EVALUATION OF POLYCROSS SWEETPOTATO SEEDLINGS FOR ROOT YIELD POTENTIAL, FLESH ROOTS COLOUR AND RESPONSE TO MAJOR SWEETPOTATO DISEASES

Nwankwo. I.I.M., Afuape, S.O and Nwaigwe, G.O

National Root Crops Research Institute, Umudike, Umuahia, Abia State
Corresponding e-mail address: nwankwomaxwell@yahoo.com

ABSTRACT
The study aimed at determining the root yield potential of the sweetpotato seedlings, the variation in storage root flesh colour and response of the storage roots to major pests and diseases attacking sweetpotato in the field .The experiment was carried out in the screen house and at the Eastern experimental field of National Root Crops Research Institute Umudike, Abia State, Nigeria. The result indicated that total number of seedlings from various families that produced storage/ enlarged roots ranging from 1 - 10 per stand were of high percentage (95.23%) when compared with those seedlings without storage/enlarged roots (4.87%). It showed evidence of yield potential of the seedlings and adaptability of the seedlings to the field conditions. The result from the study also identified the family MUSG 0608-61with superior root yield potential of 0.63kg per stand equivalent to 21.0t/ha of fresh root yield to other families and was rated as the highest top yielder according to National Agricultural Research Organization (NARO) classification. However, a total of 66.19% of colour variation among the seedlings in the families were orange fleshed genotypes with the 84.3% from the family MUSG 066-6-15 and 70.18% from the family NCPP573, 50-17-02 which indicated that majority of the seedlings from various families were mainly Orange fleshed genotypes. Farmers who wish to incorporate orange fleshed sweetpotato genotypes in their farming systems should do so especially from these two families that have high percentage of orange fleshed seedlings. All the 739 sweetpotato seedlings from the five families responded negatively to field viral and nematode infection. The 6.2% of the storage roots seedlings from the family MUSG 0614-22 responded moderately to the attack of Sweetpotato root weevil (score rate 3) while only 3.6% of seedlings in the family of MUSG 066-6-15 showed mild symptom (score rate 2) of attack of Sweetpotato root weevil. This result indicated that the seedlings in the two families were not totally resistant to the attack of Sweetpotato root weevil

Keywords: sweetpotato seedlings, yield potential, variation in flesh colour, major pests and diseases.

INTRODUCTION
Wilson (1970) defined the sweetpotato root tuber as the localized lateral swelling that develops in certain roots in sweetpotato root system. The sweetpotato root system consists of fibrous roots that absorb nutrients and water and anchor the sweetpotato plant firmly in the soil and storage roots are lateral roots which store photosynthetic products. The root system in sweetpotato plant obtained by vegetative propagation starts with adventitious roots that develop into primary fibrous roots which branch into lateral roots. As the plant mature, thick pencil roots that have some lignification are produced. Other roots that have no lignification are fleshy and thicken a lot are called storage roots.

Sweetpotato plants grown from true botanical seeds form a typical root with a central axle with lateral branches. Later on, the central axle functions as a storage root (Zossimo, 1992). The sweetpotato storage roots are the commercial part of the sweetpotato plant above 100g or 4cm in diameter that could be sold in the market for income. Some sweetpotato cultivars produce storage roots at the nodes of the mother vines. The very spreading cultivars, however, produce storage roots at some of the nodes that come in contact with the soil. Sweetpotato storage roots vary in shape and size according to cultivar, type of soil and the storage root skin colour can be whitish, cream, yellow, orange, pink, red, red purple and very dark purple (Huaman, and Asmat (1999). The intensity of the skin colour depends on the environmental factors where the plant is grown.

