Evaluation of Sweet Potato Clones for Resistance to *Cylas puncticollis* Boheman (Coleoptera: Apionidae) in Sierra Leone.

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Keywords : Potato - *Cylas puncticollis* -Evaluation - Tuber characters - Groups.

Summary

A study to evaluate fifteen clones of sweet potato for their resistance to the weevil Cylas puncticollis *was under taken over two cropping seasons. The clones were mostly advanced breeding lines or materials released to farmers in Sierra Leone. Numbers of weevils recovered from the different clones and damage levels were significantly different. However, there was a lack of correlation between damage levels and insect counts, despite significant differences for these two sets of criteria among the clones. This suggests that suitability for infestation by the weevil may be different from susceptibility to damage. Clones that suffered least damages had white fleshed tubers and skins which were elongated and dispersed in formation. Other characters for the least damaged clones include deep tuber placement and higher dry matter contents. The clones were however categorised into four groups with varying levels of susceptibility/resistance. The tuber characters are identified as conferring resistance to weevil attack and the most resistant clones are recommended for utilization in breeding programmes as indices or parents or directly as planting materials in farmers fields.*

Résumé

Evaluation de la résistance des clones de patate douce à *Cylas puncticollis* Boheman (Coléoptère: Apionidae) au Sierra Leone.

Cette étude, effectuée chez des fermiers au Sierra Leone durant deux saisons culturales, évalue la résistance de 15 clones de patate douce (lignées ou matériel diffusé par un institut de recherche) au charançon Cylas puncticollis. *Les résultats obtenus montrent que ces clones ont manifesté différentes sensibilités en tenant compte du nombre de charançons et du niveau de dégâts. Au sein de chaque clone, aucune corrélation n'a été observée entre le nombre de charançons et le niveau de dégâts. Ceci démontre que la susceptibilité à l'infestation de la patate douce par les charançons n'est pas nécessairement liée à leur sensibilité aux dégâts. Les clones tolérants étaient caractérisés par des tubercules de forme allongée à chair et peau blanches. Ces tubercules se formaient de manière dispersée en profondeur dans le sol et présentaient une haute teneur en matière sèche. Ces clones ont été classés en quatre catégories suivant leur sensibilité/résistance à l'attaque des charançons. Les clones les plus résistants à l'attaque des charançons sont à recommander dans les programmes de croisements. Ils peuvent être utilisés comme témoins, servir de parents ou être directement utilisés comme matériel de plantation chez les fermiers.*

Introduction

Sweet potato is a pan tropical crop grown for human consumption and livestock feed in many countries. In Sierra Leone, the tubers are the third most important staple after rice and cassava. In addition the leaves are eaten as some sort of spinach and constitute one of the most important sources of vegetable proteins, minerals, and vitamins. However, tuber yields are low, ca. 2.6 t/ha compared with averages for Africa and the world of ca. 9.6 t/ha and ca.15.9 t/ha respectively (7). Tuber yields of over 40 t/ha have been reported in some African countries (9). The constraints attributed to the dismally low tuber yields in Africa include diseases, insect and vertebrate pests, weed infestation, soil nutrient deficiencies, poor crop husbandry practices and socio - economic factors (1, 9, 18). Of these, insect pests are considered one of the most limiting, with the *Cylas* spp. complex being the most widely distributed and destructive (5, 12). Damages to tubers by *Cylas* spp. in the field and in storage are usually severe and yield losses in the region of 12 - 90% have been reported (4, 12, 13).

Efforts at controlling the pest in Sierra Leone are minimal and rely mostly on cultural practices such as hand picking of pests, weeding or brushing around farms and the application of insecticidal materials (1). These control methods are ineffective and at times labour intensive. Therefore, there is a need to develop appropriate and effective control measures for the weevils. The identification of resistant cultivars is one approach.

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Resistant cultivars are environmentally friendly as they leave no toxic chemical residues in the soil and water ways. They are effective, simple, cheap and easy to adopt. Once resistant cultivars are identified they can easily be made available to farmers, who only need to plant the materials to obtain/attain some measure of pest control. This study, therefore, is an attempt to identify sweet potato clones that show some levels of resistance to the weevil *Cylas puncticollis* Boheman.

Material and methods

This experiment was planted over two cropping seasons, each time to coincide with the main sweet potato growing period in Sierra Leone (September to January). Fifteen sweet potato clones were used in this study. The clones were : Njala white, 84/16, 87/06, 82/123 (Red), 84/17, 82/123 (white), 87/131, Madam, Tis 2532, Ropot 2, 93/04, 82/144, Njala wonder, 87/37 and 93/03. Some characteristics of these clones are given in Table 1. These materials were mostly advanced breeding lines (F5/F6) or released clones obtained from the Institute of Agricultural Research, Njala, Sierra Leone. Apical cuttings, ca. 30 cm long, of these clones were planted separately into single row plots, 4.8 m in length. There were four replications for each clone. The clones Njala white and 82/123 (Red) were used as susceptible and resistant checks respectively. Cuttings were planted at spacings of 30 cm within rows and 1 m between rows which were ridged. Hand weeding was done one month after planting and this was followed immediately by band placement of 15 - 15 -15 N-P-K fertilizer at the rate of 270 kg/ha.

