop using different pearl millet variety in a semi-arid environment.

MATERIALS AND METHODS

The experiment was conducted during 2010 and 2011 cropping seasons at the Teaching and Research Farm Faculty of Agriculture, Department of Crop Production, Faculty of Agriculture University of Maiduguri (11°53′N; 13°16′E and 352m above sea level) in the sudan savanna ecological zone of Nigeria Kowal and Knabe,(1971). The total rainfall received was 569.3 and 884.5 mm in 2010 and 2011, respectively DMA, (2012) The soil at the experimental site was typic ustipsamment, comprising of 80% sand, 14% silt and 5% clay. The treatments consisted of four of pearl millet varieties SOSAT-C-88, ZATIP, LACRI-9702-IC and EX-BORNO, and each was intercropped with groundnut (samnut-14). The pearl millet was grown at (3) three plants/stand, while the groundnut were grown at 2 plants/stand (Dugje,(2004). The experiment design was a split-factorial with groundnut assigned to the main-plot and millet varieties assigned to the sub-plot which were replicated three times. Plot size was 3.0 x 5.0m (15m²). An alley of 2.0m was allowed between the replicates, while 1.0 and 0.5m alley was allowed between the main plots and sub-plot respectively. The pearl millet varieties was sown at 90cm x 50cm while each groundnut was intercropped into the pearl millet row simultaneously at a distance of 45cm from the pearl millet row and 25cm within row. Each groundnut was sown at 75cm x 25cm and sole groundnut was sown at 75cm x 25cm in four separate plots for determination of biological and economical efficiencies. Seeds were treated with a pre planting fungicides Apron Star (42WS) at the rate of 5g of chemical to 1 kilogram of seeds Anaso et al.,(1998) The land was harrowed with tractor driven disc, after which the plots were laid out and levelled before sowing. Sowing of the plots was done after the rains on 9th July, 2010 and 6th July, 2011 respectively. The plots were hoe-weeded at 3 and 6 weeks after sowing millet/groundnut while thinning was done manually at 2 weeks after sowing for the pearl millet component. Fertilizer was applied at the recommended rate of 60kgN, 30kg P₂O₅ and 30kg K₂O/ha (FP DD, 2002) in 2 split dose. The first dose of 30:30:30 was applied at 2 weeks after sowing using urea (46%N). For the cowpea component 59kgP₂O₅/hectare was applied using single super phosphate (18%P₂O₅) one week after sowing. The same fertilizer rates and methods were applied each year. The component crops were harvested after physiological maturity and data collected on pearl millet include, plant height, number of leaves/plant, leaf area/plant, number of tillers/plant, days to 50% flowering, harvest index (%), grain yield kg/ hectare and straw yields, while groundnut pod yield/plant, pod yield/ha, number of pods/plant, 100 grain weight and fodder yield/ hectare.

Data collected from the two experiments were subjected to two-way Analysis of variance (ANOVA).Both the year wise and combined years analysis were run using a computer software, statisitix version 8.0 (Statistix, 2005). Difference between treatments means were compared using the least significant difference (LSD) and Ducan Multiple Range Test (DMRT) for separation of means for tables at 5% level of probability. Intercrop productivity was evaluated using land equivalent ratio (LER) as described by Mead and willey, (1980). Gross monetary returns on the intercrop products were determined by summing the total naira value of pearl millet and groundnut grains, millet straws yields and groundnut fodder per hectare Dugje,(2004).

RESULTS

Pearl millet Growth and Development Parameters
There was significant difference in plant height among the pearl millet varieties at 9 WAS in 2010, plant height was significantly (P<0.001) greater for EX-BORNO and ZATIP compared to SOSAT-C-88 and LACRI-9702-IC that produced significantly (P<0.001) lower plant height (Table 1). In 2011, at 9 WAS, ZATIP and EX-BORNO maintained their superiority in the plant height which were significantly (P<0.05) taller than SOSAT-C-88 and LACRI-9702-IC that produced significantly (P<0.01) shorter plants than the other varieties (Table 1). For the combined mean, ZATIP produced significantly (P<0.001) taller plants followed by EX-BORNO than SOSAT-C-88 and LACRI-9702-IC. At harvest in 2010, plant height was significantly (P<0.001) higher for ZATIP than the other varieties, while SOSAT-C-88 produced significantly (P<0.001) shorter plants than the other treatments at harvest (Table 1). For the combined mean, ZATIP and EX-BORNO maintained their superiority in plant height which were significantly (P<0.001) taller than SOSAT-C-88 and LACRI-9702-IC. In 2010, number of leaves/plant were significantly (P<0.001) greater for EX-BORNO and ZATIP compared to SOSAT-C-88 and LACRI-9702-IC at 9 WAS (Table 1). Also at harvest, EX-BORNO and ZATIP produced greater number of leaves compared to the two varieties. Similar trend was observed in 2011 and combined mean when number of leaves per plant was greater for EX-BORNO and ZATIP, while SOSAT-C-88 and LACRI-9702-IC had lower leaves.