The root flesh colour can be whitish, cream, yellow or orange. Some cultivars show root flesh colour that is purple, red purple pigmentation in the flesh in very few scattered spots, pigmented rings or in some cases, throughout the entire flesh of the root. Sweetpotato roots with its genetic diversity provide sweet and non-sweet varieties of varying colours (white, yellow, cream, purple and orange). Orange fleshed cultivars can contribute to the food security solution by improving food quality and availability, accessibility and utilization. The orange fleshed sweetpotato is extremely rich in bioavailable beta-carotene, which the body converts into vitamin A. (retinol) at a ratio of 12 to 1. According to Sweetpotato knowledge (2012), one small root (100 - 125 grams) of most Orange Fleshed Sweetpotato (OFSP) varieties can supply the recommended daily allowance of vitamin A for children under five years of age. In addition, OFSP contributes significant amount of vitamins C, E, K and several B vitamins. The leaves also have good micronutrient contents and adequate protein (4%) for use as food and animal feed. Sweetpotato is also a good source of dietary fiber (2.5 - 3.3g/100gm), and is classified as a low glycemic index food (Sweetpotato knowledge, 2012).

Meeting food supply needs caused by rapid population growth and rising urbanization rates across the country requires not only increased agricultural output, but also the provision of a wide range of diverse foods to meet the micronutrient requirements of children and adults. Sweetpotato roots although bulky and perishable, can contribute to improved food availability in situation of land scarcity, farmers increasingly turned to crops like sweetpotato that provide high output per unit area and can produce on marginal soils. Improved early maturing sweetpotato varieties are ready in 2 - 3 months, the crop can be harvested as needed over several months and in many settings, 2 - 3 crops can be produced annually. All these could be feasible by hybridization and selection of high yielding genotypes at the early seedling stage. Therefore, the aim of this work was to determine the root yield potential of the sweetpotato seedlings, the variation in storage roots flesh colour and response of the storage roots to major pests and diseases attacking sweetpotato in the field.

MATERIALS AND METHODS

The experiment was carried out in the screen house and at the Eastern experimental field of National Root Crops Research Institute Umudike, Umuahia- Abia State, Nigeria. The site for the experiment was located in the rainforest vegetation of agro-ecological zone of Southeastern Nigeria, at latitude 7^0 32"E and longitude 5^0 28"N of the equator on an elevation of 122 metres above sea level. The average annual rainfall was 2200mm. The air temperature varies from 22 to 32^0C while relative humidity varies from 2.69 to 7.8% per day and the sunshine hours were at the average of 4.95 (Agrometrological Station of NRCRI Umudike, 2013). The dominant soil is acid sandy loam in the ultisol group (FDALR, 1985).

The seeds collected from open pollination of sweetpotato plants from the hybridization block were dried and stored in sealed envelopes for one year under room temperature without treatment for seed weevil (bruchid). The seeds were raised in the Screen house of National Root Crops Research Institute, Umudike, Abia State. First, the seeds were poured into a plastic container of 250ml capacity containing solution of water and Omo detergent. The solution is then stirred in a circular way producing a whirlpool. This was to allow all the seeds to submerge. After about 4 - 5 minutes, all floating seeds are discarded by pouring off part of the solution. This method allowed for the selection of good seeds for planting. The seeds that settled at the bottom of the plastic container were collected and sown immediately into the filledblack polybags measuring 4cm by 6cm perforated at the bottom. The bags were filled with topsoil mixed with poultry manure and then watered with watering can, allowed to settle before sowing. The seeds were sown one seed per polybag by hand at 2cm deep. The nursery was watered twice a week and kept weed-free throughout the experiment. The sweetpotato seedlings were later transferred to the Eastern experimental field of the Institute 30days after sowing to observe the field performance.

The area for the field experiment was slashed, ploughs, harrowed and ridged. The ridges were spaced 1.0m apart and the seedlings were planted on the crest of the ridges 1.0m x .3m. The seedlings from the five sweetpotato families were replicated thrice in a randomized complete block design. The following data were collected: Seedling field establishment, while at harvest the following data were collected (a) Number of plants without storage roots, Number of plants with 1-2 storage roots per plant, Number of plants with 3-4 storage roots per plant, Number of plants with 5-6 storage roots per plant, Number of plants with 7-8 storage roots per plant and number of plants with 9-10 storage roots per plant, per family; (b) Number and percentages of plants in a family with flesh colour that are Orange, Yellow, White, Cream and Purple.
Incidences and severity of sweetpotato virus disease complex at 120 days after planting, nematodes and sweetpotato weevil attack on the enlarge roots were also collected at harvest. Number of roots per stand and fresh root weight per plant were taken from 20 most competitive plants from each family at harvest.

