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Full Length Research Paper

Varietal response of selected orange-fleshed sweetpotato cultivars to yield and the sweetpotato weevil, *Cylas puncticollis* (Boheman) (Coleoptera: Brentidae) at Umudike, Abia State, Nigeria

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Eight orange-fleshed sweet potato (OFSP) cultivars namely: NRSP/05/022, centennial, CIP440293, CIP199034.1, CIP199004.2, shaba, ex-oyinga, SPK004 and one high yielding white-fleshed cultivar TIS87/0087 (check) were evaluated for yield and susceptibility to *Cylas puncticollis* at the research farm of National Root Crops Research Institute (NRCRI), Umudike, Abia State, Nigeria between June to October 2010 and 2011. The trial was laid out in a randomized complete block design with three replications. The result identified that the newly introduced OFSP cultivars did not differ (P>0.05) significantly from the check plant stand at harvest. The foliage weight of Centennial was however significantly (P≤0.05) higher than the check. NRSP/05/022 had comparable root yield (total and marketable root numbers and weights), but a lower *C. puncticollis* attributes when compared with the check cultivar. Furthermore, the higher *C. puncticollis* total progeny number in the roots of CIP440293, centennial, CIP199004.2 and CIP199003.1 compared with the check is an indication of their higher susceptibility.

Key words: *Cylas puncticollis*, damage, infestation, orange-fleshed sweet potato (OFSP).

INTRODUCTION

According to Zandstra (1995), few crops are as genetically diverse and under-exploited as the sweet potato (*Ipomoea batatas* (L.) Lam.). It is ranked fifth in economic value production, sixth in dry matter production, seventh in energy production, ninth in protein production and it has flexibility of utilization as food, feed and industrial products (Gregory, 1992). It can also be used as animal feed or infant food (Oyeniyi et al., 2004). The low level of international trade in sweet potato reflects its important role in subsistence agriculture (Degrass, 2003). Recently, the crop has come to be appreciated as high fibre food (Candlish et al., 1987). The root and green foliage contain high levels of vitamin A and C, iron and potassium (Loebensein, 2009) and other minerals comparable to fruits (Truong, 1989).

The clamour for orange-fleshed sweet potato (OFSP) is due mainly to the nutritional and health advantages in its high vitamin A content. High pro-vitamin A helps to produce enough vitamin A, which enhances the immune system and helps the body to fight diseases better (Odebode et al., 2008). It also helps to quench the high reactive oxygen radicals in the body. Reactive oxygen species is known to destroy body protein, fat and their deoxyribonucleic acid (DNA) (Bagchi and Puri, 1998) thereby slowing down the aging process by mopping up reactive oxygen radicals. Li et al. (2003) discovered that a common carcinogen in cigarette smoke, benzo(a)pyrene, induces Vitamin A deficiency, but that a diet rich in Vitamin A can help counter that effect, thus reducing emphysema or cancer in cigarette smokers and in combating anaemia (Hans-Martin and M'Pia, 2008).

Annually, Nigeria has lost over US$15 billion in gross domestic product (GDP) to vitamin and mineral deficiencies as many staple foods are low in essential

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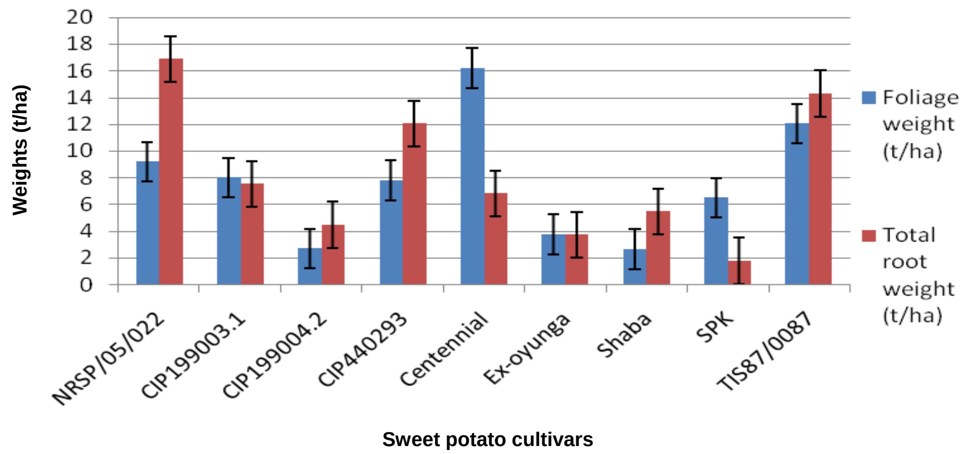

