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Research Paper

Evaluation of sweet potato seedlings for growth pattern and susceptibility to major leaf diseases of sweet potatoes

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Abstract. The experiment was conducted at the screen house and experimental field using five sweet potato families with the objectives to investigate the vegetative growth pattern of seedlings developed through open pollination and susceptibility of the leaves of the sweet potato seedlings to major field diseases attacking sweet potato crop in Umudike Southeastern Nigeria. The five sweet potato families were laid out in a randomized complete block design with 20 seedlings per plot and 100 seedlings per block and replicated twice. Data were collected 60 days after being transplanted to the field on: seedling field establishment, vine length, vine diameter, number of the primary and secondary branches, number of leaves and number of seedlings that bloom. Data collection on the incidences and severity of the major pests and diseases of sweet potato were also taken. The result indicated considerable variation in the growth pattern of the sweet potato families evaluated. The families MUSG 0614-22 and MUSG 066-6-15 had high germination percentages of 98.7 and 95.5% respectively than the rest of the families. The variability in growth pattern that existed among the sweet potato seedlings could be utilized in the varied farming systems such as in mix cropping for the erect growing genotypes and spreading genotypes with many branches for sole cropping in suppressing weeds and erosion control in erosion prone areas. Sweet potato seedlings with negative response to sweet potato virus diseases, leaf spot disease and sweet potato leaf blight disease is an indication of resistance to field infestation of major field diseases of sweet potato. Flowering observed in some genotypes could be used for selection of sweet potato plants that has favourable traits whose genes could be used for genetic improvement by breeders.

Keywords: Sweet potato seedlings, open pollination, growth pattern, farming systems, leaf diseases.

INTRODUCTION

Sweet potato (*Ipomoea batatas* (L) Lam) is a dicotyledonous plant which belongs to the family *Convulvalaceae* (Degrass, 2000). It is a perennial plant but cultivated as an annual crop. The estimated area devoted to sweet potato cultivation in Nigeria is about 204.7 million hectares (Agbo et al., 2013). Agbo et al. (2013) reported that Nigeria alone produces 3.0% of the world total output of sweet potato with a poor average yield of 3.0 million metric tonnes per hectare compare to 23.1 million metric tonnes per hectare in China in 2008. Sweet potato is one of the most popular root and vegetable crops commonly grown in every part of Nigeria. Yields in farmers field generally varies between 5.0 to 8.0 t/ha of fresh root yield of sweet potato (Nwodo, 2008). However, yields of up to 20 to 30 t/ha have been obtained under experimental conditions using improved varieties of the sweet potato coupled with improved agronomic packages such as the use of recommended rate and type of fertilizers, weeding of the plots with hand hoes from furrow up to the crest of the ridges thereby earthening up the ridges and closing cracks in the soil against root weevil infestation which destroy the enlarge roots especially during the dry season when soil moisture is low (Onunka et al., 2012). There are many varieties of sweet potato with variation in vine length, vine size and shape of leaves. There are also variations in the colour of the vine and leaf. Most sweet potato plants branched profusely while others branched less (Gasura et al., 2008). There are variations in root skin and root flesh colour. Consumers' most preferred root and leaf quality occurs in varying degrees in the cultivated local landraces. This calls for suitable screening techniques for rapid selection of genotypes with good root yield and leaf quality traits to complement the improvement of the breeding programme on other desirable and easily recognizable morphological qualities including root shape, root smoothness, low oxidation, starch content, flour quality, root skin and flesh colour.

Sweet potato leaves are edible and may serve as a protein rich leafy vegetable. The yellow and orange fleshed roots are rich in beta-carotene or pro-vitamin A (Degrass, 2003). The roots can be consumed, boiled, fried, or roasted. The fresh root and leaves are sometimes directly fed to livestock while the dry root chips are used to prepare root meal for livestock. The root flour could be consumed by humans or mixed in other food forms (Agbo et al., 2013). Sweet potato is usually planted sole or intercropped with other staples such as maize, cassava, yam or okra in West African countries where it is effective in suppressing weed growth in such fields (Eneji et al., 1995).

