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Field Evaluation of Yield and Resistances of Local and Improved Sweet Potato (*Ipomoea batatas* (L) Lam) Accessions to *Cylas puncticollis* and *Meloidogyne incognita* in Southeastern Nigeria

Emmanuel E. Bassey
Department of Crop Science, Faculty of Agriculture, University of Uyo, Akwa Ibom State, Nigeria, Tel.: +2348024686153

Abstract: Aim of the study was to evaluate local and improved accessions of sweet potato for resistances to *Cylas puncticollis* and *Meloidogyne incognita* and identify suitable ones for incorporation in breeding programmes for the production of genetically resistant and high yielding varieties. The experiment was conducted at the University of Uyo, Teaching and Research Farm located at Use Offot-Uyo, Southeastern Nigeria and laid out in a randomized complete block design, with three replications. Eighteen sweet potato accessions were studied, comprising 13 local accessions, namely: E_5, B_6, E_3, B_{26}, B_2, E_{11}, E_6, E_{17}, B_{21}, E_{14}, E_7, B_{23}, E_{10} and five IITA improved and recommended varieties (TIS 87/0087, TIS 8441, TIS 8164, TIS 2532 and TIS 86/0356) for southeastern Nigeria. Three of the IITA improved and recommended varieties (TIS 86/0356, TIS 8164 and TIS 87/0087 had higher number of root tubers per plot and higher root tuber yield per hectare than the local accessions, while eight of the local accessions indicated high resistances to *Cylas puncticollis*, namely: B_6, B_2, E_{17}, B_{21}, E_{14}, E_7, B_{23} and E_{10} and *Meloidogyne incognita*, namely: B_6,, E_3, B_{26}, B_{21}, E_{14}, E_7, B_{23} and E_{10}. The local accessions with high root tuber yields and very high resistances to *C. puncticollis* and *M. incognita* (B_6, B_{21} and E_{10}) could be incorporated in breeding programmes involving TIS 87/0087, TIS 8164, TIS 2532 and TIS 86/0356 for the production of hybrid varieties with higher yields and resistances to the pests in southeastern Nigeria.

Keywords: *Cylas puncticollis*, evaluation, *Meloidogyne incognita*, resistances, sweet potato accessions

INTRODUCTION

Sweet potato is the seventh among all food crops worldwide, from the point of total production, third in value of production and fifth in caloric contribution to human diet (Bouwkamp, 1985). China accounts for the highest sweet potato production in the world, followed by Uganda and Nigeria in that order (FAO, 2004). Sweet-potato is becoming popular as a substitute to yam and *garri* in Nigeria. It contributes significantly as a starch staple in providing the needed daily calorie intake and also serves as a breakfast meal. Some varieties have been used in raw mash at 50:50 wheat/sweet potato flour for bread making, biscuits and other confectioneries. Sweet potato tubers can be reconstituted into *fofoo*. It may be used as a major source of industrial starch for pharmaceutical products, adhesives, textile, paper and alcohol production (Woolfe, 1992). In Akwa Ibom State, the government encourages cultivation of this crop, using the Agricultural Development Programme (ADP) to reach out and educate farmers on the advantages of the crop over other root and tuber crops (Antiaobong and Bassey, 2009).

Several constraints limit sweet potato production in southeastern Nigeria (Antiaobong and Bassey, 2009). Notably among these are damages by sweet potato weevils, *Cylas puncticollis* (Ezulike *et al*., 2001) and root knot nematodes, *Meloidogyne incognita* (Nwauzor, 2001). In Nigeria, *C. puncticollis* is the major pest of sweet potato. It causes damage in the field, in storage and is of quarantine significance. It is inherently of interest to entomologists due to its strikingly colorful appearance and extremely long rostrum (beak). This weevil feeds on plants in the plant family *Convolvulaceae*. Although it has been found associated with several genera, its primary hosts are in the genus *Ipomoea*. Among vegetable crops only sweet potato (*I. batatas*), is a suitable host. Native plants can be important hosts of sweet potato weevil. Railroad vine (*Ipomoea pes-caprae*) and morning glory (*Ipomoea involucrata*) are among the suitable wild hosts (Capinera, 2009).

