Research Paper

Evaluation of the performance of some improved maize (Zea mays L.) varieties in sweet potato/maize intercrop in Bayelsa State, Nigeria

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ABSTRACT

This study carried out preliminary evaluation of the performance of some improved maize varieties (Saint Marzoca Large, Ama-TZBR-West and TZBR ELD\textsubscript{3}\ C\textsubscript{5}) including Amassoma Local in sweet potato/maize intercrop in Bayelsa State using Randomized Complete Block Design (RCBD) with four replications at Amassoma, Wilberforce Island. Data collected were sweet potato fresh root yield, maize grain yield, 1000 kernel weight and maize plant and ear heights including 50\% tasseling at maturity. The results obtained for sweet potato fresh root yield showed significant differences among treatments (TIS 87/0087/Saint Marzoca Large, TIS 87/0087/TZBR ELD\textsubscript{3}\ C\textsubscript{5}, TIS 87/0087/Ama-TZBR-West and TIS 87/0087/Amassoma Local) with TIS 87/0087/Saint Marzoca Large having the highest (11.71 t ha\textsuperscript{-1}) followed by TIS 87/0087/ TZBR ELD\textsubscript{3}\ C\textsubscript{5}, TIS 87/0087/ Ama-TZBR-West and TIS 87/0087/Amassoma Local with 8.21, 4.8 and 2.11 (t ha\textsuperscript{-1}), respectively. For maize grain yield, there were significant differences among treatments with Saint Marzaco Large having the highest (8.17 t ha\textsuperscript{-1}) followed by Ama TZR-West, TZBR ELD\textsubscript{3}\ C\textsubscript{5} and Amassoma Local with 5.33, 3.21 and 2.11 t ha\textsuperscript{-1}, respectively. Also, for maize 1000 kernel weight, there were significant differences among treatments with TZBR ELD\textsubscript{3}\ C\textsubscript{5}, had the highest (171.0 g) followed by Saint Marzoca Large, Amassoma Local and Ama TZR-West with 163.0, 151.0 and 138.0 g, respectively. Regarding maize plant height, there were significant differences among treatments with Saint Marzoca Large being the tallest (3.9 m) followed by Ama-TZBR-West, Amassoma Local and TZBR ELD\textsubscript{3}\ C\textsubscript{5} with 3.17, 2.3 and 2.12, respectively. For maize ear height, the results obtained showed that treatments were non-significant, although, TZBR ELD\textsubscript{3}\ C\textsubscript{5} had the highest (1.76 m) followed by Amassoma Local, Saint Marzoca Large and Ama TZR-West with 1.55, 1.54 and 1.46 m, respectively. For 50\% tasseling, there were significant differences among treatments with Amassoma Local being highest (75 days) followed by TZBR ELD\textsubscript{3}\ C\textsubscript{5}, Ama-TZBR-West and Saint Marzoca Large with 71, 61 and 55 days, respectively.

Keywords: Zea mays, improved varieties, yield, Nigeria.

INTRODUCTION

Since sweet potato/maize has been known to be a compatible intercrop combination and there were significant differences among the maize varieties with the three performing better than the local, further evaluation in selecting an improved maize variety as component crop is feasible to improve the productivity of maize as well as, income of farmers in sweet potato/maize intercrop cultivation in Bayelsa State, Nigeria.

Sweet potato (Ipomoea batatas L. Lam) is an important crop in daily dietary formulation because of its nutritional value and contains about 70, 1.5, 0.5, 25, 1 and 1\% water, fat, carbohydrate, fibre and ash, respectively, (Martin and
Leonard, 1955). Of the carbohydrates, 3 to 4.5% is sugar and the remainder mostly starch while 0.2 and 0.5% of the ash are calcium and phosphorous, respectively. Also, it contains carotene and fair quantities of ascorbic acid and vitamin B.

Sweet potato (*Ipomoea batatas* L. Lam), the only one of the genus, *Ipomoea* whose roots are edible, is one of the world’s most important food crops because of its high yield, nutritive value and capacity to tolerate marginal environmental conditions (Hahn, 1977; Date and Eronico, 1987).