In spite of the significant place sweet potato occupy in the dietary requirement of the people of Nigeria especially Ebonyi State of Eastern Nigeria, studies have only been concentrated on the clonal evaluation of sweet potato roots. Little research work has been carried out on the growth and growth pattern of sweet potato seedlings which has been the hallmark for root yield and of integration in the farming systems of Nigerians. Genetic improvement of the sweet potato vegetative growth will increase the root yield and make the crop easily accessible, acceptable and adaptable into the varied cropping systems of the farmers in the country.

Hybridization is one of the ways to generate variability in sweet potato improvement. The genotypes so obtained offer greater growth variability which can be expressed in contrasting environments (Oleghe, 1998; Woolfe, 1992). The vegetative growth pattern may contribute to the low yield in farmers' field when the farmers use wrong growing types in his cropping mixture. Nigerian farmers prefer mix cropping in their farming systems, it is therefore necessary for the farmer to use sweet potato with the right type of growth pattern that fit into the farming system for maximum yield. Therefore, this study was carried out to investigate the vegetative growth pattern of seedlings developed through open pollination and susceptibility of the leaves of the sweet potato seedlings to major folia field diseases attacking sweet potato crop in Umudike South eastern Nigeria. Other specific objectives include the selection of different growth pattern for varied farming systems.

MATERIALS AND METHODS

The trial was conducted in the screen house and experimental field of National Root Crops Research Institute (NRCRI) Umudike in the rain fed agro-ecology of South eastern Nigeria. Open pollinated seeds from sweet potato hybridization block were raised in the screen house and later transplanted to the experimental field. The area for the experiment was slashed, ploughed, harrowed and ridged. The ridges were spaced 1.0 m apart. The seedlings in the five families were laid out in a Randomized Complete Block Design (RCBD) with 20 seedlings per family per plot, 100 seedlings per block and replicated 3 times. The seedlings were transplanted to the field 30 days after sowing and planted on the crest of the ridges at 1.0 m × 0.3 m apart in a plot size of 1.5 m × 4.0 m. Fertilizer application was N P K 15: 15:15, applied 6 weeks after being transplanted 9 cm round the base of each seedling in the field. The whole plots were kept weed-free throughout the growth of the sweet potato seedlings with hand-hoe. Hand rouging was done toward harvesting which took place at 16 weeks after transplanting.

The following data were collected 60 days after planting: Seedling field establishment, vine length (this was determined from the soil level at the plant base to the tip of the longest vine), vine diameter (this was measured at the middle of the vine with vernier caliper), number of primary and secondary branches, number of leaves (this was determined by counting the number of leaves on the plants) and number of seedlings in the families that bloomed. All samples were taken from 5 most competitive plants from each plot and averaged on per plant bases. Data collection on the incidences and severity of the major pests and diseases of sweet potato were taken.

Data analysis for field trial

Seedling establishment (SE) was calculated as the percentage of seedlings established 30 days relative to the number of seed transplanted (Okelola et al., 2009). The following data were collected at 60 days after being transplanted: Vine length, number of leaves, and number of primary and secondary branches, vine diameter. Data on seedling establishment percentages, number of leaves, number of primary and secondary branches, were analyzed after angular transformation (log base 10). All the data collected were subjected to Analysis of Variance (ANOVA) using the SAS Statistical package (SAS Institute, 2008) and means were separated using the LSD at 5% probability level. Percentage of disease 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

Table 1. Means square analysis for growth attributes of sweet potato seedlings 60 days after planting in the field.

Sources of variance	d.f	Field establishment	Vine length	Vine diameter	No. of branches	No. of leaves	No. of flowers/plant
Family	2	651.02*	58.90**	0.081*	40.26**	20.08**	89.54**
Within family	4	87.06**	71.23**	28.76**	78.67*	41.06**	68.52**
Error	8	0.063	20.02	17.05	12.69	0.63	11.23
Total	14						

symptom (Robert et al., 2002).

RESULTS

Means square analysis

The result of the means square analysis for growth attributes of sweet potato seedlings 60 days after planting in the field are presented in Table 1. The result indicated that high significant (P< 0.01) variability exists among the sweet potato families and within the sweet potato seedlings in terms of the growth attributes (vine length, number of leaves, vine girth and number of branches). This was an evidence of segregation resulting from the crosses among the parents established in the hybridization block. Variability generated could be used for selection and for further evaluation.