Figure 1. Mean (pooled) of foliage and total weights of selected OFSP cultivars in 2010 and 2011.

micronutrients (Adesina, 2012). Of recent there are efforts to combat vitamin A deficiency in children below 6 years and pregnant women by use of OFSP cultivars as a food based approach to combat vitamin A deficiency in diets among vulnerable communities in Sub-Saharan Africa (Low et al., 2001).

A number of OFSP genotypes have been identified and tested in NRCRI, Umudike. However, the sweet potato weevil, *C. puncticollis* (Boh.) is a major production constraint in Nigeria (Nwana, 1979; Talekar, 1987; Kumar, 1991; Skoglud and Smit, 1994; Ehisianya et al., 2011). Losses due to sweet potato weevil damage range from 1 to 100% (Alvarez, 1987). It is important therefore, that before the OFSP cultivars are passed to the farmers, they are evaluated for susceptibility to this important field to store pest and cultivars that combine the ability for a high yield with *C. puncticollis* tolerance are identified.

MATERIALS AND METHODS

Field experiments were conducted to evaluate eight promising OFSP cultivars namely: NRSP/05/022, centennial, CIP440293, CIP199034.1, CIP199004.2, shaba, ex-oyinga, SPK004 and one high yielding, white-fleshed cultivar TIS87/0087 (check) for yield and *C. puncticollis* infestation at NRCRI, Umudike between June to October 2010 and 2011. The trial was laid out in a randomized complete block design with nine sweet potato cultivars replicated three times. Ten vines of each OFSP cultivar were planted 0.3 m apart on a ridge 3 m long. There were three ridges in a plot and fertilizer (NPK, 15:15:15) was applied at the rate of 400 kg/ha at 4 weeks after planting (WAP) by ring placement method, preceding manual weeding and rouging was at 8 and 10 WAP (NRCRI, 2010) to the twenty-seven plots.

At harvest, the following data were collected: plant stand, number and weight of total and marketable roots (>100 g), number of plants with soil cracks and foliage weight, at harvest were determined (ha^{-1}). Count data such as *C. puncticollis* adult and immature stages and total progeny numbers were subjected to square root ($\sqrt{x} \pm 0.5$) transformation, whereas percentage infestation and damage were transformed to arcsine values. These were to improve the normality of variate (variance stability) after which all data were subjected to analysis of variance. Treatment means were separated using Studentized Newman Keul's (SNK) test ($P = 0.05$).

RESULTS

Foliage weight from OFSP cv. Centennial weighed 16 t/ha and was significantly ($P \leq 0.05$) higher than others, including the check TIS87/0087 with 12.05 t/ha (Figure 1). The least mean weight of 2.64 t/ha was obtained from Shaba followed by CIP199004.2 with 2.68 t/ha. Analysis of the total root weghts showed that NRSP/05/022 was highest with 16.90 t/ha and was significantly ($P \leq 0.05$) higher than the others, except TIS87/0087, while SPK004 was least with 1.78 t/ha (Figure 1).

Infested roots from OFSP (cv. CIP440293) had the highest weight of 2.15 t/ha and was significantly ($P \leq 0.05$) higher than the check (TIS87/0087) with 1.51 t/ha (Figure 2). NRSP/05/022 gave the lowest infested weight of 0.01 t/ha, while SPK had no infested root. The trend was similar in their severity score as significantly ($P \leq 0.05$) higher score was recorded in CIP440293 (2.17) when compared with 1.33 from the check (TIS87/0087) and the other OFSP cultivars. Shaba had 1.17 and SPK004 had 1.0 due to the absence of infested root.

