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Evaluating for High Beta Carotene Variety Sweet Potatoes in the Guinea Savanna of Ghana

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ABSTRACT

Studies were conducted at the Savanna Agricultural Research Institute (SARI), Nyankpala to evaluate high Beta-carotene sweet potato varieties. Beta-carotene-rich (orange-fleshed) sweet potato is one of a few new crops, which is an excellent source of energy and important nutritive substances that can contribute to improve the nutrient status of communities. The crop is being promoted in the developing world as a source of provitamin-A towards alleviating vitamin-A deficiency (VAD). Most of the varieties available to farmers in the Guinea Savannah of Ghana are white and creamy-fleshed with high dry matter content and low levels of vitamin A which is very important in promoting human health. Orange-fleshed sweet potato (OFSP) varieties are known to performing very well in respect to high beta carotene content which is a food-based cheap source of beta-carotene, a precursor of Vitamin A. The aim of this work is to select high yielding beta-carotene sweet potato to meet farmers' food security and nutritional needs in the guinea savannah region. Twelve (12) varieties of sweetpotato were evaluated in a randomized complete block design experiment with three (3) replications during the 2010 and 2011 rain seasons. Treatments were the 12 different varieties of sweet potatoes. After 4 months of growth period, the plants were harvested and yield results indicated significant differences ($P<0.05$) among the varieties in root tuber number, marketable roots weight, vine weight, dry matter and total root yield. Apomuden, which is an orange-flesh sweetpotato produced the highest root tuber yield of 19.81 t/ha and the highest marketable roots tuber number of 32, significantly higher than the local check Nasamu Red Vine, a cream flesh type. The orange-flesh variety produced higher root tuber yield but indicated the lowest dry matter yield of roots. The findings

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shows high root yield potential of orange-flesh varieties than the cream and the white types.

INTRODUCTION

Sweet potatoes (*Ipomoea batatas* (L.) Lam) is an important crop in many parts of the world. It is cultivated in more than 100 countries (Woolfe, 1992). It is one of only seven world food crops with an annual production exceeding 100 million metric tonnes per year, ranking 13th globally in production value among agricultural commodities (Collins, 2005). Sweet potatoes have high nutritional value, with the exception of protein and niacin. It provides over 90% of the nutrient per calorie required by most people (Watt and Merill, 1975). The root tubers are rich source of carbohydrate and higher calories than wheat, rice or cassava. The increasing potential of sweet potato in poverty alleviation and food security due to its high productivity per unit area and time makes it an important crop for the poor (NRCRI, 2003). Sweet potato is now being used in Africa to combat widespread vitamin A deficiency that causes blindness and death for 250,000-500,000 African children a year.

Available statistics indicates that Ghana produced over 90,000mt of sweet potato in 2002 and all was consumed (FAOSTATS, 2005). In Ghana sweet potato is grown by peasant and small-holder farmers scattered in upper East and Central-regions. These two regions in Ghana produced about 93603 metric tonnes (SRID, 2007). Sweet potato is a minor root crop traditionally grown among the poorest Ghanaians especially in Northern Ghana and it is crucial to their food security (IFAD, 2007). Sweetpotato cultivars differ from one another in the colour of the tuber skin, colour of the tuber flesh, shape of the tuber, shape of the leaves, rooting depth, time of maturity, resistance to disease and other vegetative characteristics (Onwueme, 1978). Most of the varieties available to farmers in Ghana are white and cream fleshed with high dry matter content and low levels of vitamin A which is very important in promoting human health. Orange-fleshed sweet potato (OFSP) varieties are known to performing very well in respect to high beta carotene content

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which is a food-based cheap source of beta-carotene, a precursor of Vitamin A. Currently, there is considerable interest in promoting the production of orange-fleshed sweet potato (OFSP) varieties as a source of beta-carotene that the body uses to produce Vitamin A. Vitamin A deficiency (VAD) is prevalent in many parts of Sub-Saharan Africa and is a leading cause of early childhood death and a major risk factor for pregnant and lactating women (VITAA 2005). Evidence exists that the orange-fleshed varieties may also have a major impact on other diseases, such as limiting the transmission of the HIV/AIDS virus from pregnant mothers to their babies and of anaemia (low amount of red blood cells) and malaria (FAO, 2010; Stathers *et al.,* 2005).

