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Relative abundance of sweetpotato whitefly in orange-fleshed sweetpotato cultivars at Umudike, south-east Nigeria

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Abstract

Field experiments were conducted to evaluate the relative abundance of sweetpotato whitefly, *Bemisia tabaci* (Gennadius) on selected orange-fleshed sweetpotato (OFSP) cultivars namely: NRSP/05/022, CIP440293, Centennial, CIP199034.1, CIP199004.2, Shaba, Ex-Oyinga, SPK004 and one white fleshed (TIS87/0087) as a check at National Root Crops Research Institute (NRCRI), Umudike during the 2010 and 2011 cropping seasons. The experiments were laid out in a Randomised Complete Block Design replicated three times. Sampling for adult *B. tabaci* was done in the early hours of the morning (0700-0900h) starting five weeks after planting (WAP) and operated at weekly intervals from three inner plants of the middle row of each plot for a period of three months. The study revealed that selected OFSP cultivars tested were colonised by *B. tabaci.* The preponderance of *B. tabaci* on OFSP cultivars: NRSP/05/022, CIP440293 and Centennial gave mean values of 15.33, 12.83 and 10.47, respectively; which is an indication of their susceptibility to the sweetpotato chlorotic stunt virus infection, a precursor of sweetpotato virus disease.

Key words: *Bemisia tabaci*, infestation, orange-fleshed sweetpotato, sampling

Introduction

Recent clamour for orange-fleshed sweetpotato (OFSP) is due mainly to the nutritional and health advantages in its high vitamin A content. Vitamin A deficiency affects over 144 million children under five and has been identified as a wide-spread public health problem in 37 countries worldwide, affecting a considerable percentage of the population in North Eastern Brazil, sub-Saharan Africa and South East Asia (Reddy *et al*., 2005). Efforts have been geared towards combating Vitamin A deficiency in children and pregnant women using a food-based approach among vulnerable communities in Sub-Saharan Africa (Low *et al*., 2001). The roots could be grated and subsequently fermented for 1-2 days then roasted to produce sweetpotato *garri*, as in cassava. The product is tasty and keeps well (Odebode, 2004).

Sweetpotato is increasingly playing a significant role as a ready source of income from sale of storage roots, vines and processed products in rural and urban markets. However, sweetpotato yields in Nigeria are very low due largely to the menace of sweetpotato weevil (*Cylas puncticollis* (Ehisianya *et al*., 2012) and sweetpotato virus disease (SPVD). In Uganda, losses of more than 90% were observed when 11 varieties of SPVD-

affected sweetpotato cuttings were planted in farmers' fields (Aritua *et al.,* 2000). The high viral incidence in sweetpotato crops is due to the planting of infected stem cuttings (virus source) and the secondary spread of viruses by aphid and whitefly vectors.

The sweetpotato whitefly, *Bemisia tabaci* (Gennadius) is currently the most devastating pest in tropical and subtropical countries, due largely to its role in the transmission of a variety of plant viruses (Perring, 2001; Loebenstein *et al*., 2003). One of the major limiting biotic factors to increased sweetpotato productivity is sweetpotato virus disease (SPVD) (Carey *et al*., 1999) and it is reported to occur wherever sweetpotato is grown in the world (Brown *et al*., 1995). It is also a serious economic pest of agronomic, horticultural, and ornamental crops throughout warm regions of the world (Byrne *et al*., 1990; Brown, 1994). Losses of 20-30% due to sweetpotato virus diseases were observed in China (Gao *et al*., 2000). It has been reported as a major production constraint in Uganda (Aritua *at al*., 1999), Kenya and Tanzania (Loebenstein, 2009); and most of the introduced OFSP materials have succumbed to the viral infection. SPVD results from co-infection of sweetpotato plants with the aphid-borne *sweetpotato feathery mottle virus* (SPFMV) (Family *Potyviridae*: Genus *Potyvirus*) and the *B. tabaci*-borne sweetpotato *chlorotic stunt virus* (SPCSV) (Family *Closteroviridae*: Genus *Crinivirus*) (Schaefers and Terry, 1976; Gibson *et al*., 1998).

Tomlinson and Walkey (1967) noted that virus infection of vegetative propagated crops may have serious consequences. Unlike fungal (Bent, 1967) pathogens, viruses cannot be controlled in infected field by chemical treatments, and meanwhile, chemical control may also seriously aggravate *B. tabaci* by reducing natural enemies (Wang *et al*., 2007). According to Moyer and Salazar (1989), virtually all sweetpotato grown from non-virus tested materials revealed the presence of one or more viruses. More recently, Zhang *et al*. (2009) has reported the presence of SPFMV and SPCSV in CIP199004.2 genotype originating from Africa.