Growth pattern

Field establishment

Each of the sweet potato families had high significant (P < 0.01) field establishment percentage. However, the seedlings in the families of MUSG 066-6-15, MUSG 0614-22 and MUSG11006-3 had the highest field establishment percentage of 98.7 and 95.5% respectively when compared with seedlings in the family of NCPP573, 50-17-02 which showed a significantly (P < 0.01) low field establishment as indicated by their field establishment percentage of 55.5% (Table 2).

Main vine length

The result of the analysis of variance showed that the vine length of the sweet potato seedlings from the families are significantly (P < 0.01) different (Table 2). The coefficient of variation indicated that the degree of variation of 57.2% in vine length among the seedlings in the families were very high (Table 2). The average vine length of the seedlings from the various families of MUSG0608-61 and MUSG066-6-15 were 171.3 and 186.6 cm respectively longer than the vine length from the rest of seedlings from other families. This showed that these two families had seedlings that have spreading habit.

Number of leaves

There was high significant (P < 0.01) variation in the number of leaves possessed by the sweet potato seedlings within and among the families. The seedlings from the families of MUSG0608-61 possessed the highest average number of leaves (164.0), followed by the seedlings in the family of MUSG066-6-15 with average number of leaves of 152.3. The least average number of leaves was 49.7 from seedlings in the family of MUSG0614-22 (Table 2). The coefficient of variation of 48.5% indicated high degree of variation in the number of leaves among the sweet potato seedlings.

Vine diameter

High significant (P < 0.01) variation was observed within and among the vine diameter of the sweet potato seedlings in the families. The vine diameter of seedlings from the family MUSG 0608-61 was significantly (P < 0.01) higher (5.0 mm), when compared with those of the seedlings in the other four families (Table 2). The coefficient of variation indicated high degree of 66.0% in the variation of vine diameter among the seedlings in the families.

Number of branches

High significant (P < 0.01) variation exist in the number of branches produced by the sweet potato seedlings in the families. The seedlings at 60 days after planting produced an average of 17.90 branches per plant (MUSG066-6-15) the highest among the sweet potato seedlings. This was followed by the seedlings in the family MUSG 0608-61 with average of 15.33 branches per plant. The least number of branches was 5.63 (NCPP573, 50-17-02 (Table 2). The coefficient of variation of 42.8% indicated large degree of variation in the number of branches among the sweet potato

Table 2. Vigour rating and growth pattern of the seedlings per family 60 days after planting in the field.

Families name	% Field establishment	Vine length (cm)	No. of leaves	Vine girth (mm)	No. of branches	No. of seedlings that flowered
MUSG 066-6-15	95.5[a]	171.3[a]	152.3[a]	4.0[a]	17.90[a]	148[a]
MUSG 0608-61	69.0[ab]	186.6[a]	164.0[a]	5.0[a]	15.33[a]	117[a]
MUSG 0614-22	98.7[a]	44.7[a]	49.7[b]	4.0[a]	7.30[a]	13[b]
MUSG11006-3	93.3[a]	35.2[a]	62.7[b]	4.0[a]	7.90[a]	27[b]
NCPP573, 50-17-02	55.5[b]	39.8[a]	52.7[b]	4.0[a]	5.63[b]	19[b]
Sig.level	P < 0.01	P < 0.01	P < 0.01	P < 0.01	P < 0.05	P < 0.01
LSD	23.7	11.3	14.1	0.21	11.0	32.6
CV%	-	57.2	48.5	66.0	42.8	-

seedlings in all the families studied (Table 2).

Flowering seedlings

There was high significant ($P < 0.01$) variation in the flowering of the seedlings among the sweet potato families. Varietal variation was observed in the way the seedlings bloom (flowered). The flowering in the families of MUSG 066-6-15 and MUSG 0608-61 were significantly higher than those in the families of NCPP573-50-17-02, MUSG11006-3 and MUSG 0614-22. The family MUSG 066-6-15 had the highest number of individual plants (148) that flowered, followed by MUSG 0608-61 with 117 genotypes while the least was observed in the family of NCPP573, 50-17-02 with 19 genotypes (Table 2).