Table 1 Effect of pearl millet variety intercrop + groundnut on plant height (cm) at 6, 9WAS and at harvest and number of leaves/plant at 9 WAS and at harvest of pearl millet.

<table>
<thead>
<tr>
<th>Millet Variety</th>
<th>Plant height</th>
<th>No. of leaves/plant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6 WAS</td>
<td>9 WAS</td>
</tr>
<tr>
<td><strong>2010</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOSAT-C-88</td>
<td>97.45</td>
<td>154.71</td>
</tr>
<tr>
<td>ZATIP</td>
<td>97.26</td>
<td>161.62</td>
</tr>
<tr>
<td>LACRI-9702-IC</td>
<td>98.75</td>
<td>150.45</td>
</tr>
<tr>
<td>EX-BORNO</td>
<td>98.14</td>
<td>161.43</td>
</tr>
<tr>
<td>SE (±)</td>
<td>1.76</td>
<td>1.40</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>2.66</td>
<td>2.87</td>
</tr>
<tr>
<td><strong>2011</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOSAT-C-88</td>
<td>85.45</td>
<td>143.68</td>
</tr>
<tr>
<td>ZATIP</td>
<td>89.92</td>
<td>147.00</td>
</tr>
<tr>
<td>LACRI-9702-IC</td>
<td>82.42</td>
<td>143.21</td>
</tr>
<tr>
<td>EX-BORNO</td>
<td>88.47</td>
<td>146.11</td>
</tr>
<tr>
<td>SE (±)</td>
<td>1.86</td>
<td>1.34</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>3.34</td>
<td>2.81</td>
</tr>
<tr>
<td><strong>Combined Mean</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOSAT-C-88</td>
<td>91.45</td>
<td>149.19</td>
</tr>
<tr>
<td>ZATIP</td>
<td>93.59</td>
<td>154.31</td>
</tr>
<tr>
<td>LACRI-9702-IC</td>
<td>90.59</td>
<td>146.83</td>
</tr>
<tr>
<td>EX-BORNO</td>
<td>93.10</td>
<td>153.77</td>
</tr>
<tr>
<td>SE (±)</td>
<td>2.17</td>
<td>2.14</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>3.51</td>
<td>4.26</td>
</tr>
</tbody>
</table>

The results showed that there was significant difference among the pearl millet varieties at 6 WAS pearl millet varieties ZATIP and SOSAT-C-88 produced significantly (P< 0.001)
greater leaf area compared to the other treatments. At 9 WAS ZATIP and SOSAT-C-88 produced significantly (P<0.01) greater leaf area compared to LACRI-9702-IC and EX-BORNO which produced significantly (P<0.01) lower leaf area (Table 2). At harvest, similar trend was observed for ZATIP and SOSAT-C-88 compared to LACRI-9702-IC and EX-BORNO treatments. In 2011, leaf area was significantly (P<0.05) greater for SOSAT-C-88 and ZATIP compared to EX-BORNO and LACRI-9702-IC at 6 WAS and at 9 WAS, significantly (P<0.01) greater leaf area was observed for ZATIP and SOSAT-C-88, while EX-BORNO and LACRI-9702-IC produced significantly (P<0.001) lower leaf area. Variety ZATIP and SOSAT-C-88 produced relatively higher leaf area compared to the LACRI-9702-IC and EX-BORNO at harvest (Table 2). For the combined mean at 3 WAS EX-BORNO produced slightly greater leaf area compared to SOSAT-C-88, LACRI-9702-IC and ZATIP. At 6 and 9 WAS, ZATIP and SOSAT-C-88 produced significantly (P<0.001) greater leaf area than LACRI-9702-IC and EX-BORNO. Similar trend was observed at harvest when SOSAT-C-88 and ZATIP produced significantly (P<0.01) greater leaf area compared to LACRI-9702-IC and EX-BORNO.