A symptom of infestation by sweet potato weevil is yellowing of vines, but a heavy infestation is usually necessary before this is apparent. Thus, incipient problems are easily overlooked and damage not apparent until tubers are harvested. The principal form of damage to sweet potato is mining of the tubers by larvae. The infested tuber is often riddled with cavities, spongy in appearance and dark in color. In addition to damage caused directly by tunneling, larvae cause damage indirectly by facilitating entry of soil-borne pathogens. Even low levels of feeding induce chemical reaction that imparts a bitter taste and terpene odour to the tubers. Larvae also mine the vine of the plant, causing it to darken, crack or collapse. The adult may feed on the tubers creating numerous small holes that measure about the length of their head (Capinera, 2009).

Hahn and Leuschner (1981) reported serious effect of potato weevil on root tuber yield of several sweet potato varieties in Nigeria. Losses due to the pest have been estimated between 60-100% by Chalfant *et al*. (1996). Similarly, Tewe *et al*. (2001) reported yield losses of up to 80% attributed to *C. puncticollis* alone, Onwueme (1978) reported 25-75% crop loss due to the pest while Sutherland (1986) reported losses from 50% to 100%. Capinera (2009) reported losses ranging from 5 to 97% in areas where the weevil occurs.

Meloidogyne incognita is the major nematode damaging sweet potato in southeastern Nigeria. The Nematode second stage juvenile invades sweet potato roots in the region of tissue differentiation. Infection in the primary root causes unusual development of root cells resulting in giant cell or galls (Taylor, 1977). Secondary roots are deformed and tubers may crack resulting in the reduction of quality marketable root tubers. Generally, the infection is associated with foliage chlorosis and reduction in yield of root tubers (Nwauzor *et al*., 2006). Many varieties of sweet potato are susceptible to attack by root knot nematodes (*M. incognita*) and *Cylas puncticollis*. Anioke and Agbalu (2003) reported that in the high rainforest environment of southeastern Nigeria, famers spend so much money on chemical control of sweet potato pests and diseases. Several attempts have been made to protect sweet potato against sweet potato weevil and root knot disease. Worse still, information on the responses of sweet potato clones to pests and diseases in high rainforest zone of Nigeria is lacking, such information would be useful in dissemination of improved materials to growers. However, the use of chemicals appears to cause environmental hazards and effective botanical formulations have not been achieved and even when that happens most rural farmers will not be able to afford those (Nwauzor *et al*., 2006).

Resistant varieties have been developed by the International Institute of Tropical Agriculture (IITA), Ibadan and the National Root Crops Research Institute (NRCRI), Umudike, both in Nigeria, but such varieties have to be screened for resistances to pests and diseases in Akwa Ibom State where there is increasing interest for sweet potato production. The objective of the study was to evaluate 18 sweet potato accessions for resistances to *C. puncticollis* and *M. incognita* in relation to yield and identify suitable ones for incorporation in breeding programmes for the production of broad based genetically resistant and high yielding sweet potato varieties for southeastern Nigeria.

MATERIALS AND METHODS

The study was conducted at the Teaching and Research Farm of the University of Uyo, Akwa Ibom State, Nigeria in 2010 and 2011 cropping seasons. The State lies within Latitude 4° 33' and 5° 33' North and longitude 7°35' and 8° 25' East and falls within the tropical rainforest zone of dominant vegetation (Akwa Ibom State Ministry of Finance, 2007). The experiment occupied a land area of 19×14 m and was laid out in a randomized complete block design with three replications. The experimental materials were eighteen sweet potato accessions; five were obtained from Benue State (B_6, B_2, B_{26}, B_{21} and B_{23}) and eight from Ebonyi State (E_5, E_3, E_{11}, E_6, E_{17}, E_{14}, E_7 and E_{10}) while the remaining five (TIS 87/0087, TIS 8441, TIS 8164, TIS 2532 and TIS 86/0356) were obtained from the International Institute of Tropical Agriculture, Ibadan, all in Nigeria.