A number of newly introduced OFSP cultivars are being tested for release to farmers at National Root Crops Research Institute (NRCRI), Umudike; and information on their response to *B. tabaci* is not available yet. Therefore, there is need to ascertain the response of selected OFSP cultivars available to *B. tabaci* colonisation and infestation. This study was embarked upon to determine the susceptibility of the introduced OFSP cultivars to *B. tabaci*.

Materials and methods

Field experiments were conducted to evaluate different elite OFSP cultivars namely: NRSP/05/022, CIP440293, Centennial, CIP199034.1, CIP199004.2, Shaba, Ex-Oyinga, SPK004 and white-fleshed TIS87/0087 (check) for *B. tabaci* infestation at NRCRI, Umudike during the 2010 and 2011 cropping seasons. The ecological factors of study location are presented in Table 1. The trial was laid out in a randomised complete block design, with the nine cultivars as treatments replicated four times. Ten vines were planted on a ridge of 3 m and space 0.3 m apart with three ridges in a plot. Weeding was at 4 weeks after planting (WAP) preceding fertiliser (NPK 15:15:15)

Table 1. Ecological factors and study condition of location (Umudike) in Nigeria (2010 and 2011)

Ecological factor	Year	
	2010	2011
Latitude	05° 29'N	05° 29'N
Longitude	07° 33'E	07° 33'E
Altitude	122.00m	122.00m
Rainfall (Mean)	132.12mm	170.37mm
Temperature (Mean)	26.68^{0}C	26.50^{0}C
Humidity (Mean)	75.04%	81.33%
Soil	Sandy loam	Sandy loam

Source: Meteorological unit, NRCRI, Umudike, 2011

application at the rate of 400 kg/ha by ring placement method and rouging at 8 and 10 WAP.

Visual count of *B. tabaci* commenced at one month after planting (MAP) and operated at weekly intervals from three inner plants of the middle row of each plot for a period of three months. In each population assessment, whiteflies were counted between 0700 and 0900 hr when the insects are relatively inactive on the first fully expanded leaves starting from the apex. Each leave was carefully turned to expose the lower surface and all adults were counted and recorded.

The number of adult *B. tabaci* counted weekly were transformed to square root values before subjecting to two-way analysis of variance using SAS and significant means were separated using Student-Newman-Keuls' (SNK) Test at 5% probability.

Results

The pooled mean number of adult *B. tabaci* counted on selected OFSP cultivars in 2010 and 2011 is shown in Figure 1. Irrespective of periods of sampling, significantly ($P \leq 0.05$) higher population of *B. tabaci* was counted on the OFSP cultivars in 2011 than in 2010, except Shaba, Ex-Oyunga and CIP199003.1. The check was, however, significantly higher than OFSP cultivars, except NRSP/05/022 and Shaba. In 2011, NRSP/05/022 and CIP440293 were not significantly ($P>0.05$) different from the check.

Mean number of *B. tabaci* at different times on the OFSP cultivars in 2010 and 2011 is shown in Table 2. CIP199003.1 had the least number of adult *B. tabaci* at weeks 2, 3, 4 and 5 when compare with the other, and was significantly lower than TIS87/0087. NRSP/05/022, CIP440293 and Centennial gave mean values of 15.33, 12.83 and 10.47, respectively, but was not significantly different from the check. TIS87/0087 and NRSP/05/022 showed consistently higher population of *B. tabaci* throughout the study period. Table 3 shows the weekly population of *B. tabaci* at different times on selected OFSP cultivars sampled in 2010 and 2011. Irrespective of cultivar tested, there was no significant difference in the population of adult *B. tabaci* on OFSP leaves, except in weeks 1, 6, 8, 9 and 10.