Table 2: Effect of pearl millet variety on pearl millet leaf area (cm²) at 3, 6, 9 WAS and at harvest at Maiduguri 2010, 2011 and combined mean

<table>
<thead>
<tr>
<th>Millet variety</th>
<th>3 WAS</th>
<th>6 WAS</th>
<th>9 WAS</th>
<th>Harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2010</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOSAT-C-88</td>
<td>133.3</td>
<td>152.1</td>
<td>183.7</td>
<td>136.2</td>
</tr>
<tr>
<td>ZATIP</td>
<td>133.0</td>
<td>164.3</td>
<td>190.7</td>
<td>138.0</td>
</tr>
<tr>
<td>LACRI-9702-IC</td>
<td>132.3</td>
<td>148.4</td>
<td>169.2</td>
<td>131.9</td>
</tr>
<tr>
<td>EX-BORNO</td>
<td>133.4</td>
<td>147.6</td>
<td>175.0</td>
<td>131.3</td>
</tr>
<tr>
<td>SE (±)</td>
<td>1.33</td>
<td>1.86</td>
<td>2.62</td>
<td>1.60</td>
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<tr>
<td>LSD (0.05)</td>
<td>2.11</td>
<td>3.80</td>
<td>5.36</td>
<td>3.27</td>
</tr>
<tr>
<td><strong>2011</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOSAT-C-88</td>
<td>133.8</td>
<td>150.5</td>
<td>179.4</td>
<td>133.4</td>
</tr>
<tr>
<td>ZATIP</td>
<td>134.3</td>
<td>151.3</td>
<td>181.9</td>
<td>135.7</td>
</tr>
<tr>
<td>LACRI-9702-IC</td>
<td>134.1</td>
<td>147.3</td>
<td>172.3</td>
<td>132.4</td>
</tr>
<tr>
<td>EX-BORNO</td>
<td>135.5</td>
<td>145.6</td>
<td>170.7</td>
<td>131.2</td>
</tr>
<tr>
<td>SE (±)</td>
<td>1.27</td>
<td>1.34</td>
<td>2.22</td>
<td>1.47</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>2.00</td>
<td>2.75</td>
<td>4.54</td>
<td>2.41</td>
</tr>
<tr>
<td><strong>Combined Mean</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOSAT-C-88</td>
<td>133.7</td>
<td>151.3</td>
<td>181.6</td>
<td>134.8</td>
</tr>
<tr>
<td>ZATIP</td>
<td>133.6</td>
<td>157.9</td>
<td>186.3</td>
<td>136.9</td>
</tr>
<tr>
<td>LACRI-9702-IC</td>
<td>133.2</td>
<td>147.8</td>
<td>170.8</td>
<td>132.2</td>
</tr>
<tr>
<td>EX-BORNO</td>
<td>134.3</td>
<td>146.6</td>
<td>172.8</td>
<td>131.3</td>
</tr>
<tr>
<td>SE (±)</td>
<td>0.87</td>
<td>1.67</td>
<td>1.73</td>
<td>1.31</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>2.31</td>
<td>3.33</td>
<td>3.44</td>
<td>2.60</td>
</tr>
</tbody>
</table>

The difference among pearl millet varieties in the expression of number of tillers/plant at 3 WAS in 2010 was slightly higher for SOSAT-C-88 compared to ZATIP, LACRI-9702-IC and EX-BORNO that had comparable number of tillers/plant in 2010. At 6 WAS in 2010, there was significantly (P<0.05) greater number of tillers/plant for SOSAT-C-88 than the other varieties. At 9 WAS, values were significantly (P<0.001) greater for SOSAT-C-88 and EX-BORNO while ZATIP and LACRI-9702-IC had comparable values (Table 3). In 2011, number of tillers were significantly (P<0.05) greater for SOSAT-C-88 and EX-BORNO, while ZATIP and LACRI-9702-IC produced significantly (P<0.05) lower number of tillers/plant at 3 WAS. The difference among the pearl millet varieties SOSAT-C-88 and EX-BORNO produced significantly
(P<0.001) higher number of tillers per plant compared to LACRI-9702-IC and ZATIP varieties. The result for the combined mean was 6 and 9 WAS showed that SOSAT-C-88 and EX-BORNO produced significantly (P<0.01) greater number of tillers/plant compared to the ZATIP and LACRI-9702-IC (Table 3). Number of days to 50% flowering was significantly (P<0.001) delayed for ZATIP and EX-BORNO compared to SOSAT-C-88 and LACRI-9702-IC in 2010 (Table 3). In 2011, days to 50% flowering was also significantly (P<0.01) earlier for SOSAT-C-88 and LACRI-9702-IC than EX-BORNO and ZATIP, but SOSAT-C-88 significantly flowered earlier than other varieties. For the combined mean, SOSAT-C-88 and LACRI-9702-IC significantly (P<0.001) flowered earlier than ZATIP and EX-BORNO that had significantly (P<0.001) higher number of days to 50% flowering (Table 3).