The recent introductions of white and orange- fleshed clones of sweetpotato require a study to match varieties with locations in Ghana. Significant sweet potato yield differences due to variety and environmental conditions have been reported in studies carried out in Kenya and other parts of the world (Ndamage, 1987; Ajanga, *et al.*, 1992; Irungu and Kidanemariam 1992). The varietal and environmental responses are attributed to differences in pest and disease attack, soil fertility, management practices, genetic variability and rainfall. Most sweet potato varieties produced in Ghana are local varieties that are adaptable to the local growing conditions but are low yielding and susceptible to sweet potato weevils and feathery mottle virus. In addition most local sweet potato landraces are white or cream - fleshed and therefore supply little or no pro-vitamin A. Continued use of the local varieties has led to vitamin A deficiency, especially among children, and increased risk of blindness. According to Low *et al.,* (2008), 100g of orange-fleshed sweet potato (OFSP) can provide enough beta carotene to produce from 0-100% of the suggested daily Vitamin A requirement (350 µg) per day for infants and young children. The objective of the experiments was therefore to select high yielding beta-carotene sweet potato varieties as contributing efforts in promoting orange-fleshed sweet potato (OFSP) to meet food security and nutritional needs in the guinea savannah region.

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MATERIALS AND METHODS

The experiments were conducted at the experimental field of the Savanna Agricultural Research Institute (SARI), Nyankpala near Tamale in the Guinea Savanna during the 2010 and 2011 full cropping seasons. The experiment of the 2010 rainy season was planted in mid July, while that of the 2011 season was planted in late June. Rainfall was high and well distributed during the cropping season (Table 1). Physical properties of soil consisted of 83% sand, 12.45% silt and 4.55% clay. In experiments 1 and 2, a randomized complete block design was used with three replications and twelve (12) treatments. The experimental treatments were the twelve (12) varieties, in which 1 was a local cultivar (Nasamu-red vine, NRV), 5 varieties (Apomuden, Otoo, Ogyefo, Junkwa Orange and Santompona) are cultivars developed at the Crops Research Institute in Kumasi and 6 are introduced varieties from Cuba, Tanzania and Uganda. The experimental field was ploughed and harrowed, vines cuttings of 20cm long, with 4 to 6 nodes depending on the variety were planted on prepared ridges in a plots area of 20 m^2 per treatment, made up of 4 rolls per plot. A population of 68 plants per plot were planted and net plots of 8.8 m^2 were harvested from each treatment for evaluation. Yield parameters from each plot were recorded and the following characters such as vine length, weight of vine, number of tubers per plant, weight of tubers per plant, percentage dry matter of tuber and yield of tuber (t/ha). The data, obtained for different yield and yield components were statistically analysed using analysis of variance and significant means were compared using Duncan's multiple range tests.

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Table 1: Climatic data during the experimental period

Month	Mean Maximum Temprature^{0}C	Mean Maximum Relative Humidity %	Total Rainfall (mm)	Rainy days
2010				
June 8	32.9	93	180.9	
July 12	30.0	94	151.9	
August 15	30.3	94	330.8	
September 19	29.8	96	184.0	
October 15	32.4	92	156.8	
2011				
June 11	32.2	91	250.9	
July 8	30.6	93	145.7	
August 14	29.7	94	255.7	
September 13	31.0	93	210.1	
October 8	32.7	89	102.4	

RESULTS AND DISCUSSIONS

Performances of the varieties were measured in terms of yield and yield parameters during the two growing seasons. Results showed significant differences ($p<0.05$) among the varieties in vine weight, number of root tubers per plant, marketable root tuber number, total root yield and dry matter percentage.