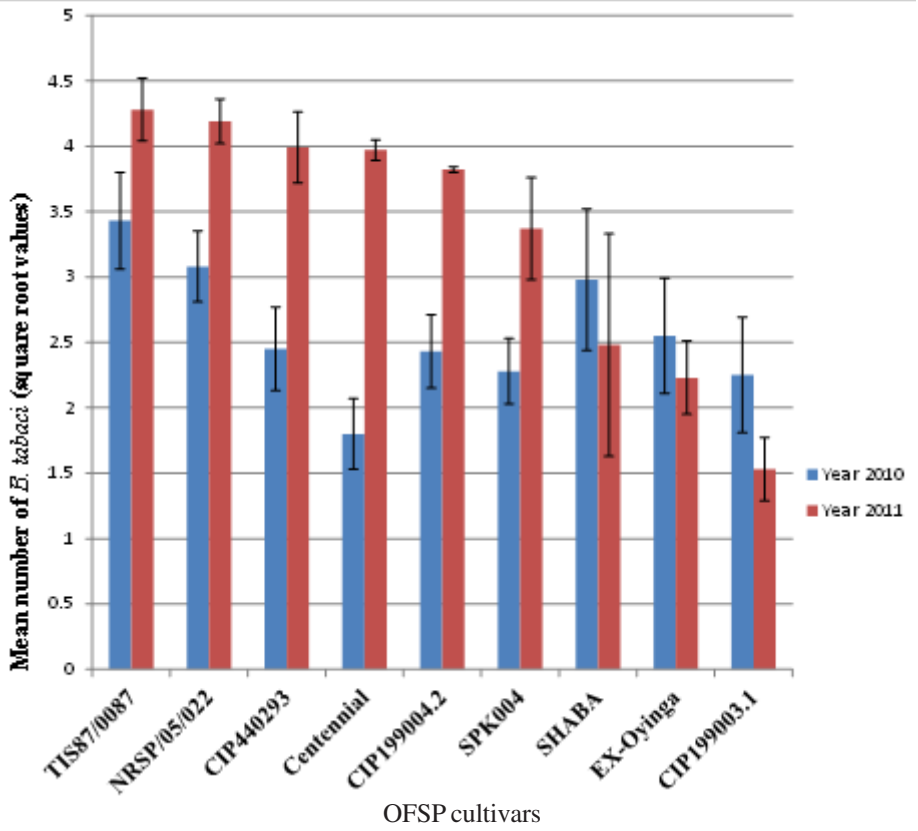

Figure 1. Pooled mean number of *B. tabaci* on selected OFSP cultivars.

Discussion

The results of this study revealed that the OFSP cultivars tested were colonised and consequently were susceptible to *B. tabaci* infestation. The high population of adult *B. tabaci* on OFSP cv. NRSP/05/022, CIP440293 and Centennial predisposes them to SPCSV. Sweetpotato chlorotic stunt virus synergises the infection of SPFMV (Karyeija *et al.,* 1998) and appears to be the key in the spread of SPVD, being closely associated with the prevalence of *B. tabaci* on crops (Aritua *et al.,* 1999a). Also, the rarity of the aphids in fields and apparent absence of SPFMV in symptomless plants result in SPCSV being the limiting factor in the incidence of SPVD and may explain how the spread of SPVD has largely been associated with the abundance of *B. tabci*. In controlled experiments, SPFMV-infection alone did not reduce yield compared to virus-free control, while the complex infection with SPCSV reduced yield by 50% or more (Gutierrez *et al*., 2003). Cassava and sweetpotato are cultivated under similar environmental requirements and can both be infested by *B. tabaci*. It is significant that evidence suggests that these are distinct biotypes that do not cross colonise (Legg, 1996) as the polyphagous biotype B does not appear to feed on cassava plant. Similarly, studies by Basu (1995) and, Palaniswami and

Table 2. Mean number of *Bemisia tabaci* at different times on selected orange-fleshed sweetpotato cultivars at Umudike in Nigeria (June to October, 2010 and 2011)