Regarding utilization, sweet potato cultivation is for human consumption (Hahn, 1977; Horton, 1988; Tewe et al., 2000; Ojeniyi and Tewe, 2003; Odebode, 2004; Asuquo et al., 2005; Odebode et al., 2008), livestock feed (Tewe and Ologhobo, 1983; Woolfe, 1992; Asuquo et al., 1992; Asuquo and Anuebunwa, 1993; Okorji et al., 1996; Okposen et al., 1996; Onwubuemeli et al., 1996), industrial processing to make alcohol and starch (Martin and Leonard, 1955; Prain et al., 1997) including fish (Madugba et al., 2005), while the whole plant is a natural weed suppressant and is medicinal in combating blindness and diabetes in humans (Low et al., 1996; Carey et al., 1999).

Maize (*Zea mays*), the third most important cereal crop in the world, is an important dual purpose crop for human diet including animal feeds as well as, industrial processing and contains 1.2, 9.2, 3.9, 73.7, 1.6 and 1.2% water, protein, fat, carbohydrate, fibre and ash, respectively, (Martin and Leonard, 1955). Kastner (2008) indicated maize as the most domesticated of all field crops ranked as the second largest cereal crop in the world surpassed only by wheat. It is important in world economy and trade as food, feed and industrial crop. Like soybean, world maize production is concentrated in a few countries unlike other crops with U. S. producing 41% and China the next largest producer followed by Brazil including European Union making these countries produce over 60% of 524.17 million tonnes globally (Taylor and Koo, 2012).

In Nigeria, where maize ranks third after sorghum and rice with its production mostly concentrated in the Southern Guinea Savanna and Forest Zone (Raemakers, 2001), maize grin production was 5.3 million metric tons (USDA, 2012). Regarding maize consumption, it is projected to increase by 50% globally and 90% in sub-Saharan Africa from 1995-2000 (Abebe et al., 2005). However, Aquino et al. (2001) reported that although much of the global increase in maize use was for animal feed, human consumption was increasing and accounted for 70% in sub-Saharan Africa. Taylor and Koo (2012) reported that world maize consumption increased by 52% between 1992 and 2010 with European Union, United States and China having the largest growth in consumption due mainly to growth in the livestock sector and maize-based ethanol production in China and United States, respectively.

It has the potential of supplying large amounts of energy-rich forage for animal diets and its fodder can safely be fed at all stages of growth without any danger of oxalic acid and prussic acid as in the case of sorghum (Dahmardeh et al., 2009). Therefore, forage maize has become a major constituent of ruminant rations in recent years and its inclusion in dairy cow diets improves forage intake, increases animal performance and reduces production cost (Anil et al., 2000).

Intercropping which is the growing of two or more crop species simultaneously in the same field during a growing season (Andrew and Kassam, 1976; Ofori and Stern, 1987) has many advantages over sole cropping. It provides an efficient utilization of environmental resources (Willey et al., 1983; Francis, 1989; Beets, 1990; Innis, 1997; Anil et al., 1998) as well as, higher crop yields and greater financial stability to farmers (Ifenkwe et al., 1989; West and Griffith, 1992; Seran and Brintha, 2009). Also, it reduces soil erosion (Beets, 1990; Chukwu et al., 1996; Kariaga, 2004; Reddy and Reddi, 2007) and risk to the cost of production (Woolley and Davis, 1991), decreases pest damage (Brown, 1935; Power, 1990; Flett et al., 1996; Herick and Pector, 1997), suppresses weed growth more than monocultures (Mongi et al., 1976; Altieri and Liebman, 1986; Beets, 1990; Zuofa, 1992), improves soil fertility through nitrogen increase to the system (Adu-Gyamfi et al., 2007) including forage yield and quantity (Francis et al., 1976; Willey, 1979; Toniolo et al., 1987).

The intercropping system is suitable for the smallholder who depends on maize as staple crop and the best system to implement will ultimately depend on the location, the cultural practices and the objectives of the farmer. Where intercropping is not practiced, introducing intercropping with a plant that is already known to the farmer reduces the amount of education needed to introduce a new crop species. Before introducing a new crop to farmers, it is important to determine if the crop will be utilized with its existing in the traditional farming operations, intercropping sweet potato and maize is expected to maximize the utilization of scarce resources and thereby increase the farmer’s income. Although maize has been intercropped with other vegetable cover crops and food crops, there seems to be a dearth of information on intercropping with sweet potato. However, a combination of the two crops will encourage two cropping seasons on the same land since they are both short duration crops.