Data analysis for field test
(1) Seedling establishment (SE) calculated as the percentage of seedlings established 30 days relative to the number of seedlings transplanted (Okelola et al., 2009). Percentage number of seedlings with various number of storage roots were taken. Weight of storage root yield potential per plant and in tonnes per hectare was estimated from 20 sampled seedlings from each family. Percentages were used to calculate the colour segregation in various families (2) Data collection on the incidences and severity of the major pests and diseases of sweetpotato were taken and percentage of infected plants and severity were recorded for each family using a subjective 5 point severity rating scale where 1 = no symptom, 2 = mild symptom, 3 = moderate symptom, 4 = severe symptom and 5 = very severe symptom (Robert, et al., 2002).

RESULTS AND DISCUSSION

Percentage field establishment and Seed weight

The Number of seedlings transplanted and the establishment percentage per family are presented in Table 1. The family MUSG 066 - 6 -15 gave the highest percentage of field establishment of 74.33%. This was followed by the family MUSG0614 - 22 which were 50.93% while the least field establishment percentage of 11.90% was obtained from the family NCPP573, 50-17-02. The variation in field establishment percentage may be attributed to the ability of the seedlings to adapt to the harsh environmental conditions existing outside the screen house. The stored food reserve of the seeds contributed in seed germination and vigour and the ability of the seedlings to grow and withstand harsh field conditions. Light weight seeds perform poorly in terms of germination, growth and field establishment. Seed weight has been reported to be associated with high percentage germination, high vigour, and good field establishment and root yield (Gasura et al., 2008, Table 1). The seedlings in the family MUSG 0614-22 indicated high field establishment percentage (74.33%), which was evidence of high adaptability to the local conditions. According to (Gasura et al., 2008), parents that are already adaptable to the local environment should be constituted in the hybridization block and use as the female parents for the new hybrids since sweetpotatoes have high maternal inheritance (Gasura et al., 2008). Sweetpotato seedlings used for this experiment were seeds collected from local landraces constituted in the hybridization block.

Number of Seedlings with storage/enlarge roots

The number of roots harvested per seedling per family at harvest in 120 days after planting is presented in Table 2.

Number of roots per plant

The root yield depends on the number of storage roots per plant (Wilson et al., 1989). Number of roots can be used to predict the root yielding potential of given genotype. Enlarged /storage roots within short period of maturity relates to earliness. This singular attribute is preferred by farmers who engage in commercial sweetpotato production. The total number of seedlings in all the families that produced 9-10 number of storage roots per stand was 67 which represented 9.07%. The number of seedlings from all the families that produced 7-8 number of storage roots per stand was 88 which represented 11.91% and the number of seedlings from the families that produced 5 to 6 storage roots per stand was 143 which represented 19.35%. Also the number of seedlings from all the families that produced 3 to 4 storage roots per stand was 214 which represented 28.96%, those that produced 1 to 2 storage root per stand was 191 which represented 25.85% while the number of seedlings from all the families that produced no storage roots were only 36 which represented 4.87%. Numbers of seedlings that produced enlarged/ storage roots within and between the families were more than those that did not produce storage roots. However, this result indicated that total number of seedlings from various families that produced storage/ enlarged roots ranging from 1 - 10 per stand were of high percentage (95.23%) when compared with those seedlings without storage/enlarged roots from various families (4.87%, Table 2). It showed evidence of yield potential of the seedlings and adaptability to the local field conditions. However, high root number per stand is an indication of high yielding potential (Gasura et al., 2008 and Nwankwo et al., 2013).These families produced more than one large root per stand and could be included among high yielding genotypes since number of roots is a function of yield (Table 2).

