

Assessment of selected orange-fleshed sweetpotato cultivars for sweetpotato weevil (*Cylas puncticollis* Boheman) (Coleoptera: Brentidae) infestation at Umudike, south east Nigeria

1. EHISIANYA, C. N., 2. LALE, N.E.S. and 3. UMEOZOR, O. C.

1. National Root Crops Research Institute, Umudike, P. M. B. 7006, Umuhia, Abia State, Nigeria
2. Department of Crop and Soil Science, Faculty of Agriculture, University of Port Harcourt, Port Harcourt
3. Department of Animal and Environmental Biology, College of Natural and Applied Science, University of Port Harcourt, Port Harcourt

Nig. J. Ent. 29: 17-30 (2012) ABSTRACT. Selected orange-fleshed sweetpotato (OFSP) cultivars namely: NRSP/05/022, CIP199004.2, CIP440293, Centennial and a cream-fleshed check TIS2532.op.1.13 were evaluated for yield and *Cylas puncticollis* (Boheman) (Coleoptera: Brentidae) infestation at the research farms in the National Root Crops Research Institute (NRCRI), Umudike (05°29'N, 07°33'E and 122 m above sea level), Abia State, Nigeria during the 2010 and 2011 cropping seasons. Field experiments were laid out in a randomized complete block design with each sweetpotato cultivar replicated three times. The results showed that OFSP cultivars had higher beta-carotene ranging from 7.76 µg/100g (CP440293) to 3.03 µg/100g (CIP199004.2), than the cream-fleshed check (0.03 µg/100g). The number of plant stand and fresh roots at harvest of the OFSP cultivars showed no significant differences when compared with the check in both years, whereas the mean weights of their biomass showed that cv. TIS2532.op.1.13 (12.05 t/ha) was significantly ($P=0.05$) higher than the others, except Centennial (10.84 t/ha) and NRSP/05/022 (8.41 t/ha). The total number of *C. puncticollis* progeny and percentage root damage on NRSP/05/022 (1.33 and 0.56) were significantly lower than on the check (15.67 and 23.35) cultivar. The coefficient of association between total root yield (number and weight) and weight of biomass was positive, whereas, the relationship between the weight of biomass and weevil severity score and percentage infestation were negative. There was a positive coefficient of relationship between soil crack and *C. puncticollis* incidence (infestation and damage). This implies that higher weevil infestation was observed in roots from plants in soils with higher number of cracks.

Key Words: Orange-fleshed, Sweetpotato, Weevils, Infestation

Corresponding author: Email: colpino@yahoo.co.uk

INTRODUCTION

In Nigeria, sweetpotato ranks fourth after cassava (*Manihot esculenta*), yam (*Dioscorea* spp.), and cocoyam (*Xanthosoma* spp.) or taro (*Colocasia* spp.) amongst major root and tuber crops produced (Tewe *et al.*, 2003). Some of the factors accounting for its increase in importance in the nation's farming and food systems are its relative ease of cultivation, short-maturing time, and enormous industrial and economic potentials (Fawole, 2007). The flexibility of the harvest time makes sweetpotato an important food security crop at times of adverse conditions. Its storage roots are mainly grown for home consumption (Smit, 1997; Abidin, 2004). Sweetpotato is equally important in the starch, alcohol, livestock, and pharmaceutical and textile industries (Woolfe, 1992).

Orange-fleshed sweetpotato is very rich in vitamin A (Jack *et al.*, 1992) and has higher (Beta) β -carotene content than any other root and tuber crop (Suda *et al.*, 1999; Jassens, 2001). Structurally, vitamin A (retinol) is essentially one half of the β -carotene molecules. Consequently, β -carotene is the most potent provitamin A; it is also the most wide-spread (Rodriguez-Amaya and Kimura, 2004). According to Low *et al.* (2008), 100g of sweetpotato can provide enough beta-carotene to produce from 0-100% of the suggested daily Vitamin A requirement (350 μ g/day) for infants and young children.

Annually, Nigeria loses over US\$15 billion in GDP to vitamin and mineral deficiencies as many staple foods are low in essential micronutrients (Adesina, 2012) and the clamour for orange-fleshed sweetpotato (OFSP) is due mainly to the nutritional and health advantages in its high vitamin A content. According to Adesina (2012), UNICEF reports show that 43 percent of children under five years in Nigeria are stunted, and approximately 250,000 to 500,000 malnourished children in developing world go blind each year from a deficiency of vitamin A, half of whom die within a year of becoming blind. As important as sweetpotato is to the subsistence economy, growth in output in the last three decades was attributed to increase in land area cultivated rather than to increase in yield (Ojiako, 2008).