In Nigeria, the cultivation of sweet potato is now coming
into prominence and thorough observation shows that it is extensively grown more in the northern than southern states. Also, it has been found to be available in varying quantities in the appropriate local market all-the-year-round. Intercropping sweet potato, a high calorie food is for its tuberous root as source of carbohydrate, vitamins and minerals, feed including agro-industrial raw materials (Wolfe, 1992; Martin, 1982) and ensures supply of dietary carbohydrate, vitamin and minerals to the rural populace.

Being native to the world, maize and sweet potato have been cultivated together in polyculture for thousands of years. However, these agricultural practices are principally a means of enhancing land utilization and are believed to hamper the development of populations of insect pests of maize which may cause significant yield losses (Holl et al., 2000). Also, insect pest densities are decreased when maize is grown in diversified cropping system.

Mkamilo (2004) recommended planting of maize plants and sweet potato to increase maize yield in both sole cropping and intercropping with sweet potato. However, for sweet potato/maize intercropping, Amede and Nigatu (2001) recommended use of an early-maturing maize variety and shade-tolerant sweet potato variety, planting maize and sweet potato simultaneously at the beginning of the rainy season as locally practiced and planting maize at 25 cm spacing in rows 75 cm apart, sweet potato midway between maize rows with an intra-row spacing of 30 cm and weeding is, especially, important at the beginning of the season. In addition to harvesting maize ears and sweet potato fresh roots, sweet potato vines may be used as fodder.

Sweet potato is a common intercrop combination in the semi-arid Rift Valley of East Africa and Nigeria. National Root Crops Research Institute (NRCRI) scientists Chinaka (1983) and Nwinyi (1991) reported sweet potato/maize intercropping but that sweet potato does well under shade and would best be mixed with other crops in alternate rows.

Since maize and sweet potato require plenty of water, early planting comes up in March-April and late planting in July-September. However, planting of sweet potato and maize simultaneously gives better yield. Amede and Nigatu (2001) found that planting maize and sweet potato simultaneously did not influence maize grain yields whereas late planting of sweet potato negatively affects maize yield. Also, maize has been recognized as a common component in most intercropping systems and seems to dominate as the cereal component of intercrop and it is often combined with different root crops and cover crops (Anil et al., 1998).

Sweet potato/maize intercropping has many advantages. Fisher (1979) found that popondo (Phaseolus lunatus) and mucuna (Mucuna utilis) lower maize yield while sweet potato (Ipomoea batatas) and green grain (Phaseolus aureus) had much less effect on maize and were themselves tolerant to maize shade. Maize/sweet potato intercropping suppresses weeds and insures against total crop failure when one crop fails (Mongi et al., 1976). Also, intercropping maize/sweet potato reduces stem borers (Henrick and Pecter, 1997). Maize leaf hopper (Dalbulus maidis L.) was reduced under intercropping (Power, 1990). Brown (1935) noted that Louisiana budworm infestation in pure maize was greater than in maize associated with sweet potato. Trenbath (1993) reported that insects and diseases were high in monocropping as compared to intercropping and Singh and Adjeigbe (2002) stated that monocropping needs more chemicals to control pest and diseases than intercropping.

Intercropping controls soil erosion by preventing raindrops from hitting the bare soil where they tend to seal surface pores, prevent water from entering the soil and increase surface erosion. In maize/sweet potato intercropping, sweet potato acts as best cover crop and reduces soil erosion. Some scientists (Kariaga, 2004; Reddy and Reddi, 2007) stated that taller crops act as wind barrier for short crops. Rows of maize in a field with shorter crops will reduce the wind speed above the shorter crops and, thus, reduce desiccation.

Usually, intercropping gives higher yields compared to monocropping. Mutsaers et al. (1993) found that maize/sweet potato intercropping performed better than sole sweet potato. Also, Ifenkwe et al. (1989) found that maize was not affected by maize/sweet potato intercropping. Equivalent yield over sole maize yield and kernel yield of maize were unaffected in maize/sweet potato intercropping. West and Griffith (1992) observed that maize yield was increased by 20% in maize/sweet potato strip intercropping and, in maize intercropping, maize yield was not affected.

Yield is taken as primary consideration in the assessment of the potential of intercropping practices. Anil et al. (1998) found that by intercropping, land was effectively utilized, while yield was improved. The crops are grown together because of higher yield and greater biological and economic stability in the system (Seran and Brintha, 2009). When two crops are grown together, yield advantages occur due to difference in their use of resources (Willey et al., 1983). Maize yield was not affected by intercropping with sweet potato (Mahta and Dey, 1980). Also, Beets (1990) found that multiple-cropping systems increase the soil production by increased vegetative growth during critical erosion period.