Vine weight

Okerewe produced the highest biomass (Figure 1.) in both seasons, recording values of 16.9 t/ha and 15.8 t/ha in 2010 and 2011 seasons respectively. Junkwa orange recorded biomas of 15.5 t/ha in 2010 season but as low as 3.1 t/ha in the 2011

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season. Nasamo red vine, the local check, recorded consistently low biomas of 7.2 t/ha and 4.2 t/ha in the 2010 and 2011 seasons respectively. However, Junkwa orange recorded the lowest biomass of 3.1 t/ha in the 2011 season. The high biomas records of Okerewe and Junkwa orange could be exploited for the production of fodder production for livestock feeding.

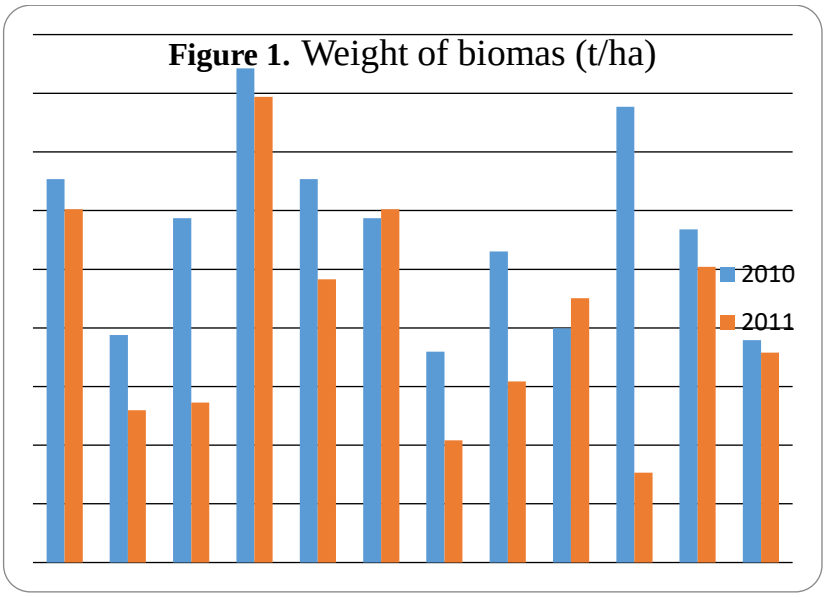

Figure 1. Weight of biomas (t/ha)

Root tuber number

Apomuden, which is an orange-flesh sweet potato, produced the highest root tuber number (75) resulting in the highest root yield of 19.8 t/ha (Figure 2) in the 2010 and 2011 rainy seasons. The local check variety, NRV, recorded the highest total number (59 tubers) of roots in the first year of evaluation, which was not statistically different from that of Apomuden, which recorded 58 root tubers, hence, did not result in higher yields for the local check variety. Carrot-C recorded no root tubers, producing what is termed “pencil roots” during the two years of evaluation.

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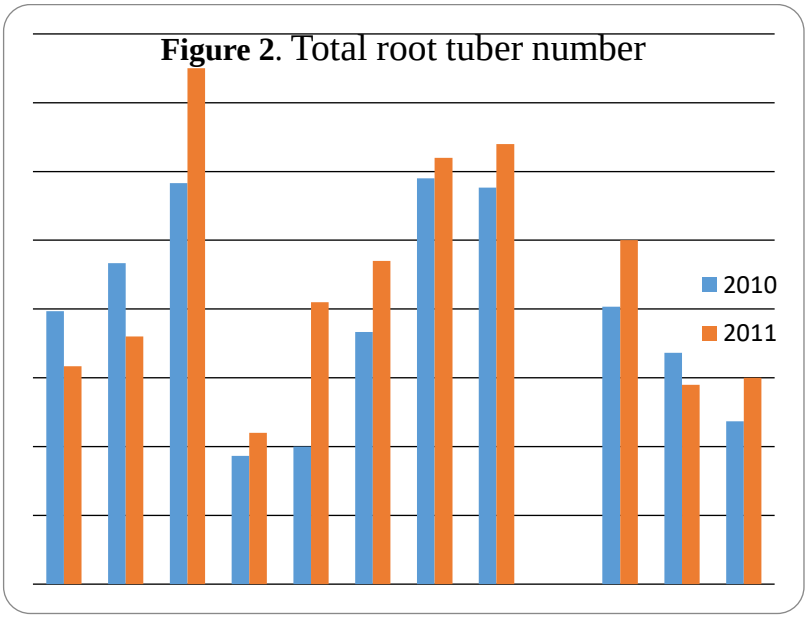