Table 3: Effect of pearl millet variety on pearl millet number of tillers per plant at 3, 6 and 9 WAS and number of days to 50% flowering at Maiduguri 2010, 2011 and combined mean

<table>
<thead>
<tr>
<th>Millet variety</th>
<th>Number of tillers/plant</th>
<th>Number of days to 50% flowering</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 WAS</td>
<td>6WAS</td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOSAT-C-88</td>
<td>2.5</td>
<td>2.4</td>
</tr>
<tr>
<td>ZATIP</td>
<td>1.4</td>
<td>2.3</td>
</tr>
<tr>
<td>LACRI-9702-IC</td>
<td>1.3</td>
<td>2.2</td>
</tr>
<tr>
<td>EX-BORNO</td>
<td>1.5</td>
<td>2.3</td>
</tr>
<tr>
<td>SE (±)</td>
<td>0.68</td>
<td>0.34</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>0.19</td>
<td>0.07</td>
</tr>
<tr>
<td>2011</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOSAT-C-88</td>
<td>1.3</td>
<td>2.3</td>
</tr>
<tr>
<td>ZATIP</td>
<td>1.2</td>
<td>2.2</td>
</tr>
<tr>
<td>LACRI-9702-IC</td>
<td>1.2</td>
<td>2.2</td>
</tr>
<tr>
<td>EX-BORNO</td>
<td>1.3</td>
<td>2.4</td>
</tr>
<tr>
<td>SE (±)</td>
<td>0.05</td>
<td>0.09</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>0.16</td>
<td>0.06</td>
</tr>
<tr>
<td><strong>Combined Mean</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOSAT-C-88</td>
<td>1.9</td>
<td>2.3</td>
</tr>
<tr>
<td>ZATIP</td>
<td>1.3</td>
<td>2.2</td>
</tr>
<tr>
<td>LACRI-9702-IC</td>
<td>1.2</td>
<td>2.2</td>
</tr>
<tr>
<td>EX-BORNO</td>
<td>1.4</td>
<td>2.4</td>
</tr>
<tr>
<td>SE (±)</td>
<td>0.34</td>
<td>0.06</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>0.11</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Results showed that greater number of grains per panicle was produced by ZATIP + groundnut and SOSAT-C-88 + cowpea intercrop. The lowest number of grains was observed for LACRI-9702-IC + groundnut treatments. For the combined mean, number of grains per panicle was also significantly (P<0.05) greater number of grains for ZATIP, EX-BORNO and SOSAT-C-88 compared to LACRI-9702-IC which produced significantly (P<0.05) lower number of grains per panicle (Table 6). The lowest grain yield was observed for LACRI-9702-IC grown in combination with groundnut. In 2011, also grain yield was significantly (P<0.05) greater for sole millet compared to the intercrop systems. Grain yield for SOSAT-C-88, ZATIP and EX-BORNO + groundnut was significantly (P<0.05) greater than the LACRI-9702-IC + groundnut. Grain yield did the three varieties of millet + groundnut treatment. Slightly greater grain yield was observed for sole millet compared to the intercrop treatments for the combined mean. Among the intercrop treatment relatively greater grain yield was observed for SOSAT-C-88 + groundnut.
compared to LACRI-9702-IC + groundnut that produced lower grain yield. Thus, grain yield/hectare for sole millet was higher by 13, 15, 24 and 29 % than SOSAT-C-88 + groundnut, ZATIP + groundnut and EX-BORNO + groundnut intercrops, respectively, for the combined mean (Table 6). Intercropping groundnut with pearl millet had no effect on pearl millet straw yield/plants in 2010 (Table 6). Sole millet produced superior straw yield per plant compared to the intercrop treatments. Similarly, ZATIP + groundnut and LACRI-C-9702-IC + groundnut produced higher straw yield per plant than millet + groundnut or millet + soybean, which relatively produced the lowest straw yield per plant (Table 6). In 2011, straw yield per plant was significantly (P<0.01) greater for sole millet compared to millet in the intercrops. ZATIP + groundnut intercrop also significantly (P<0.01) produced greater straw weight than the other intercrops. EX-BORNO produced the lowest straw weight when grown in association with groundnut. A similar trend was observed for the combined mean, where sole millet and ZATIP + groundnut significantly (P<0.01) realized superior straw weight. Among the intercrop treatments, ZATIP + groundnut produced significantly (P<0.01) greater straw yield per plant than the other intercrops. SOSAT-C-88 + groundnut and EX-BORNO + groundnut significantly (P<0.01) realized the lowest straw yield per plant for the combined mean. In 2010, there was significantly (P<0.05) lower harvest index for EX-BORNO + groundnut and ZATIP + groundnut compared to the intercrops (Table 6). Sole millet produced significantly (P<0.05) higher harvest index (%) which was comparable to millet + cowpea. In 2011, sole millet produced significantly (P<0.001) higher harvest index than the intercrop treatments. However, among the intercrops, LACRI-9702-IC + groundnut and SOSAT-C-88 + groundnut produced significantly (P<0.001) greater harvest index than the ZATIP + groundnut or EX-BORNO treatments, that produced comparable and low harvest indices.