Sweetpotato cultivars	Sampling intervals (weeks)										Mean
	1	2	3	4	5	6	7	8	9	10	
TIS87/0087	32.50(5.59) [a]	23.17(4.62) [a]	17.67(3.95) [a]	21.83(4.58) [a]	25.50(4.97) [a]	16.83(3.81) [a]	12.50(3.48) [a]	5.83(2.78) [a]	12.00(3.22) [a]	6.00(2.18) [a]	17.38(3.78)[a]
NRSP/05/022	31.33(5.36) [a]	16.00(3.930 [a]	17.00(4.06) [a]	21.00(4.47) [a]	17.67(4.14)[ab]	13.17(3.58) [a]	14.67(3.61) [a]	9.17(2.17) [a]	8.33(2.62) [a]	5.50(1.82) [a]	15.33(3.56)[ab]
CIP440293	28.00(4.82) [a]	10.33(3.07)[ab]	14.17(3.56)[ab]	7.83(2.750 [ab]	15.67(3.76)[ab]	11.83(3.32) [a]	11.17(3.16) [a]	8.50(1.73) [a]	12.00(3.11) [a]	4.33(1.92) [a]	12.28(3.16)[abc]
CENTENNIAL	21.00(3.85) [ab]	7.50(2.09) [ab]	12.17(3.24)[ab]	9.83(2.98) [ab]	9.83(2.92) [ab]	10.50(2.9) [a]	9.17(2.93) [a]	7.83(2.7) [a]	10.33(2.61) [a]	6.50(2.01) [a]	10.47(2.80)abc
CIP199004.2	16.50(3.81) [ab]	8.83(2.76) [ab]	11.50(3.00)[ab]	13.83(3.61)[ab]	13.50(3.61)[ab]	8.00(2.75) [a]	11.50(3.35) [a]	9.50(2.94) [a]	12.83(3.30) [a]	6.00(2.12) [a]	11.20(3.04)[abc]
SPK004	14.17(3.51) [ab]	9.00(2.96) [ab]	7.83(2.69)[ab]	9.67(2.97) [ab]	10.67(3.15)[ab]	10.17(3.00) [a]	9.00(2.79) [a]	9.17(2.71) [a]	8.50(2.50) [a]	4.50(1.71) [a]	9.27(2.76)[abc]
SHABA	14.83(3.28) [ab]	8.83(2.58) [ab]	9.50(2.74) [ab]	16.17(3.49)[ab]	14.67(3.67)[ab]	8.83(2.73) [a]	9.83(2.82) [a]	4.33(1.79) [a]	7.00(2.50) [a]	4.00(1.75) [a]	9.80(2.68)[abc]
EX-OYUNGA	9.67(2.88) [ab]	9.17(2.9) [ab]	6.33(2.39) [ab]	8.50(2.78) [ab]	7.83(2.47) [b]	6.67(2.46) [a]	10.67(2.94) [a]	2.50(1.37) [a]	8.17(2.42) [a]	3.33(1.28) [a]	7.29(2.34)[bc]
CIP199003.1	2.17(1.11) [b]	3.33(1.40) [b]	3.67(1.51) [b]	7.17(2.12) [b]	5.83(1.90)[b]	6.67(2.54) [a]	9.33(3.00) [a]	3.67(1.54) [a]	8.00(2.24) [a]	2.33(1.48) [a]	5.22(1.86)[c]
Prob.(0.05)	0.0016	0.026	0.0391	0.0192	0.052	0.2487	0.9036	0.012	0.2647	0.8156	0.0012

Means within a column followed by the same letter do not differ significantly from each other (P > 0.05; SAS, PROC GLM, SNK), while figure in parenthesis are square root values

Table 3. Weekly number of *Bemisia tabaci* at different times on selected orange-fleshed cultivars at Umudike in Nigeria (2010 and 2011)

Year	Sampling intervals (weeks)									
	1	2	3	4	5	6	7	8	9	10
2011	25.63(4.42)[a]	11.19(3.11)[a]	11.89(3.10)[a]	11.11(3.04)[a]	13.70(3.33)[a]	14.11(3.56)[a]	11.82(3.23)[a]	10.15(2.95)[a]	16.07(3.92)[a]	7.56(1.56)[a]
2010	12.19(3.18)[b]	10.19(2.92)[a]	10.30(2.93)[a]	14.63(3.58)[a]	13.22(3.46)[a]	6.48(2.45)[b]	9.82(3.01)[a]	3.30(1.65)[b]	3.30(1.58)[b]	1.89(0.79)[b]
Prob. (0.05)	0.0018	0.6145	0.457	0.1293	0.8304	0.0002	0.2825	0.0001	0.0001	0.0001

Means within a column followed by the same letter do not differ significantly from each other (P > 0.05; SAS, PROC GLM, SNK), while figure in parenthesis are square root values

Nair (1995) in India indicated the presence of host-associated strains in *B. tabaci*.

Although, trichome configuration of the cultivars were not assessed in this study, the preference for cv. NRSP/05/022 over other OFSP cultivars with respect to the higher number of *B. tabaci* on the leaves could be due to differences in physical and chemical characteristics (trichome) of the leaves of this cultivar. In general, hairy plant species have been found to be preferred over globrous ones up to a certain level when hairiness begins to interfere with feeding and attachment of eggs to the leaf epidermis. In their study, Butler and Henneberry (1984), reported that *B. tabaci* showed higher preference for hairy-leaf varieties of cotton to globrous ones. McAuslane (1996) also reported a positive correlation between hairiness and oviposition of *B. tabaci* on soybean. In the present study, *B. tabaci* preferred sweetpotato cultivars which have trichomes covering the leaf surface.

Conclusion

Orange-fleshed sweetpotato (OFSP) cultivars in fields of NRCRI, Umudike, Nigeria revealed colonisation by *B. tabaci,* indicating their susceptibility to sweetpotato chlorotic stunt virus (SPCSV) which predisposes them to SPVD. It is evident from this study that *B. tabaci* poses a serious threat to the crop. Steps must therefore, be taken to protect OFSPs. Breeding of OFSP cultivars with globrous leaves should be encouraged to deter oviposition, population buildup and thus abate the transmission of SPCSV.

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