Major constraints to high productivity identified by farmers include, declining soil fertility, low yielding varieties and low nutritive value (low dry matter and low β -carotene content), shortage of improved cultivars and planting materials (Lenne, 1991; Anioke and Ogbalu, 2003), genetic erosion, short shelf-life, poor aesthetic and market value, lack of storage technology, marketing problems, and limited range of processing and utilization options. Additional constraints include high pre- and post-harvest losses of fresh roots and their products caused largely by the African sweetpotato weevil, *Cylindrocephalus puncticollis* (Boh.), in the field and storage (Nwana, 1979; Talekar, 1987; Kumar

1991, Skoglund and Smith, 1994; Ehisianya *et al.*, 2011) and store. Losses due to sweetpotato weevil damage range from 1 to 100% (Alvarez, 1987). The weevil damage varies from season to season and from location to location. The damage by weevil is higher during the dry season (Talekar, 1987). One of the reasons for the high level of infestation is the fact that the crop can be successfully grown throughout the year (Edison *et al.*, 2009) and all plant parts; roots, stems, foliage, and flowers seeds could be infested (Edison *et al.*, 2009). Plants may wilt or even die because of extensive stem damage, and damage to vascular system can reduce the size and number of storage roots (Rajamma and Pillai, 1991), while extensive damage to root can lead to a complete loss (Stathers *et al.*, 2003). A number of OFSP genotypes have been bred or identified and tested at Nigerian Root Crops Research Institute (NRCRI), Umudike. It is important to evaluate these for susceptibility to *C. puncticolis* before release to farmers. This paper reports the relative susceptibility of four OFSP genotypes.

MATERIALS AND METHODS

This study was carried out at the research farm of National Root Crops Research Institute Umudike, Nigeria (05°

29'N, 07° 33'E and 122 m above sea level), in 2010 and 2011 cropping seasons. The treatments consisted of four OFSP namely: NRSP/05/022, CIP199004.2, CIP440293, Centennial and a cream-fleshed TIS2532.op.1.13 (check) (Table 1). Each cultivar was planted each on ridges spaced 0.3x1m apart in 3 m x 3 m plot replicated three times in randomized complete block design in June 2010 and 2011. After manual weeding NPK, 15:15:15 fertilizer was applied at the rate of 400 kg/ha by ring placement method at 4 weeks. Roguing was at 8 and 10 WAP. Harvesting was done at 5 MAP and the following data were recorded:

- a) plants standing at harvest,
- b) biomass (foliage) weight,
- c.) number of plants with soil cracks
- d.) number and weight of plants
- e.) total and
- f.) marketable (>100 g root size) roots per hectare (Levett, 1993)
- g.) Percentage infestation (number of infested roots per plot divided by the number of total roots harvested per plot multiplied by 100), while percentage damage (weight of infested roots per plot divided by weight of total roots harvested per plot multiplied by 100).
- h.) Severity of root damage per plot assessed

Table 1. Physico-chemical properties of sweetpotato cultivars evaluated

Attribute	OFSP cultivars			Green fleshed Control	
	IRSP/05/0.22	CIP199004.2	CIP440293	Centennial	TIS2532.op.1.13
Skin colour	Deep pink	Pink	Orange	Orange	Purple
Flesh colour	Orange	Pale orange	Deep orange	Orange	Cream
Peak absorbance (400-700 nm)	6.12	8.18	7.76	5.94	0.03
Vitamin C (µg/100 g)	413.00	215.00	646.70	578.35	2.5
Dry matter content (g/200 g)	54.97	60.00	39.33	63.97	27.00

Table 2. Effect of year on yield components, infestation and damage by *Cylas puncticollis* to selected sweetpotato cultivars

Parameter	Year		
	2010	2011	LSD (0.05)
Yield			
Harvest Plant Stand (ha ⁻¹)	23037.00	28148.00	3793.60
Foliage weight (t/ha)	7.63	9.47	1.94
Total root number (ha ⁻¹)	71705.00	67610.00	16487.30
Total root weight (t/ha)	11.02	14.05	3.28
Marketable root number (ha ⁻¹)	40211.00	40173.00	9389.80
Marketable root weight (t/ha)	9.81	12.85	3.12
<i>Cylas puncticollis</i> infestation/damage			
No. of plants with soil cracks (ha ⁻¹)	9233.00	5511.00	2350.50
¹ Percentage infestation	9.4 (15.50)	3.0 (5.50)	5.90
¹ Percentage damage	12.6 (17.30)	5.3 (7.20)	8.81
Severity score (1-5)	2.33	1.40	0.42
² Total progeny	11.94 (3.06)	7.07 (1.52)	1.21
² Adult number	2.07 (1.06)	1.20 (0.56)	0.62
² Immature number	9.87 (2.81)	5.87 (1.38)	1 10