Table 4: Effect of pearl millet + groundnut Intercrop system on number of grains/panicle, grain yield /ha, straw yield/plant (g) and harvest index of pearl millet in Maiduguri 2010, 2011 and combined mean

<table>
<thead>
<tr>
<th>Crop system</th>
<th>No of Grains/ Panicle</th>
<th>Grain yield (kg/ha)</th>
<th>Straw yield/plant (g)</th>
<th>Harvest index %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2010</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sole millet</td>
<td>2420.8</td>
<td>2715.7</td>
<td>50.9</td>
<td>37.5</td>
</tr>
<tr>
<td>SOSAT-C-88</td>
<td>2109.5</td>
<td>2466.2</td>
<td>47.1</td>
<td>35.3</td>
</tr>
<tr>
<td>ZATIP</td>
<td>2266.7</td>
<td>2417.2</td>
<td>50.0</td>
<td>34.9</td>
</tr>
<tr>
<td>LACRI-9702-IC</td>
<td>2190.3</td>
<td>1922.1</td>
<td>48.0</td>
<td>37.5</td>
</tr>
<tr>
<td>EX-BORNO</td>
<td>2081.1</td>
<td>2240.9</td>
<td>47.3</td>
<td>34.6</td>
</tr>
<tr>
<td>SE (±)</td>
<td>108.91</td>
<td>106.66</td>
<td>1.44</td>
<td>0.92</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>212.43</td>
<td>245.9</td>
<td>2.12</td>
<td>2.12</td>
</tr>
<tr>
<td><strong>2011</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sole millet</td>
<td>2539.2</td>
<td>3067.4</td>
<td>63.1</td>
<td>61.2</td>
</tr>
<tr>
<td>SOSAT-C-88</td>
<td>2019.2</td>
<td>2576.9</td>
<td>48.4</td>
<td>46.7</td>
</tr>
<tr>
<td>ZATIP</td>
<td>2182.5</td>
<td>2535.4</td>
<td>54.7</td>
<td>45.9</td>
</tr>
<tr>
<td>LACRI-9702-IC</td>
<td>2212.6</td>
<td>2098.7</td>
<td>50.7</td>
<td>48.8</td>
</tr>
<tr>
<td>EX-BORNO</td>
<td>2068.0</td>
<td>2413.7</td>
<td>48.2</td>
<td>45.8</td>
</tr>
<tr>
<td>SE (±)</td>
<td>96.53</td>
<td>145.77</td>
<td>1.28</td>
<td>1.35</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>222.61</td>
<td>336.14</td>
<td>2.97</td>
<td>3.05</td>
</tr>
<tr>
<td><strong>Combined Mean</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sole millet</td>
<td>2486.0</td>
<td>2891.5</td>
<td>56.9</td>
<td>49.4</td>
</tr>
<tr>
<td>SOSAT-C-88</td>
<td>2074.5</td>
<td>2521.3</td>
<td>47.8</td>
<td>41.7</td>
</tr>
<tr>
<td>ZATIP</td>
<td>2424.6</td>
<td>2326.3</td>
<td>52.3</td>
<td>40.2</td>
</tr>
<tr>
<td>LACRI-9702-IC</td>
<td>2201.5</td>
<td>2060.4</td>
<td>49.3</td>
<td>43.1</td>
</tr>
</tbody>
</table>
Groundnut Yield and Yield Components