The land was mechanically ploughed, harrowed and ridged at 1m apart. Sweet potato vine cuttings measured 30 cm long, with seven nodes. The vines were sown 30 cm on the crest of the ridges and 10 cm below the soil surface, leaving three nodes on the soil surface. Each plot contained 30 plants, giving 2,250 plants in the entire experimental plot.

Fertilizer NPK (15:15:15) was applied at the rate of 400 kg/ha at 4 Weeks After Planting (WAP), immediately after the first weeding. Manual weeding was done once by hoeing at 4 WAP, but selective removal of *Panicum maximum* by hand pulling was carried out at 8 WAP. The sweet potato root tubers were harvested at 16 WAP (Ezulike *et al*., 2001). Data were collected on number of storage roots per plot and root tuber yield (tonnes/ha) in 2010 and 2011. The accessions were also evaluated for resistances to *C. puncticollis* and *M. incognita* in 2010 and 2011 following the procedures of Stathers *et al*. (2003) and Williams (1989). Percentage roots per accession affected by *Cylas punticollis* and root knot nematode were determined using the formula: $\frac{total\ number\ of\ roots\ affected\ per\ accession}{total\ number\ of\ roots\ per\ accession}$ x$\frac{100}{1}$. The scale and descriptor used to categorize the observed variation into classes of resistance and susceptibility were:

- No apparent damage-high resistance (No tuber damaged by the pests)
- Very little damage-resistant (1-25% of tubers affected by the pests)
- moderate damage-weak susceptibility (26-50% of tubers damaged by the pests)
- Considerable damage-susceptible (51-75% damaged by the pests)
- Severe damage-high susceptibility (76-100% of tubers damaged by the pests)

Analysis of variance was conducted on metric traits: number of roots tubers per plot and root tuber yields (tonnes/ha) for 2010 and 2011 and their means separated with the Least Significant Difference (LSD) (Wahua, 1999). The t-test was used to compare the yield and resistances of the accessions between years and tested for significance ($p<0.05$).

RESULTS AND DISCUSSION

Root tuber yield and number of roots per plant of sweet potato accessions: Table 1 shows the tuber yield and number of root tubers of sweet potato accessions in Uyo, Akwa Ibom State, Nigeria for 2010 and 2011. Significant differences were observed for number of root tubers per plot and root tuber yield (tonnes/ha) ($p<0.05$). The highest root tuber of 14.2 (tonnes/ha) in 2010 and 14.6 (tonnes/ha) in 2011 were indicated by TIS 86/0356, followed by TIS 8164 with 13.4 tonnes/ha and 13.2 tonnes/ha for 2010 and 2011, respectively while the check variety TIS 87/0087 had 12.6 and 13.1 tonnes/ha in the two years, respectively.

The root tuber yields of twelve accessions, namely TIS 86/0356, TIS 8164, TIS 87/0087, E_5, TIS 8441, E_{11}, B_6, B_2, B_{21}, E_{14}, E_{11} and TIS 2532 were higher than the minimum national yield of 7.0 tonnes/ha reported for Zone E (South zone) comprising Cross River, Akwa Ibom, Rivers, Anambra, Imo, Enugu States (Tewe *et al*., 2001). Also, all the recommended varieties: TIS 87/0087, TIS 8164, TIS 2532 and TIS 86/0356 had higher root tuber yields than the local accessions from Ebonyi and Benue States, except E_5 whose yield was higher than TIS 8441 and TIS 2532. The study shows that increase in yield of the improved varieties was due to large number of tubers per plant. Higher number of root tubers observed for the improved varieties could be transferred into the local accessions whose resistances to pests are relatively high. The local accessions such as E_5, B_6, B_2, E_{11}, B_{21} and E_{10} with high yield of root tubers could be incorporated in breeding programmes for the production of hybrid varieties for the area.