A two-way analysis of variance indicated that the mean number of plant stand at harvest showed no significant ($P>0.05$) differences among the OFSP and the check

Table 1. Mean number of plant stand at harvest and foliage weight of selected orange-fleshed sweet potato (OFSP) cultivars evaluated in 2010 and 2011.

OFSP cultivars	OFSP cultivars			
	Plant stand at harvest (ha-¹) Mean ± SE		Foliage weight (t/ha) Mean ± SE	
	2010	2011	2010	2011
NRSP/05/022	22963 ± 1959.82[a]	28519 ± 1614.41[a]	9.04 ± 0.82[ab]	9.319 ± 1.27[ab]
CIP199003.1	15926 ± 5341.56[a]	27037 ± 2592.59[a]	10.51 ± 4.86[ab]	5.50 ± 1.42[ab]
CIP199004.2	23333 ± 3333.33[a]	27037 ± 1335.39[a]	3.27 ± 0.26[b]	2.09 ± 0.69[b]
CIP440293	25556 ± 4490.50[a]	28889 ± 1924.50[a]	7.89 ± 2.95[ab]	7.732 ± 2.16[ab]
Centennial	17037 ± 6457.63[a]	27778 ± 641.50[a]	20.05 ± 4.26[a]	12.31 ± 1.95[a]
Ex-Oyunga	27037 ± 3533.11[a]	20741 ± 2592.59[a]	3.16 ± 1.29[b]	4.35 ± 1.44[ab]
Shaba	17407 ± 2592.59[a]	22222 ± 2222.22[a]	2.04 ± 1.30[b]	2.31 ± 0.37[b]
SPK004	16667 ± 2796.23[a]	22963 ± 1481.48[a]	6.97 ± 3.54[b]	6.03 ± 4.21[ab]
TIS87/0087	26296 ± 2428.68[a]	28519 ± 1335.39[a]	11.60 ± 0.76[ab]	12.49 ± 1.61[a]
Prob.	0.2138	0.0531	0.0116	0.0100

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

cultivar in both years tested. However, their foliage (biomass) weights showed that Centennial weighed 20.05 t/ha and was significantly (P≤0.05) higher than SPK004 (6.97t/ha), CP199004.2 (3.27 t/ha) and Shaba (2.04 t/ha), but did not differ with the others in 2010 (Table 1). A similar trend was observed in 2011 as TIS87/0087 weighed 12.49 t/ha and Centennial gave 12.31 t/ha, but were not significantly (P>0.05) higher than others, except Shaba (2.31t/ha) and CIP199004.2 (2.09 t/ha) in 2011 (Table 1).

The mean total root number of OFSP and the check cultivar were not significantly (P>0.05) different in 2010, but in 2011, significantly (P≤0.05) higher numbers of roots were recorded by OFSP cvs. CIP440293 (89401.00) and Centennial (87363.00), but they were not significantly (P>0.05) different from white-fleshed cv. TIS87/0087 (59056.00), excerpt CIP199003.1 (22857.00) and SPK004 (4489.00) (Table 2). NRSP/05/022 gave 56914.00 number of marketable roots, but was not significantly (P>0.05) higher than the check and other OFSP except CIP199003.1 (9430.00) and SPK004 (11264.00) in 2010. The trend was similar in 2011, except for CIP199003.1, SPK004, Ex-Oyunga and Shaba. The weights of marketable roots showed that the check (TIS87/0087) cultivar weighed 15.54 t/ha and was significantly (P≤0.05) higher than the OFSP cultivars, except NRSP/05/022 with 14.32 t/ha. In 2011, the highest weight of 17.20 t/ha was recorded for NRSP/05/022, but it was not significantly (P>0.05) higher than the others except Shaba, Ex-Oyunga, CIP199004.2 and SPK004 with 3.27, 2.57, 0.97 and 0.00t/ha, respectively (Table 2).