Table 5 presents the effect of intercropping and pearl millet variety on the yield components of groundnut. Number of pods per plant was significantly lower at groundnut/ZATIP compared with the other combinations that had statistically similar values except in 2011 when the difference between groundnut/ZATIP and groundnut/EX-BORNO intercrop was not significant. Pearl millet variety effects on the number of pods/plant was significant in 2010, while groundnut/LACRI-9702-IC combinations had a higher number of pods/plant compared with the other combination with the exception of groundnut/SOSAT-C-88 in 2011. In both the years, the highest number of pods/plant was obtained at groundnut/LACRI-9702-IC and the lowest at groundnut/ZATIP intercrop. The groundnut differed in pod yield with groundnut/LACRI-9702-IC having the highest pod yield while groundnut/ZATIP and groundnut/EX-BORNO had the least pod and fodder yield. Groundnut pod yield was reduced by 47% as a result of intercropping with pearl millet (Table 5). In intercrop, Groundnut/SOSAT-C-88 out-yielded the other intercrop combination except in 2010 when groundnut/LACRI-9702-IC was at par with these combinations. In both the years, Groundnut/ZATIP and groundnut/EX-BORNO were the lowest yielders. groundnut/SOSAT-C-88 and groundnut/LACRI-9702-IC produced significantly higher fodder yield than the other combinations.

Table 5: Effects of intercropping pearl millet on groundnut number of pods per plant, pod yield per plant (g), seed yield (kg/ha),100 grain weight (g) and fodder yield/ (kg/ha) of groundnut at Maiduguri 2010, 2011 and combined mean