Seedling enlarged root weight

Twenty competitive sweet potato seedlings from each family were harvested, the number of roots per family were noted and the enlarge roots were weighed with a scale for fresh weight yield. The result obtained is presented in Table 3. The highest root weight per stand (0.63kg/stand) was produced by the family MUSG 0608-61, equivalent to 21.0t/ha followed by MUSG 066-6-15, MUSG11006-3 and NCPP573, 50-17-02 with 0.51kg of roots per stand in each family which was equivalent to 17t/ha respectively while the least number of root per stand of 0.36kg was produced by MUSG 0614-22 equivalent to 12t/ha. Although, the family MUSG 0608-61 produced lower number of root per stand (2.00 per stand) than the family MUSG066-6-15 which had 2.65 roots per stand, its root weight per stand of 0.63kg was an indication that the family will produce large storage/ commercial roots. Based on this result, the family therefore distinguished itself as genotypes for high large root yielding potential. According to NARO (National Agricultural Research Organization) yield classification criteria, genotypes were grouped into three root tuber yield classes: high yielding (18-30t/ha), moderate yielding (11-17t/ha) and low yielding genotypes (<11t/ha) The seedlings in the family MUSG 0608-61 were in the top group (high yielding). However, the seedlings in the other four families were in the moderate yielding class (Table 3).

Root flesh colour segregation of the seedlings

Numbers of sweetpotato seedlings with variation in flesh root colour areshowedin Table 4.
Of all the 739 seedlings that survived in the field, the colour segregation indicated that 489 seedlings which represented 66.2% were orange fleshed genotypes which are power store house for vitamin A. The orange fleshed sweetpotato is extremely rich in bioavailable beta-carotene, which the body converts into vitamin A (Zossimo (1992).A total of 178 genotypes represented by 24.09% were yellow fleshed genotypes which also contain elevated amount of vitamin A and good carbohydrates. Others includes 6 genotypes represented by 0.81%, contain anthocyanin which is of purple colour. This variety is widely sort for since it contains anti-cancer property (Sweetpotato knowledge, 2012) while 10 genotypes represented by 1.35% were white fleshed and 29 genotypes represented by 3.92% were cream fleshed genotypes which contain prestigious carbohydrates for making pounded fufu like yam (Oleghe, 1998). The white fleshed genotypes could be further improved through the use of modern agronomic packages and in reducing the pressure on cassava in garri making and could be used in fries like in Irish potato.

Response of the sweetpotato seedlings to major pests and diseases

The response of the sweetpotato seedlings to major pests and diseases attacking sweetpotato seedlings in the field are presented in Table 5. The 739 sweetpotato seedlings from the five families responded negatively to field viral and nematode infection with severity score of 1 (Table 5). This was a good trait observed from newly developed genotypes. However, 6.2% of the storage roots seedlings from the family MUSG 0614-22 responded moderately to the attack of Sweetpotato root weevil (severity score of 3) while only 3.6% of seedlings in the family of MUSG 066-6-15 showed mild symptom (severity score of 2) of attack of Sweetpotato root weevil. This result indicated that the seedlings in the two families were not totally resistant to the attack of Sweetpotato root weevil. However, the attack of the Sweetpotato root weevil could be minimized by employing cultural practices that reduces the damage of the weevil such as earthing up the base of the crop to cover cracks, use of clean planting material, harvesting immediately the crop mature and avoid planting when the crop will meet dry weather(Woolfe, 1992).

CONCLUSION

The high number of roots per stand is an indication of high yielding genotypes which could be selected for higher root yield while the variation in the grouping of the yield differences of the sweetpotato seedlings according to NARO classification indicated that there were considerable variations in the root yield potential of the seedlings. The variation in root flesh colour in the sweetpotato families evaluated showed that there were segregation in the root flesh colour which was as a result of intermating of the parents in the hybridization block while the flesh colour of the genotypes is additional indication that these genotypes could be put into various uses in terms of food forms and good for health (orange and purple flesh). The study also identified the family MUSG 0608-61with superior root yield potential of 0.63kg per stand equivalent to 21.0t/ha than other families and was rated as the highest top yielder according to NARO classification (Wilson, 1970). The seedlings from this family produced large storage commercial roots and were also resistant to major diseases attacking sweetpotato in the field. However, a total of 66.19% of colour variation among the seedlings in the families were orange fleshed genotypes with the 84.3% from the family MUSG 066-6-15 and 70.18% from the family NCPP573, 50-17-02 showing that majority of the seedlings from these families were mainly Orange fleshed genotypes. Farmers who wish to incorporate orange fleshed sweetpotato genotypes in their farming systems should do so especially from these two families that have high percentage of orange fleshed seedlings.