Disease infestation

The result of the Incidences, severity and percentage of seedlings in each family affected by sweet potato virus disease (SPVD), leaf spot disease and sweet potato bacteria blight disease are presented in Table 3. The result showed that all the sweet potato seedlings in each of the families had severity rating scale of 1 which indicated no visible symptom to most of the field folia diseases such as sweet potato virus diseases (SPVD), to mild symptom such as sweet potato leaf blight disease (score 2) and moderately severe symptom of sweet potato leaf spot (score 3). In the family MUSG 0614-22, 19.7% of the seedlings are moderately severe (score rate of 3) affected by the leaf spot disease.

DISCUSSION

The high significant ($P < 0.01$) genetic variability that existed among sweet potato families and within the sweet potato seedlings suggested that there is ample opportunity for selection of seedlings for further evaluation and for crop improvement programme. The wide coefficient of variation among the traits evaluated indicated high degree of genetic variability among the traits which could lead for further selection of traits for genetic improvement in breeding objectives. According to Francis and Kannenberg (1978), low coefficient of variation and high mean is used to select cultivars in cassava with stability in character since edaphic factors within season and agro-ecological zones could significantly influenced their performance. High percentage of field establishment showed high adaptability of the seedlings to the field harsh conditions. It has been noted by Gasura et al. (2008) that parents already adaptable to the local environment should be constituted in the hybridization block and used as the female parents since sweet potatoes have high maternal inheritance (Wilson et al., 1989). This indicated that most of the seedlings in the families will do well under harsh field conditions (Table 1).

The number of leaves is an indication of the vigour of the crop. It could however not be an indication of high yielding genotypes as a result of environmental influence (Wilson, 1982). Although the leaves assist in photosynthesis of the crop which leads to high yield, high number of leaves is also an indication of high vigour of the crop. High number of leaves leads to complete coverage of the soil surface thereby preventing soil erosion (Onwueme and Sinha, 1991).

Vine length indicates the growth pattern / plant morpho - types of the sweet potato genotypes. Two families MUSG0608-61 and MUSG066-6-15 were identified to have seedlings with spreading habit of 171.3 and 186.6 cm respectively than the rest of seedlings from other families. Vine length could be of various lengths and this gives the sweet potato genotypes its characteristic morpho-types such as erect, semi-erect, spreading and extremely spreading. Main vine length of less than 75 cm is regarded as erect while main vine length of 250cm is regarded as extremely spreading. Vine length of 75 to 150 cm is intermediate/semi-erect (IBPGR, 1999). According to Onwueme and Sinha (1991), lengthy spreading vigorous vine genotypes with many branched vines suppress weeds and other plants in the ecology

Table 3. Incidences, severity and percentage of seedlings in each family affected by SPVD, leaf spot disease and sweet potato bacteria blight.

Family name	Number of seedlings planted	Sweet potato virus disease (SPVD)			Sweet potato leaf blight			Leaf spot		
		Incidences	Severity	%	Incidences	Severity	%	Incidences	Severity	%
MUSG 066-6-15	194	194	1	100	3	2	1.5	194	1	100
MUSG 0608-61	292	292	1	100	1	1	100	292	1	100
MUSG 0614-22	193	193	1	100	193	1	100	38	3	19.7
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									

and with many branches they produce more planting material. These ones could be used for sole sweet potato production. Majority of lengthy spreading vine genotypes produce enlarge roots at the nodes while creeping (Huaman and Asmat, 1999). Small scale or subsistence farmers that harvest piecemeal roots prefer vines that produce roots at the nodes and at planting points while commercial farmers prefer vines that produce roots at planting points for easy mechanization during harvest. Most seedlings possess semi-erect vines, a growth habit which may be appreciated by some farmers while majority have spreading vine habit with their branches. Farmers need compact or erect vines which are best for intercropping. This trait may be appreciated by farmers which are needed for combating weeds and provides enough vines for planting materials as well as for use as cover crop in erosion prone areas. However, spreading vine genotypes with many branches may not be appreciated by some farmers in any intercrop farming as the spreading types may suppress the performance of some low growing crops in the mixture (Table 2). Gomez and Gomez (1984) reported that the size difference in plant character between the varieties in a mixed cropping plays an important role in determining the extent of varietal competition effects. They further observed in a study on varietal competition effects in rice that tall and high tillering varieties compete better than the short and low tillering ones. Thus, short and low tillering variety would be at a disadvantage when planted adjacent to a plot with a tall and high tillering variety. So the smaller the varietal difference in sweet potato vine length the greater is the expected disadvantage if planted in a crop mixture.