1. The mean of percentage infestation and damage are actual values, while arcsine values to which LSD values are applicable are in parenthesis
2. The mean of *C. puncticollis* (Boh.) adult and immature are actual values, while square root values to which LSD values are applicable are in parenthesis

(i) on a five-point score, where 1 = 0 %; 2 = 1 - 25 %; 3 = 26 - 50 %; 4 = 51 - 75 %; 5 = 75 % (Stathers *et al.*, 2003) and

(j) using number of adults and immature (pupae and larvae) dissected from infested roots, yield data (t/ha) were determined. Insect counts were transformed to square root ($\sqrt{x+0.5}$) values, whereas data in percentages were transformed to arcsine (\sqrt{x}) values before analysis. Significantly different means were separated using LSD at 5 % error limit for treatment means of four and below, whereas treatment means above four were separated using Studentized Neumann Keul's (SNK) test ($P=0.05$). Physico-chemical properties were determined by harvestPlus method (Burgos *et al.*, 2009) and relationships between parameters were examined using correlation analysis.

RESULTS

Table 1 presents the physicochemical properties of sweetpotato cultivars evaluated. The OFSP cultivars gave higher beta-carotene ($\mu\text{g}/100\text{ g}$), vitamin and dry matter content ($\text{g}/200\text{ g}$) when compared with the check

TIS2532/op.1.13. NRSP/05/022 cultivar had the highest dry matter, a moderately higher beta-carotene, while CIP440293 had the highest vitamin A and betacarotene content.

Variance analysis on results showed that plant stand and foliage biomass at harvest were significantly ($P=0.05$) lower in 2010 than 2011, whereas foliage biomass at harvest, numbers and weights of harvested roots were statistically comparable ($P >$

0.05) in both years. *C. puncticollis* infestation (excluding number of adults, infested roots) and damage at harvest were significantly ($P = 0.05$) higher in 2010 than in 2011.

Table 3 presents the mean (pooled) attributes of yield and *C. puncticollis* on selected orange-fleshed sweetpotato (OFSP) cultivars. There was no significant difference in the plant stand at harvest of the OFSP and the check cultivars. A similar trend was observed in the biomass yield from Centennial (10.84 t/ha) and NRSP/05/022 (8.41 t/ha) when compared with the check cultivar (12.05 t/ha). Attributes of *C. puncticollis* on roots at harvest on NRSP/05/022 was significant lower when compared with the check and other OFSP cultivars, except for the number of plant in soil with cracks (Table 3).

The correlation coefficient for the relationship between root yield and *C. puncticollis* (Boh.) attributes of selected orange-fleshed sweetpotato genotypes are presented in Table 4. The coefficient for association between total root yield (number and weight) and weight of biomass was positive. However, the relationship between the weight of biomass and weevil severity score and percentage infestation were negative. There was a significantly positive coefficient of relationship between soil crack and percentage infestation and damage by the weevil. This implies that higher weevil infestation was observed in roots from plants in soils with higher number of cracks.

Table 3. Effect of infestation and damage by *Cylas puncticollis* on sweetpotato cultivar