The mean *C. puncticollis* attributes of selected OFSP roots namely: percentage plants in soils with cracks and percentage infestation and damage showed no significant (P>0.05) differences between the check and OFSP cultivars in both years (Table 3). Mean number of *C. puncticollis* (Boh.) progenies in orange-fleshed sweet potato (OFSP) cultivars in 2010 and 2011 are presented in Table 4. Analysis of variance indicated no significant differences between the OFSP and the check cultivar in respect to the number of *C. puncticollis* immature, adult or total progenies counted in their roots at harvest, although, higher number of insects were recorded in OFSP cvs CIP440293, CIP199003.1 and Centennial.

DISCUSSION

The evidence from the data in this study indicated that the newly introduced OFSP cultivars can be grown in southeastern agro-ecology of Nigeria. NRSP/05/022 gave appreciable yield when compared with the white-fleshed check (TIS87/0087) which is a known high yielder (Eke-Okoro, 2011). The high foliage weight of Centennial (16.18 t/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 have been concluded on the feeding value of sweet potato foliage (Chen and Chen, 1979). The nutritive value of sweet potato leaves has been attributed to the high content of antioxidant especially phenolic compounds (Islam et al., 2002; Yoshimoto et al., 2005). Leaves are widely consumed in East Africa (Abidin, 2004), and it has gained popularity as commercial cattle feed (Achata et al., 1988) in Peru, China, Japan and Taiwan. Aregheore (2003) also reported that better life weight gain was obtained when mixed diet of sweet potato forage and batiki grass were fed to goats.

The low *C. puncticollis* attributes of roots might be attributable to time of planting and harvesting. High rainfall precludes crack formation in the soil, which prevents ovipositing female weevil access to roots, since

Table 2. Mean of yield attributes of selected orange-fleshed sweet potato (OFSP) cultivars in 2010 and 2011.

OFSP cultivars	Root yield attributes							
	Total number Mean ± SE		Total weight Mean ± SE		Marketable number Mean ± SE		Marketable weight Mean ± SE	
	2010	2011	2010	2011	2010	2011	2010	2011
NRSP/05/022	85123 ± 13099.08^{a}	69151 ± 10473.41^{ab}	15.51 ± 1.21^{a}	18.29 ± 2.52^{a}	56914 ± 8143.47^{a}	45501 ± 1715.98^{a}	14.32 ± 1.48^{a}	17.20 ± 1.98^{a}
CIP199003.1	33010 ± 11264.16^{a}	22857 ± 11231.77^{bc}	2.12 ± 1.39^{c}	12.93 ± 5.59^{ab}	9430 ± 7182.26^{b}	6016 ± 2357.08^{b}	1.52 ± 1.22^{c}	12.24 ± 5.26^{ab}
CIP199004.2	7784 ± 5168.66^{a}	69775 ± 3767.25^{ab}	7.35 ± 0.76^{bc}	1.60 ± 0.49^{bc}	40741 ± 3854.94^{ab}	48423 ± 4857.62^{a}	6.01 ± 0.90^{bc}	0.97 ± 0.33^{c}
CIP440293	75006 ± 15780.79^{a}	89401 ± 18727.73^{a}	10.27 ± 2.46^{b}	13.81 ± 4.20^{ab}	36443 ± 11816.84^{ab}	58665 ± 12815.40^{a}	9.33 ± 2.10^{b}	12.78 ± 4.32^{ab}
Centennial	55128 ± 19736.93^{a}	87363 ± 4278.52^{a}	4.70 ± 1.68^{bc}	8.97 ± 0.26^{abc}	28856 ± 8948.53^{ab}	40647 ± 4494.42^{a}	3.82 ± 1.19^{bc}	7.28 ± 0.16^{abc}
Ex-Oyunga	69864 ± 9414.13^{a}	40333 ± 12810.13^{abc}	3.81 ± 0.66^{bc}	3.57 ± 1.42^{bc}	22578 ± 7471.11^{ab}	12308 ± 5763.80^{b}	1.64 ± 0.61^{c}	2.57 ± 1.09^{bc}
Shaba	58148 ± 31909.94^{a}	37058 ± 18592.89^{abc}	5.91 ± 2.98^{bc}	5.03 ± 1.88^{bc}	25370 ± 13303.72^{ab}	14268 ± 8792.27^{b}	4.76 ± 2.38^{bc}	3.27 ± 1.76^{bc}
SPK004	45701 ± 22459.81^{a}	4489 ± 2278.09^{c}	2.36 ± 1.04^{c}	0.31 ± 0.22^{c}	11264 ± 5162.48^{b}	617 ± 617.28^{b}	1.76 ± 0.89^{c}	0.00 ± 0.00^{c}
TIS87/0087	65284 ± 6753.02^{a}	59056 ± 5657.13^{ab}	17.26 ± 1.77^{a}	11.36 ± 2.79^{abc}	38300 ± 3579.27^{ab}	42923 ± 5498.97^{a}	15.54 ± 1.86^{a}	10.42 ± 2.66^{abc}
Prob.	0.4124	0.0010	0.0001	0.0018	0.211	0.0001	0.0001	0.0010