The vine girth (vine diameter) measures the thickness of the vine. Those genotypes producing vine thickness of less than 4.0 mm produce poor vine diameter that may not survive long drought period. Vine thickness of between 4.0 to 6.0 mm is regarded to be acceptable (Gasura et al., 2008) since they store adequate water and dry matter and could withstand long period of drought. Gasura et al. (2008) further added that they are good planting material and most preferred by farmers because of its keeping quality and high survivability during dry periods. The sweet potato seedlings in the families have good quality vine materials (Table 2). Vine length and vine thickness are highly heritable traits. These two traits are also maternally inherited (Wilson et al., 1989). Improvement of these two traits through breeding is easy to meet farmers' preferences. Vines with thick stem produce strong vines as planting material which establish well at planting, whereas thin stem vines produce weak cuttings which may die immediately after harvest. Climbing vines diameter that are thin (<0.2 mm) produce poor planting material. Weevils damage thick stem vines more severely than thin stem vines. However, medium stem vines establish well in the field and less susceptible to weevil damage. Stem thickness maternally inherited crosses are best made with female parents with thick vines (Wilson et al., 1989). The Breeders require breeding population that exhibit strong vine survivals to enable them use this trait adequately in population improvement.

Branches in sweet potato contribute to the vigour of the crop since the branches hold the leaves and keep them in place for photosynthesis using the sun energy. Farmers may prefer few branches in the intercropping, whereas the spreading branches are needed in combating weeds. Spreading branches are needed in combating weeds and in addition provide more planting material. The variation in the number of branches per plant and length of the vines indicated the sweet potato morpho-types and the bases for farmers' choice in incorporating the sweet potato genotypes in their farming systems.

Flowering in sweet potato could be used in genotype discrimination such as non flowering types, sparse flowering and profuse flowering types. According to Nwankwo et al., (2012) flowering could be used in discriminating against yam genotypes into: non flowering types, sparse flowering and profuse flowering types. Flowering could be used for selection of plants that has favourable traits whose genes could be used for genetic improvement. Flowering in sweet potato is of no importance to the farmer. The farmer is only interested in root yield for food and in leaf production as vegetable or as fodder for the animals such as sheep, goats, cattle and pigs. Whereas flowering sweet potato genotypes are of great asset to the plant breeder for the genetic improvement of the sweet potato crop.

Farmers, however, require sweet potato vines that are free from diseases. Breeding objectives include selecting seedlings that are free from field diseases. Most of the sweet potato seedlings were free from major sweet potato field diseases such as sweet potato virus disease and sweet potato leaf blight that are attacking the vines and the leaves. However, 19.7% of the seedlings from the family MUSG 0614-22 were susceptible to leaf spot disease (score rate 3). Those seedlings susceptible in the family were an indication that the family may eventually succumb to sweet potato leaf spot if favourable condition for the establishment of the disease exist (Robert et al., 2002). Since the infection is on the leaves, it will affect the photosynthetic capacity of the crop and thereby adversely affect the yield of the crop. The affected seedlings were rogued and destroyed as they may pose a danger for the spread of the disease to other seedlings if not removed.

CONCLUSION

The study indicated that variability existed within the seedlings and among the families of the sweet potato seedlings evaluated. The study also identified these families MUSG 0614-22 (98.7%) and MUSG 066-6-15 (95.5%) with superior seed vigour and high germination percentage. The growth pattern/morphological variation identified could be utilized in the varied farming systems. These traits of lengthy, spreading, vigorous vine genotypes, with many branched vines, may be appreciated by farmers which are needed for combating weeds and provides enough vines for planting materials as well as for use as cover crop in erosion prone areas could be used for sole sweet potato production while most farmers may need compact or erect vines which are best for intercropping. Sweet potato seedlings with negative response to major field diseases of sweet potato is an indication of resistance to field infestation of sweet potato virus diseases, leaf spot disease and sweet potato leaf blight disease. The susceptibility of some of the seedlings in the family of MUSG 0614-22 to leaf spot disease was an indication that some of the seedlings in the family could easily be susceptible to leaf spot diseases attacking sweet potato in the field. Flowering could be used for selection of plants that has favourable traits whose genes could be used for genetic improvement by breeders.

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