Resistance of sweet potato accessions to *Cylas puncticollis*: Some local accessions demonstrated very high resistances *to C. puncticollis* than the improved varieties recommended for the south zone of Nigeria. They include: B_6, B_2, E_{17}, E_{10}, B_{21}, E_{14}, E_7 and B_{23}. Some of the local sweet potato accessions and the improved varieties were of equal level of resistance to *C. puncticollis* with the. However, B_{26} was highly susceptible to *C. puncticollis*, while TIS 2532 showed weak resistance; the severity of damage was higher on the susceptible ones. Generally, higher root tuber yields were obtained from the moderate resistant clones, suggesting the need for incorporation of the local resistant clones in breeding programmes for developing higher number of root tubers per plant. This study shows the need for breeding programmes that can transfer resistance genes from the local resistant accessions into the improved ones, yet maintaining higher yields as the primary breeding objective.

Resistance of sweet potato accessions to *Meloidogyne incognita:* Nine local accessions were highly resistant to *M. incognita*, they had no apparent root knot cracks on the tubers. The accessions include: E_5, B_6, E_3, B_{26}, B_{21}, E_{14}, E_7, B_{23} and E_{10}, while E_{11} and the recommended improved IITA varieties (TIS 87/0087, TIS 8441, TIS 8164, TIS 2532 and TIS 86/0356) showed tolerance to the disease. This result showed that B_2, E_6 and E_{17} were highly susceptible to root knot

Table 1: Sweet potato root tuber yield and number of roots per plant, *Cylas* and nematode scores for 2010 and 2011 at use Offot, Uyo, Southeastern Nigeria

Accession	Root tubers t/ha		No. of roots/plot		*Cylas* score		Nematode score	
	2010	2011	2010	2011	2010	2011	2010	2011
E_5	12.5^l	13.0^m	41.7^h	41.3^e	2	2	2	2
B_6	10.5^i	10.2^g	50.7^c	50.9^f	1	1	1	1
E_3	6.10^d	6.70^d	27.7^d	27.4^c	2	2	1	1
B_{26}	7.10^e	7.80^e	29.4^e	28.6^c	5	5	1	1
B_2	10.6^i	10.4^h	34.8^f	35.0^d	1	1	5	5
E_{11}	11.8^k	11.6^k	37.3^e	36.8^d	2	2	2	2
E_6	5.70^c	6.10^c	34.9^b	35.1^d	2	3	4	4
E_{17}	1.90^a	2.20^a	16.9^j	17.9^b	1	1	5	5
B_{21}	10.8^j	11.0^i	59.9^b	60.2^h	1	1	1	1
E_{14}	9.10^g	8.90^f	16.4^a	16.2^b	1	1	1	1
E_7	3.00^b	2.60^b	12.7^c	13.0^a	1	1	1	1
B_{23}	8.30^f	9.00^f	27.7^i	27.3^c	1	1	1	1
E_{10}	10.0^h	10.1^g	56.3^k	55.8^g	1	1	1	1
TIS 87/0087	12.6^{lm}	13.1^m	67.4^j	67.8^i	2	3	2	2
TIS 8441	11.8^k	11.6^j	58.6^j	58.2^h	2	2	2	2
TIS 8164	13.4^m	13.2^{mn}	61.4^j	61.6^h	2	2	2	2
TIS 2532	12.4^l	12.6^i	59.6^j	59.3^h	3	3	2	2
TIS 86/0356	14.2^n	14.6^o	60.9^j	61.0^h	2	2	2	2
LSD (0.05)	0.15	0.18	2.01	2.54	-	-	-	-