<table>
<thead>
<tr>
<th>Intercrop system</th>
<th>No. of pods /plant</th>
<th>Pod yield /plant (g)</th>
<th>Grain/ yield (kg/ha)</th>
<th>100 weight</th>
<th>Seed (kg/ha)</th>
<th>Fodder (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2010</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G/nut + SOSAT-C-88</td>
<td>33.48</td>
<td>7.75</td>
<td>657.83</td>
<td>37.58</td>
<td>658.92</td>
<td></td>
</tr>
<tr>
<td>G/nut + ZATIP</td>
<td>23.47</td>
<td>7.53</td>
<td>635.67</td>
<td>61.00</td>
<td>454.08</td>
<td></td>
</tr>
<tr>
<td>G/nut + LACRI-9702-IC</td>
<td>64.00</td>
<td>8.90</td>
<td>705.00</td>
<td>35.16</td>
<td>623.08</td>
<td></td>
</tr>
<tr>
<td>G/nut + EX-BORNO</td>
<td>23.02</td>
<td>7.48</td>
<td>581.42</td>
<td>54.25</td>
<td>576.17</td>
<td></td>
</tr>
<tr>
<td>SE (±)</td>
<td>2.96</td>
<td>0.30</td>
<td>29.69</td>
<td>1.74</td>
<td>122.26</td>
<td></td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>7.26</td>
<td>0.74</td>
<td>72.65</td>
<td>4.27</td>
<td>146.21</td>
<td></td>
</tr>
<tr>
<td><strong>2011</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G/nut + SOSAT-C-88</td>
<td>15.98</td>
<td>10.56</td>
<td>663.17</td>
<td>39.83</td>
<td>650.08</td>
<td></td>
</tr>
<tr>
<td>G/nut + ZATIP</td>
<td>13.38</td>
<td>10.50</td>
<td>404.50</td>
<td>61.00</td>
<td>323.83</td>
<td></td>
</tr>
<tr>
<td>G/nut + LACRI-9702-IC</td>
<td>24.38</td>
<td>11.98</td>
<td>667.50</td>
<td>37.08</td>
<td>464.75</td>
<td></td>
</tr>
<tr>
<td>G/nut + EX-BORNO</td>
<td>16.13</td>
<td>9.23</td>
<td>451.42</td>
<td>54.75</td>
<td>385.17</td>
<td></td>
</tr>
<tr>
<td>SE(±)</td>
<td>1.23</td>
<td>0.59</td>
<td>34.16</td>
<td>2.45</td>
<td>38.09</td>
<td></td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>3.01</td>
<td>1.46</td>
<td>83.59</td>
<td>6.00</td>
<td>133.54</td>
<td></td>
</tr>
<tr>
<td><strong>Combined Mean</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G/nut + SOSAT-C-88</td>
<td>24.73</td>
<td>9.26</td>
<td>660.04</td>
<td>38.76</td>
<td>654.50</td>
<td></td>
</tr>
<tr>
<td>G/nut + ZATIP</td>
<td>18.42</td>
<td>8.99</td>
<td>531.33</td>
<td>60.45</td>
<td>433.96</td>
<td></td>
</tr>
<tr>
<td>G/nut + LACRI-9702-IC</td>
<td>40.06</td>
<td>10.44</td>
<td>684.08</td>
<td>36.12</td>
<td>548.92</td>
<td></td>
</tr>
<tr>
<td>G/nut + EX-BORNO</td>
<td>27.70</td>
<td>8.38</td>
<td>509.12</td>
<td>54.50</td>
<td>480.67</td>
<td></td>
</tr>
<tr>
<td>SE(±)</td>
<td>1.60</td>
<td>0.35</td>
<td>22.33</td>
<td>1.36</td>
<td>57.76</td>
<td></td>
</tr>
</tbody>
</table>
Neither intercropping variety a had significant effect on relative competitive ability of pearl millet (Table 6). Relative competitive ability of groundnut was significantly affected by both intercropping and pearl millet variety. A comparison of the pearl millet intercrop groundnut showed that LACRI-9702-IC in association with groundnut had the highest relative competitive ability (RCA) and Land equivalent ratio (LER) in both seasons but this combinations was not different from groundnut in 2010. In 2011 SOSAT-C-88/groundnut and LACRI-9702-IC + groundnut had the highest relative competitive ability while ZATIP + groundnut had the least (RCA).Intercropping pearl millet variety LACRI-9702-IC with groundnut gave the highest total LER followed by SOSAT-C-88 and groundnut while EX-BORNO in combination with groundnut intercrop had the least LER. The monetary advantage from the pearl millet + groundnut intercrop was greater for LACRI-9702-IC intercrop (₦ 229,312.35) in 2010 and SOSAT-C-88 + groundnut (₦ 391,099.77) in 2011 and (₦ 280,325.52) for the combined mean (Table 6). Monetary advantage was slightly higher for EX-BORNO + groundnut intercrop during the two years compared to ZATIP + groundnut intercrops.

Table 39: Effects of intercropping on relative competitive ability, land equivalent ratio (LER) and monetary Advantage (₦) of pearl millet + groundnut intercrop at Maiduguri