Figure 2. Total root tuber number

Root yield/ Tuber weight

The 2011 season recorded an improved general yield performance in all the sweetpotato varieties evaluated, than the 2010 season (Figure 3.). Apomuden recorded the highest root weight which could be due to inherent hardiness of the variety that makes them capable of high yield even in harsh weather conditions. (Woolfe, 1992). In the two years of planting, Apomuden recorded the highest of 12.84 t/ha root yield in the 2010 rainy season. Similarly, the highest (19.81t/ha.) root yields for the 2011 season was also recorded by Apomuden. Even though NRV recorded the highest tuber number in 2010, it did not record higher root yield in 2010. This is attributed to smaller sizes of the root tubers produced compared to that of Apomuden. Carrot-C recorded zero (0 kg) yields in the 2010 season and 1.1 t/ha in the 2011 season.

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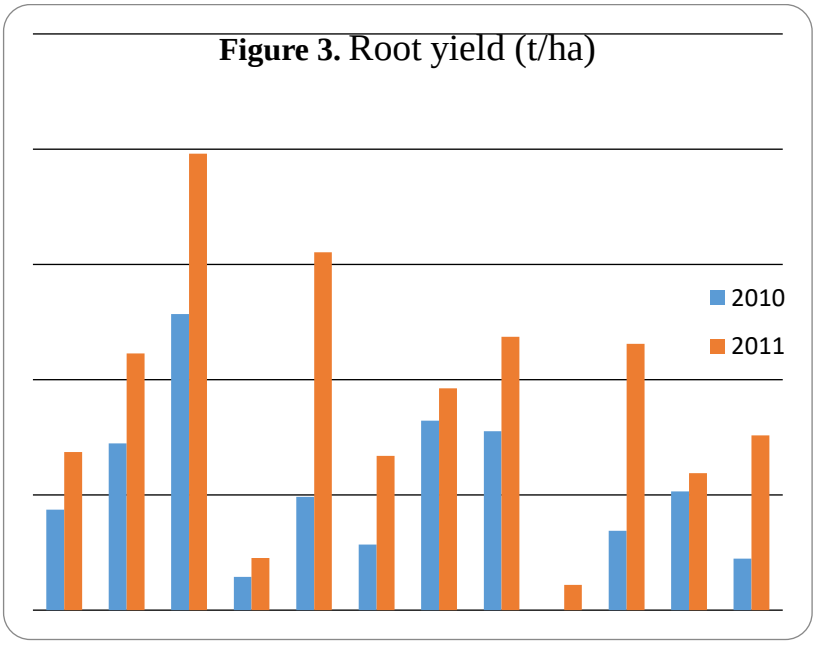
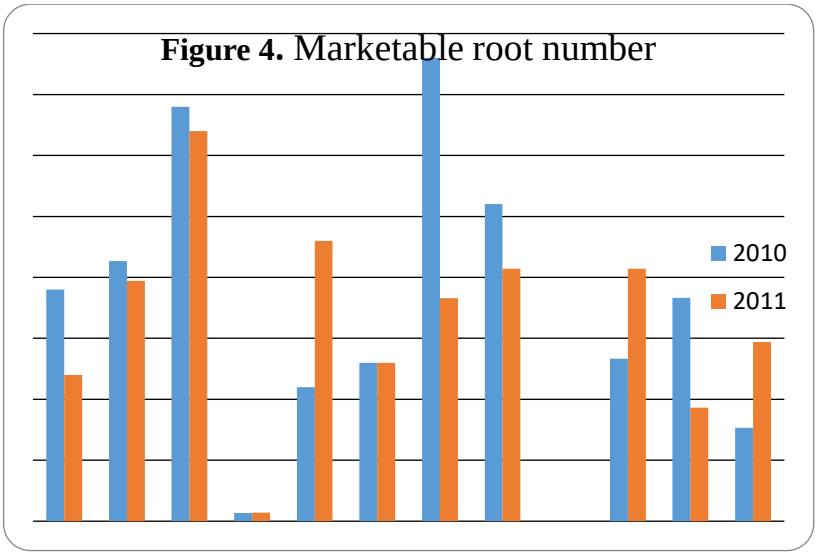