In Nigeria, maize is often intercropped with cassava, cocoyam, sweet potatoes, yam cowpeas or vegetables (Udeolar, 2005). However, it usually matures earlier and farmers use it for dishes during starvation period in rural areas. Since there is prevalence of planting sweet potato/maize intercrop with various yield effects farmers use local maize varieties which are low-yielding in Nigeria, particularly, Niger Delta. The objective of this study, therefore, was to carry out preliminary evaluation of the performance of some improved maize varieties in sweet
Table 1: Means for sweet potato fresh root yields including maize yield and 1000 kernel weight at Amassoma, Wilberforce Island in 2012.

<table>
<thead>
<tr>
<th>Crops combination</th>
<th>Sweet potato Fresh root (t ha⁻¹)</th>
<th>Maize grain yield (t ha⁻¹)</th>
<th>1000 kernel weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIS 87/0087/Saint Marzoca Large</td>
<td>11.71</td>
<td>8.17</td>
<td>163.0</td>
</tr>
<tr>
<td>TIS 87/0087/TZBR ELD3CS</td>
<td>8.21</td>
<td>3.21</td>
<td>171.0</td>
</tr>
<tr>
<td>TIS 87/0087/Ama-TZBR-West</td>
<td>4.83</td>
<td>5.33</td>
<td>138.0</td>
</tr>
<tr>
<td>TIS 87/0087/Amassoma Local</td>
<td>2.11</td>
<td>2.29</td>
<td>151.0</td>
</tr>
<tr>
<td>LSD.05</td>
<td>2.42</td>
<td>2.28</td>
<td>12.79</td>
</tr>
</tbody>
</table>

potato/maize intercrop in Bayelsa State, Nigeria.

MATERIALS AND METHODS

This study was conducted at the Niger Delta University, Teaching and Research Farm Amassoma, Wilberforce Island, Bayelsa State, located in South-South Nigeria tropical area between latitudes 5° and 6.05° East and longitudes 26° and 5° North. The altitude is 122 m above sea level and the soils are classified as Typic Paleudult derived from Coastal Plain Sands. The soils are acidic and deficient in nitrogen including potassium with the topsoil (0 to 20 cm) as loam texture.

The experiment was laid out in a Randomized Complete Block Design (RCBD) with four treatments of maize varieties intercropped with sweet/potato in each of three replications. After land clearing and harrowing, one variety of sweet potato (TIS 87/0087) from National Root Crops Research Institute (NCRI), Umudike, Nigeria was intercropped with three improved maize varieties (Saint Marzoca Large, TZBR ELD₃ Cs and Ama-TZBR-West) from International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria and a local variety (Amassoma Local).

Sweet potato vines with four nodes were planted on the crest of ridges at 1 × 0.5 m spacing (20, 000 plants ha⁻¹) and alternating maize row at 1 × 0.5 m spacing with three maize seeds per hole and, later, thinned to two plants per stand (20, 000 plants ha⁻¹). Weeding was at 3 weeks after planting (W. A. P.) and NPK 3: 20: 3 Neem-based organic fertilizer applied at 400 kg ha⁻¹ by side-dressing. The second weeding was at 8 W. A. P. and no longer weeded after sweet potato’s full vegetative cover.

Data collected were sweet potato fresh root yield, maize grain yield and 1000 kernel weight, maize plant and ear heights including 50% tasseling at maturity and harvest. Data were subjected to analysis of variance (ANOVA) and Least Significant Difference (LSD) at 5% probability level used to compare treatment means.

RESULTS AND DISCUSSION

Table 1 shows sweet potato fresh root and maize grain yields including 1000 kernel weight from the sweet potato/maize intercrop. The results obtained for sweet potato fresh root yields showed significant differences among treatments (TIS 87/0087/Saint Marzoca Large, TIS 87/0087/TZBR ELD₃ Cs, TIS 87/0087/Ama-TZBR-West and TIS 87/0087 Amassoma Local) in which TIS ELD₃ Cs TIS 87/0087/Amassoma Local with 8.21, 4.83 and 2.11 t ha⁻¹, respectively, indicating differential effect of maize varieties on sweet potato yield in the intercrop.