Table 1: Number of seedlings transplanted and establishment Percentage per family

Families name	No. of seedlings transplanted	Number of seedlings established	% Establishment
MUSG 066-6-15	300	223	74.33
MUSG 0608-61	986	196	19.88
MUSG 0614-22	428	218	50.93
MUSG11006-3	194	45	23.29
NCPP573, 50-17-02	479	57	11..90

Table 2: Number of harvested sweetpotato seedlings with number of enlarged roots per pl ant per family

Families name	No. Seedling without enlarge roots	%	No. of seedlings with 1-2 enlarged roots	%	No. of seedlings with 3-4 enlarged roots	%	No. of seedlings with 5-6 enlarged roots	%	No. of seedlings with 7-8 enlarged roots	%	No. of seedlings with9-10 enlarged roots	%
MUSG 066-6-15	8	3.59	34	15.25	46	20.63	66	29.60	32	14.35	37	16.59
MUSG 0608-61	8	4.08	84	42.90	77	39.29	14	7.14	9	4.59	4	2.04
MUSG 0614-22	12	5.50	36	16.51	65	29.82	50	22.94	37	16.97	18	8.26
MUSG11006-3	4	8.89	16	35.56	9	20.00	7	15.56	5	11.11	4	8.89
NCPP573, 50-17-02	4	7.02	21	36.84	17	29.82	6	10.53	5	8.77	4	7.02
Total no. of genotypes =739	36	4.87	191	25.85	214	28.96	143	19.35	88	11.91	67	9.07

Table 3.Storage root number and Weight of 20 sweetpotato seedlings from each family

Families name	**Storage root number**	**Number of storage roots per stand**	**Storage root weight(kg)**	**Weight of roots per stand**	**Root yield in t/ha per family**
MUSG 066-6-15	53	2.65	12.65	0.51	17.0
MUSG 0608-61	40	2.00	10.23	0.63	21.0
MUSG 0614-22	39	1.95	7.20	0.36	12.0
MUSG11006-3	45	2.25	10.25	0.51	17.0
NCPP573, 50-17-02	42	2.10	10.10	0.51	17.0

Table 4 Flesh root colour Segregation per family of the sweetpotato seedlings

Families name	No. of seedlings harvested	White Fleshed	% no. with white fleshed	Cream fleshed	% no. with Cream fleshed	Yellow fleshed	% no. with Yellow fleshed	Orange fleshed	% no. with Orange fleshed	Flesh colour mixed with purple	% No. with purple colour
MUSG 066-6-15	223	0	0.0	11	4.93	23	10.31	188	84.30	1	0.44
MUSG 0608-61	196	8	4.08	10	5.10	79	40.31	98	50.00	1	0.5
MUSG 0614-22	218	0	0.0	7	3.21	61	27.98	147	67.43	3	1.38
MUSG11006-3	45	2	4.44	1	2.22	2	4.44	16	35.56	0	0.0
NCPP573,50-17-02	57	0	0.0	0	0.0	13	22.81	40	70.18	1	1.75
Total number of flesh colour genotypes	**739**	**10**	**1.35**	**29**	**3.92**	**178**	**24.09**	**489**	**66.19**	**6**	**0.81**

Table 5: Incidences, severity and percentage of seedlings in each family affected by major sweetpotato pests (Root Weevils (Cylas Punticollis) and nematodes and Disease SPVD

Family name	Number of seedlings planted	SPVD (Sweet potato virus disease)			Sweetpotato root weevil			Nematode		
		Incidences	Severity	%	Incidences	Severity	%	Incidences	severity	%
MUSG 066-6-15	194	194	1	100	7	2	3.6	194	1	100
MUSG 0608-61	292	292	1	100	1	1	100	292	1	100
MUSG 0614-22	193	193	1	100	12	3	6.2	193	1	100
MUSG11006-3	21	21	1	100	21	1	100	21	1	100
NCPP573, 50-17-02	34	34	1	100	34	1	100	34	1	100
Total	739									

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