Marketable roots

The local check, NRV recorded the highest of 38 marketable root tuber sizes of average 440grams and above in weight, in the 2010 season (Figure 4.), recording as low as 18 root tubers in 2011 season. Apomuden recorded statistically similar number of marketable root tuber sizes as the local check in the 2010, but significantly highest in the 2011 season. Carrot-C recorded zero (0) number of root tubers for the two seasons of evaluation.



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Dry matter percentage

Despite the higher yields recorded by Apomuden, the dry matter (DM %) percentage was the lowest among the genotypes (Figure 5). Apomuden recorded the lowest DM % of 22.2 % in the root tubers in both 2010 and 2011 rainy seasons. Cemsa 72-228 recorded the highest root tuber dry matter percentage of 42.5 % in the 2011 rainy season, while Okerewe recorded the highest root tuber dry matter percentage of 42.13%.

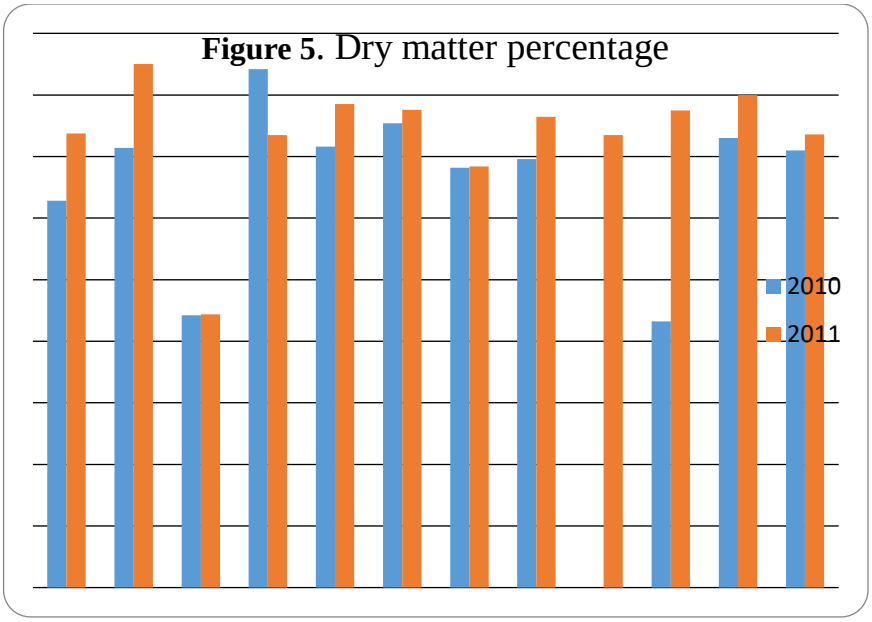

Figure 5. Dry matter percentage

CONCLUSION

Apomuden recorded the highest performance in terms of number of root tubers, as well as number of marketable root tuber sizes and total root tuber yields consistently in the 2010 and 2011 rainy seasons, which out-performed the local check variety (NRV) in terms of yield and other yield attributes. Apomuden seems to be the most promising orange-fleshed sweet potato (OFSP) variety hence it's recommended for further on-farm trials and eventual release to farmers. This will promote easy-to-cultivate Vitamin rich OFSP as supplement in food of children and adults. Kemb 37 and Santompona recorded relatively low yield and yield parameters, but could be

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evaluated further for other qualities. Okerewe which produced the highest biomass in both seasons could be evaluated for other purposes.

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