Parameter	OFSP cultivars			Cream colored Control	
	NRSP/05/022	CIP199004.2	CIP440293	Centennial	TIS2532.op.1.13
Yield					
Harvest Plt Std (ha ⁻¹)	25741.00 ^a	25185.00 ^a	27222.00 ^a	22407.00 ^a	27407.00 ^a
Foliage weight (t/ha)	8.41 ^{ab}	4.39 ^c	7.07 ^{bc}	10.84 ^a	12.05 ^a
Total root number (ha ⁻¹)	77137.00 ^a	50420.00 ^a	82203.00 ^a	71246.00 ^a	67281.00 ^a
Total root weight (t/ha)	16.90 ^a	10.14 ^{ab}	12.03 ^{ab}	6.83 ^b	16.78 ^a
Marketable root no. (ha ⁻¹)	51207.00 ^a	23378.00 ^b	47554.00 ^a	34752.00 ^{ab}	44167.00 ^a
Marketable root weight (t/ha)	15.76 ^a	9.12 ^{ab}	11.06 ^{ab}	5.55 ^b	15.15 ^a
<i>Cylas puncticollis</i>					
Number of plants in soil with crack	10284.00 ^a	4283.00 ^a	7167.00 ^a	6594.00 ^a	8533.00 ^a
¹ Percentage infestation	0.25(3.66) ^a	7.48(8.00) ^a	7.68(14.71) ^a	7.86(11.40) ^a	7.65(12.26) ^a
¹ Percentage damage	0.05(0.56) ^b	9.00(14.75) ^{ab}	14.17(17.38) ^{ab}	4.73(8.98) ^{ab}	16.96(23.35) ^a
Severity score (1-5)	1.33 ^a	2.00 ^a	2.17 ^a	1.83 ^a	2.00 ^a
² Total progeny	0.47(0.68) ^b	3.11(1.76) ^{ab}	2.60(1.61) ^{ab}	1.72(1.31) ^{ab}	3.57(1.89) ^a
² Adult number	0.00(0.00) ^b	2.50(1.25) ^{ab}	1.33(1.15) ^{ab}	1.00(1.59) ^{ab}	3.33(1.82) ^a
² Immature number	1.33(0.47) ^a	10.50(2.81) ^a	9.67(2.45) ^a	5.50(1.59) ^a	12.33(3.17) ^a

Means within a row followed by the same letter(s) do not differ significantly from each other (P > 0.05; SAS, PROC GLM, SNK)

¹Data were transformed to arcsine (vx) prior to analysis, ²Data were square root transformed prior to analyses

Table 4. Correlation analysis (Pooled) of sweetpotato root yield and *Cylas puncticollis* (Boh.) Attributes

	Score	Foliage weight	Exposed root/soil crack	Total root number	Total root weight	Damage (%)
Score	1.000					
Foliage weight	-0.185	1.000				
Exposed root/soil crack	0.036	0.095	1.000			
Total root number	0.134	0.080	0.174	1.000		
Total root weight	0.077	0.134	0.074	0.233	1.000	
Damage (%)	0.689***	0.024	0.055	0.138	-0.013	1.000
Infestation (%)	0.618***	-0.048	0.461*	-0.104	-0.214	0.579**

*Significant at 5%, ** at 1% and *** at 0.1% probability

DISCUSSION:

Data from this study suggest that the orange-fleshed (OFSP) cultivars of sweetpotato had comparable roots and biomass yield with TIP2532.op.1.13 which is known for high yields (Eke-Okoro, 2011). Sweetpotato is known to produce more biomass and nutrients per hectare than any other food crop in the world (Loebenstein, 2009). The high foliage weight of Centennial (10.84t/ha) is significant as a source of green vegetable (Loebenstein, 2009), to bridge the vitamin and mineral deficiency gap in the diet of many Africans. Studies on the food value of sweetpotato foliage (Chen and Chen, 1979) show that the leaves are widely

consumed in East Africa (Abidin, 2004), and it has gained popularity as commercial cattle feed in Peru, China, Japan and Taiwan (Achata *et al.*, 1988). Aregheore (2003) also reported that better life weight gain were obtained when mixed diet of sweetpotato forage and batiki grass were fed to goats.

Results from this work also showed that the development of *C. puncticollis* was slower on the cream-fleshed TIS2532.op.1.13 than on the OFSP cultivars (CIP440293 and Centennial). The intensity of the flesh colour of the OFSP reflects the amount of beta-carotene

Present in the fresh roots and it is also used to differentiate cultivars. An earlier study by Njoku *et al.* (2009) reported that CIP440293 and Centennial lines of sweetpotato contained higher levels of carotene. The results from this field study follows the pattern earlier reported by Ehisiyanya *et al.* (2010) and Zakka *et al.* (2010) in which processed forms of orange- and white-fleshed sweetpotato roots, artificially infested with flour beetle,

T. castaneum in storage, revealed that the pest utilized the OFSP (CIP440293) flour and chips more than those from the white-fleshed variety.

High levels of root infestation was associated with soil cracking suggesting that agronomic practices that reduce soil cracking such as hilling up the soil around the roots (Smit, 1997) would be necessary.

CONCLUSION:

The result of this study suggest that sweetpotato cultivar NRS/05/022 had significantly higher root yield and low attributes of *C. puncticollis* as a pest on its roots at harvest when compared with the TIS2532.op.1.13. However, other OFSP cultivars did not significantly differ from the cream-fleshed TIS2532.op.1.13 in terms of susceptibility to *C. puncticollis*. In view of the high value to the under-exploited crop, there is the need for its protection and further screening during the drier seasons and other parts of the country.

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