Also, for maize grain yields (Table 1), there were significant differences among treatments (TIS 87/0087/Saint Marzoca Large, TIS 87/0087/TZBR ELD₃ Cs, TIS 87/0087/Ama-TZBR-West and TIS 87/0087 Amassoma Local) with Saint Marzoca Large having the highest (8.17 t ha⁻¹) followed by Ama-TZBR-West, TZBR ELD₃ Cs and Amassoma Local with 5.33, 3.21 and 2.29 t ha⁻¹, respectively. However, Saint Marzoca Large was significantly different from others while Ama-TZBR-West was significantly different from Amassoma Local but non-significantly different from TZBR-ELD₃ Cs and TZBR-ELD₃ Cs. For maize 1000 kernel weight, there were significant differences among treatment with TZBR ELD₃ Cs which had the highest (171.0 g) followed by Saint Marzoca Large, Amassoma Local and Ama-TZBR-West with 163.0, 151.0 and 138.0 g, respectively. Although Ama-TZBR-West was non-significantly different from Saint Marzoca Large, it was significantly different from others and Saint Marzoca Large non-significantly different from Amassoma Local but significantly different from Ama-TZBR-West.

Since West and Griffith (1992) reported that planting sweet potato intercropping maize yield was not affected and Amede and Nigatu (2001) also reported that planting sweet potato and maize simultaneously did not influence maize grain yields the significant differences among maize varieties for yield and 1000 kernel weight could be due to the varieties. With TIS 87/0087/Saint Marzoca Large treatment being the highest for sweet potato fresh root and maize yields, this appears promising followed by TIS 87/0087/TZBR ELD₃ Cs and Ama-TZBR-West.

Table 2 shows the mean plant and ear heights including 50% tasseling. The results obtained showed significant differences among treatments for maize plant height with Saint Marzoca Large being the tallest (3.9 m) followed by
Table 2: Means for maize plant and ear heights including 50% tasseling at Amassoma in 2012.

<table>
<thead>
<tr>
<th>Crops combination/treatment</th>
<th>Maize plant height (m)</th>
<th>Maize ear height (m)</th>
<th>50% tasseling (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIS 87/0087/Saint Marzoca Large</td>
<td>3.9</td>
<td>1.54</td>
<td>55</td>
</tr>
<tr>
<td>TIS 87/0087/TZBR ELD3C5</td>
<td>2.3</td>
<td>1.76</td>
<td>71</td>
</tr>
<tr>
<td>TIS 87/0087/Ama-TZBR-West</td>
<td>3.17</td>
<td>1.46</td>
<td>61</td>
</tr>
<tr>
<td>TIS 87/0087/Amassoma Local</td>
<td>2.12</td>
<td>1.55</td>
<td>75</td>
</tr>
<tr>
<td>LSD.05</td>
<td>0.42</td>
<td>-</td>
<td>1.24</td>
</tr>
</tbody>
</table>

Ama-TZBR-West, TZBR ELD3C5 and Amassoma Local with 3.17, 2.3 and 2.12 m, respectively. In addition, the significant differences among the maize varieties could be varietal. For maize ear height, treatments were non-significant although TZBR ELD3C5 was highest (1.76 m) followed by Amassoma Local, Saint Marzoca Large and Ama-TZBR-West with 1.55, 1.54 and 1.46 m, respectively.

Regarding number of days to 50% tasseling, there were significant differences among treatments (Saint Marzoca Large, TZBR ELD3C5, Ama-TZBR-West and Amassoma Local) with Amassoma Local having the highest (75 days) followed by Amassoma Local, Saint Marzoca Large and Ama-TZBR-West with 1.55, 1.54 and 1.46 m, respectively.

Because the maize varieties were significantly different for number of days to 50% tasseling and, compared to Amassoma Local and TZBR ELD3C5, Saint Marzoca Large would be regarded as early-maturing and, still, appears promising to farmers in line with the findings of Amede and Nigatu (2001) who reported using early-maturing maize variety in sweet potato/maize intercrop as beneficial.

**Conclusion**

Generally, the results from the study showed the improved varieties as better intercrops with sweet potato regarding yield and earliness and, therefore, appear more promising as compared to the local variety. Since sweet potato and maize have been known to be a compatible intercrop combination and there were significant differences among the maize varieties with the three improved varieties performing better than the local, with further evaluation, selecting an improved maize variety appears feasible to improve the productivity of maize as well as, income of farmers in sweet potato/maize intercrop cultivation in Bayelsa State.

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