<table>
<thead>
<tr>
<th>Intercrop System</th>
<th>RCA Millet</th>
<th>RCA Groundnut</th>
<th>Total LER</th>
<th>Monetary Advantage (₦)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G/nut + SOSAT-C-88</td>
<td>0.90</td>
<td>0.44</td>
<td>1.34</td>
<td>170,399.18</td>
</tr>
<tr>
<td>G/nut + ZATIP</td>
<td>0.89</td>
<td>0.40</td>
<td>1.29</td>
<td>137,782.53</td>
</tr>
<tr>
<td>G/nut + LACRI-9702-IC</td>
<td>0.92</td>
<td>0.56</td>
<td>1.48</td>
<td>229,312.35</td>
</tr>
<tr>
<td>G/nut + EX-BORNO</td>
<td>0.82</td>
<td>0.42</td>
<td>1.25</td>
<td>186,368.63</td>
</tr>
<tr>
<td>2011</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G/nut + SOSAT-C-88</td>
<td>0.84</td>
<td>0.65</td>
<td>1.49</td>
<td>391,099.77</td>
</tr>
<tr>
<td>G/nut + ZATIP</td>
<td>0.81</td>
<td>0.43</td>
<td>1.24</td>
<td>128,374.13</td>
</tr>
<tr>
<td>G/nut + LACRI-9702-IC</td>
<td>0.84</td>
<td>0.66</td>
<td>1.50</td>
<td>214,554.20</td>
</tr>
<tr>
<td>G/nut + EX-BORNO</td>
<td>0.72</td>
<td>0.50</td>
<td>1.22</td>
<td>110,508.37</td>
</tr>
<tr>
<td>Combined mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G/nut + SOSAT-C-88</td>
<td>0.87</td>
<td>0.54</td>
<td>1.41</td>
<td>280,325.52</td>
</tr>
<tr>
<td>G/nut + ZATIP</td>
<td>0.85</td>
<td>0.42</td>
<td>1.27</td>
<td>133,078.33</td>
</tr>
<tr>
<td>G/nut + LACRI-9702-IC</td>
<td>0.88</td>
<td>0.61</td>
<td>1.49</td>
<td>221,933.28</td>
</tr>
<tr>
<td>G/nut + EX-BORNO</td>
<td>0.77</td>
<td>0.46</td>
<td>1.23</td>
<td>148,438.50</td>
</tr>
</tbody>
</table>

RCA = Relative Competitive Ability
LER = Land Equivalent Ratio

DISCUSSION
The result of this two-year study have shown a lack of effect of groundnut on the grain yield and yield component of pearl millet indicating that pearl millet was not adversely affected by the competition with groundnut Willey and Rao, (1981). It had been noted that in intercropping pearl millet with groundnut in the semi-arid zone, pearl millet yield is only reduced if groundnut is planted simultaneously with millet Baker (1996). The sole plot of the pearl millet variety was generally higher than the intercrop combinations. Dugje and Odo,(2006b) opined that in pearl millet/groundnut intercropping in the semi arid-zone, at about latitude 12° the greater the duration
of between the components, the smaller the yield of inter cropped components. On the other hand, at about latitude 13° where the length of the rainy season is shorter, early introduction of the groundnut/ LACRI-9702-IC intercrop compared with the other intercrop combinations presumably because of higher solar radiation capture as results of sparse canopy of LACRI-9702-IC which allow transmission of photosynthetic energy to the lower storey of the groundnut components toward grain development. LACRI-9702-IC/ groundnut intercrop yielded poorly compared with the three varieties Dugje, (2004) attributed the poor yield potential of short pearl millet varieties is due to inadequate root system. Among the pearl millet varieties, SOSAT-C-88 had the highest grain yield and this could be attributed to its relatively greater leaf area, panicle diameter and high grain yield. According Willey and Rao,(1981) an appropriate groundnut cultivar for intercropping with pearl millet in the dry savanna would be the one that is highly competitive and yields both grain and fodder. The highest mean intercrop yield advantage of 26% was recorded using SOSAT-C88/ groundnut and this was due to its high partial LER. The superiority of SOSAT-C-88 was further demonstrated by its higher gross return compared with the intercropping combinations. High gross return is an indication of the complementarily and development of the component of the intercrop Chiezey and Bernard, (2008). The highest gross monetary returns at SOSAT-C-88 and groundnut combinations compared with other intercrop treatments, was due to the highest proportion of groundnut in association with SOSAT-C-88 intercrop which produced both grain and fodder which were higher than the companion millet products. These results agrees with those of Henri et al., (2009) who indicated that higher proportion of groundnut is necessary for higher net returns from cereal- legume intercropping systems. The present results demonstrated that there is a scope for famers to increase pearl millet and system productivity in the sudan savanna by intercropping pearl millet with groundnut (samnut-14). The productivity of the system could be further enhanced by adopting pearl millet variety SOSAT-C-88 and groundnut combination to increased pearl millet productivity without decreasing productivity of the groundnut component and also offered an opportunity for selective input manipulation Reddy et al.,(2003).

REFERENCES
Department of Meteorological Service Federal ministry of Aviation, Maiduguri Nigeria Annual Report (2012) P.22

Henrich C.W.(2013), Preliminary studies of intercropping combinations based on legumes – Cereals. Experimental Agric. 16:29-39


Statistix (2005). Statistical package, version 8.0; Carry U.S.A.