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

Table 3. Mean of *C. puncticollis* (Boh.) attributes of roots in selected orange-fleshed sweet potato (OFSP) cultivars in 2010 and 2011.

OFSP cultivars	Percentage plant in soil with cracks (ha^{-1}) Mean ± SE		Percentage infestation Mean ± SE		Percentage damage Mean ± SE	
	2010	2011	2010	2011	2010	2011
NRSP/05/022	14.48 ± 0.73^{a}	12.14 ± 3.20^{a}	2.32 ± 2.32^{a}	0.00 ± 0.00	1.06 ± 1.06^{a}	0.00 ± 0.00^{a}
CIP199003.1	55.09 ± 25.78^{a}	6.43 ± 5.17^{a}	0.00 ± 0.00^{a}	14.29 ± 7.73	0.00 ± 0.00^{a}	3.72 ± 2.37^{a}
CIP199004.2	9.95 ± 3.61^{a}	9.84 ± 3.90^{a}	15.29 ± 4.63^{a}	0.00 ± 0.00	18.02 ± 5.94^{a}	0.00 ± 0.00^{a}
CIP440293	12.21 ± 2.72^{a}	7.53 ± 1.95^{a}	20.11 ± 2.68^{a}	6.02 ± 6.02	21.42 ± 10.51^{a}	11.29 ± 11.29^{a}
Centennial	47.17 ± 27.22^{a}	8.33 ± 2.25^{a}	21.52 ± 7.34^{a}	0.00 ± 0.00	16.99 ± 4.33^{a}	0.00 ± 0.00^{a}
Ex-Oyunga	6.39 ± 3.41^{a}	3.20 ± 1.62^{a}	16.42 ± 9.28^{a}	0.00 ± 0.00	25.17 ± 15.45^{a}	0.00 ± 0.00^{a}
Shaba	5.47 ± 3.00^{a}	26.06 ± 14.84^{a}	6.25 ± 6.25^{a}	6.49 ± 6.49	10.44 ± 10.44^{a}	3.03 ± 3.03^{a}
SPK004	18.77 ± 10.79^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}
TIS87/0087	14.99 ± 3.65^{a}	14.13 ± 5.56^{a}	12.55 ± 6.88^{a}	0.00 ± 0.00	20.52 ± 10.94^{a}	0.00 ± 0.00^{a}
Prob.	0.1113	0.1772	0.0570	0.1678	0.2719	0.5521

Means within a column followed by the same letter do not differ significantly from each other (P > 0.05; SAS, PROC GLM, SNK). Means of percentage infestation and damage are transformed to arcsine values prior to analyses.

damage by weevil is usually higher during the dry season (Talekar, 1987). The damage severity score and number of *C. puncticollis* (Boh.) progenies that developed in TIS87/0087 roots were not significantly different from the OFSP cultivars, although more progenies were observed

Table 4. Mean number of *C. puncticollis* (Boh.) progenies in selected orange-fleshed sweetpotato (OFSP) cultivars in 2010 and 2011.