Descriptors and scaling for quantification of resistance and susceptibility of sweet potato accessions for 2010 and 2011: (1) No apparent damage-high resistance (no tuber damaged by the pests), (2) Very little damage-resistant (1-25% of tubers affected by the pests), (3) Moderate damage-weak susceptibility (26-50% of tubers damaged by the pests), (4) Considerable damage-susceptible (51-75% damaged by the pests), (5) Severe damage-high susceptibility (76-100% of tubers damaged by the pests) nematode disease caused by *M. incognita*. Tewe *et al.* (2001) identified a total of 55 clones which were resistant to the root knot nematode of sweet potato in Nigeria and suggested the use of such varieties in nematode prone areas.

High resistance to both *C. puncticollis* and M incognita by the local accessions in this study could be due to the fact that the local types have adapted to the environment by creating a niche and also possess resistance genes while the improved varieties were not (Ngeve, 2001). In general, B_6, B_{21}, E_{14}, E_7, B_{23} and E_{10} demonstrated high resistance to both *C. puncticollis* and *M. incognita* in the high rainforest environment of southeastern Nigeria. The dual resistances for *C. puncticollis* and *M. incognita* exhibited by the local accessions are desirable agronomic attributes for increased sweet potato yield and tuber quality in southeastern Nigeria. Several literatures have confirmed of resistances shown by local accessions to pests and diseases in Nigeria (Ngeve, 1994) but such sweet potato genotypes have not been distributed to local farmers. Resistances to the pest and disease of sweet potato are governed by genes (Williams, 1989) and identification of resistant clones could boost farmers' yield. Hahn and Leuschner (1981) reported that information about sweet potato weevil and root knot nematodes on yield will be useful to growers and could be used to reduce heavy losses in the field. Ngeve (1994) noted that the local accessions with high yields and resistance to pests and diseases would be quite useful as female parents in breeding programmes, by crossing them with higher yielding varieties of low resistances to develop varieties carrying genes of both traits.

However, where the recommended IITA improved, low resistant varieties are sown by farmers in the South zone of Nigeria appropriate pest and disease management packages could be adopted to obtain good quality tubers. The use of integrated pest-disease management packages, rather than sole reliance on chemical control alone would offer a more suitable approach to problems associated with sweet potato production in this area. The local accessions with very low yields and resistances to either *C. puncticollis* or *M. incognita* (namely, E_6 and E_{17}) could be eliminated from the sweet potato list for the south zone, including the highly susceptible ones. Multiple location trials of high yielding and resistant accessions identified in this study should be conducted to establish the pest-disease status of the sweet potato accessions in other zones in Nigeria.

CONCLUSION

Three IITA improved varieties (T1586/0356, T158164 and T1587/0087) were identified with the highest average tuber yields of 14.4, 13.3 and 12.8 t/ha, respectively though with moderate (weak) resistance to *C. Puncticollis* and *M. Incognita*. Conversely, the local accessions: B_6, B_{21}, E_{14}, B_{23} and E_{10} with mean tuber yields of 10.4, 10.9, 9.0, 8.9 and 10.1 t/ha, respectively were highly resistant to the pests.

The behaviors of the sweet potato accessions tended to suggest that the mechanisms and patterns of resistance to *C. puncticollis* and *M. incognita* are similar and could be selected for. For example, the accessions with very high resistance to *C. puncticollis* also demonstrated similar behavior to *M. incognita*. Also, the local accessions with high tuber yields similar to the IITA improved ones, namely E_5 and E_{11} showed moderate resistance.

Based on these findings, the local accessions with high tuber yields (B_{21}, B_6 and E_{10}) and high resistance may be used as female parents, while the IITA improved varieties, namely T15 86/0356, T15 8164 and T15 87/0087 would serve as the male parents for the breeding of high yielding-pest resistant varieties in the environment.

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