OFSP cultivars	Immature stages		Adults		Total progeny	
	2010	2011	2010	2011	2010	2011
NRSP/05/022	2.67 ± 2.67 [a]	0.00 ± 0.00[a]	0.00 ± 0.00 [a]	0.00 ± 0.00[a]	2.67 ± 2.67 [a]	0.00 ± 0.00[a]
CIP199003.1	0.00 ± 0.00 [a]	12.67 ±7.21[a]	0.00 ± 0.00[a]	3.33 ±1.67[a]	0.00 ± 0.00[a]	16.00 ± 8.71[a]
CIP199004.2	8.33 ± 3.52 [a]	0.00 ± 0.00[a]	1.67 ± 1.20 [a]	0.00 ± 0.00[a]	10.00 ± 4.72[a]	0.00 ± 0.00[a]
CIP440293	12.00 ± 4.72[a]	7.33 ± 7.33[a]	2.67 ± 2.18 [a]	0.00 ±0.00[a]	14.67 ± 6.76[a]	7.33 ± 7.33[a]
Centennial	11.00 ± 4.04[a]	0.00 ± 0.00[a]	2.00 ± 1.15 [a]	0.00 ±0.00[a]	13.00 ± 5.19[a]	0.00 ± 0.00[a]
Ex-Oyunga	7.33 ± 5.04[a]	0.00 ± 0.00[a]	2.67 ± 1.76 [a]	0.00 ±0.00[a]	10.00 ± 6.80[a]	0.00 ± 0.00[a]
Shaba	1.67 ± 1.67 [a]	10.00 ± 6.08 [a]	0.00 ± 0.00[a]	2.67 ±0.57[a]	1.67 ±1.67[a]	12.67 ± 8.50[a]
SPK004	0.00 ± 0.00 [a]	0.00 ± 0.00[a]	0.00 ± 0.00[a]	0.00 ±0.00[a]	0.00 ± 0.0[a]	0.00 ± 0.00[a]
TIS87/0087	8.33 ± 4.63 [a]	0.00 ± 0.00[a]	2.00 ±1.15[a]	0.00 ±0.00[a]	10.00 ± 5.78[a]	0.00 ± 0.00[a]
Prob.	0.1930	0.2048	0.4786	0.2487	0.2435	0.1837

Means within a column followed by the same letter do not differ significantly from each other (P > 0.05; SAS, PROC GLM, SNK). Means of immature, adult and total progenies are transformed to square root values prior to analyses.

on OFSP cultivars namely: CIP440293, CIP199003.1 and Centennial.

It is significant to note that the higher insect progenies in roots is an indication of the higher susceptibility of the OFSP cultivars when compared with white-fleshed TIS87/0087, since the pest is capable of producing several generations (multivoltine) in one year. This perhaps may also be attributed to the higher levels of Vitamin A in CIP440293 and Centennial cultivars (Njoku, 2009) thereby providing this insect with more nutrition. Our result follow the pattern reported by Ehisianya et al. (2010) and Zakka et al. (2010) in which processed orange- and white-fleshed sweet potato roots were artificially infested with the flour beetle, *Tribolium castaneun* (Herbst) and the pest utilized the OFSP (cv. CIP440293) flour and chips more than those from the white-fleshed variety.

Conclusion

We conclude from this study that plant stand at harvest of these new OFSP cultivars did not significantly differ from the white-fleshed check (TIS87/0087). OFSP cv. Centennial gave significantly higher foliage weight than TIS87/0087.

NRSP/05/022 had a high root yield but it was not significantly different from TIS87/0087. Centennial and CIP440293 had higher *C. puncticollis* (Boh.) attributes than the check. It is important to note that this high value, beta-carotene rich sweet potato cultivars provide a unique opportunity for increased production of highly nutritious food and feed in fresh and processed forms for local and international markets. It is therefore recommended that further screening be carried out during the drier (minor) cropping season and growers should protect the crops to reduce damage by this pest.

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