For each clone, the following data were collected fifteen weeks after planting :

a) length of tuber neck
b) depth of tuber placement in the soil
c) tuber length
d) tuber width
e) weight of damaged and undamaged tubers
f) skin and flesh colours
g) cortex thickness of tubers
h) number of larvae
i) number of adult weevils
j) dry matter content of tubers

Except for skin and flesh colours and dry matter contents, each of the above parameters was obtained from 10 randomly selected plants per clone per replication. Tuber neck lengths and placement depths were measured at harvest while the tubers were still submerged in the soil. Tuber placement depth measurements were from the soil surface to the upper part of the tubers embedded in the soil. Tuber lengths and widths were measured using vernier calipers after harvesting. Assessment of the number of damaged and undamaged tubers was done by visual examination of the tubers after harvest. The cortex thickness was also measured using vernier calipers. The skin and flesh colours were determined by visual examination and with the aid of a Munsell chart. Adults and larvae of the weevils were extracted from the tubers by chipping them into small bits to facilitate removal and counting. For each clone, a 100 g sample from freshly harvested

Table 1
Some characteristics of the different sweet potato clones.

Clone	Petiole colour	Leaf colour (mature)	Mature leaf shape	Tuber shape	Tuber skin colour	Tuber flesh colour	Tuber formation
Njala white	Green	Green	Lobed	Elongated	White	Pink	Dispersed
84 / 16	Green with purple near leaf	Green	Lobed	Elongated	White	White	Open cluster
87 /06	Green with purple near leaf	Purple	Lobed	Ovate	Pink	White	Open cluster
82 /123 (Red)	green	Green	Elliptical	Elongated	White	Pale yellow	Closed cluster
84 / 17	Green with purple near leaf	Purple	Lobed	Elongated	White	White	Open cluster
82 /123 (White)	Green	Purple	Triangular	Elongated	White	White	Dispersed
87 / 131	Green	Purple	Triangular	Elongated	White	White	Open cluster
Madam	Green	Green	Triangular	Elongated	Reddish yellow	Reddish yellow	Open cluster
Tis-2532	Green	Green	Triangular	Elliptical	White	White	Open cluster
Ropot 2	Green with purple near leaf	Green with purple at edges	Lobed	Ovate	Pink	White	Open cluster
93 / 04	Green with purple near leaf	Purple	Lobed	Elongated	White	Yellow	Open cluster
82 / 144	Green with purple near leaf	Green	Triangular	Elliptical	Red	Yellow	Dispersed
Njala wonder	Green	Green	Lobed	Elongated	White	White	Open cluster
87 / 37	Green with purple near leaf	Purple	Lobed	Elliptical	Pink	White	Open cluster
93 / 03	Green with purple near leaf	Green	Lobed	Elliptical	White	White	Dispersed

tubers was cut into slices and the dry matter content was determined. The samples were initially sun - dried for two days and later oven dried to constant weight in a moisture extraction oven for 5 days at 80°C. The dry weights were recorded and the percentages dry matter determined as follows :

$$\text{Percent dry matter} = \frac{\text{dry weight of tubers}}{\text{fresh weight of tubers}} \times 100$$

The data collected were subjected to analyses of variance (ANOVA) and the means were separated by LSD. Regression analysis was run between percent damaged tubers and weevil counts for the clones tested.

Results

The differences in the numbers of larvae and adults recovered were highly significant among the clones (Table 2). Significantly more weevils were recorded from clones such as Madam, 87/37, 82/123 (Red) and 84/17. Clones with low weevil counts were 93/04, 93/03 and 82/123 (White). Similarly, the weights of tubers produced and damaged were highly significant for the different clones (Table 3). Clones like Madam, 82/123 (Red) and 87/37 had higher weights of damaged tubers with mean values of 0.58, 0.78 and 1.0 kg respectively, while 82/144, Tis 2532, Njala white, Njala wonder and 93/03 had lower weights of damaged tubers with values of 0.28, 0.26, 0.24, 0.18 and 0.16 kg respectively (Table 3). Percent tuber damages were highest in 87/37, 82/123 (Red) and Madam and lowest in 93/04, 93/03 and Njala white. The relationship between percent damaged tubers and number of weevils recorded was described by the equation Y = 25.06 - 0.10X (R^2 = 0.0021; $P < 0.05$). Tubers yields were also variable for the clones tested (Table 3). The clones 87/37 and 87/06 had the highest yields of over 2 kg per 40 plants .

Tuber characteristics such as tuber neck lengths, placement depths, lengths and widths, cortex thicknesses, numbers of tubers per plant and dry matter weights were significantly different among the clones (Table 4). Njala white and 82/123 (Red) were clones with long tuber necks and having mean values of 7.6 and 9.3 cm respectively, while 87/06 and 87/37 had short necks with values of 3.2 and 3.3 cm respectively. Njala white and Njala wonder had deep tuber placements with mean values of 9.7 and 9.5 cm respectively. Conversely, 87/06, 84/16 and 82/123 (White) had short tuber placements with values of 5.5, 5.4 and 5.3 cm respectively. Clones with long tubers included 82/144, and 84/17 with mean values of 11.9 and 12.0 cm respectively, 93/04 and Madam had short tuber lengths with values of 8.2 and 8.1 cm respectively (Table 4). Tuber widths were highest in clones 87/37 and 87/06 with mean values of 4.7 and 5.4 cm respectively, while Njala wonder and Njala white had smaller widths with values of 3.0 and 2.9 cm respectively. Tuber cortex was thickest in 87/131 and thinnest in 93/03 with mean values of 8.7 and 1.2 mm respectively. Madam and 84/16 had the highest number of tubers per plant while Ropot 2 and 93/03 had the lowest (Table 4). Percent dry matter weights were high in 93/04, TIS 2532 and 93/03 with values of 36.9, 37.1 and 39.3 respectively and low for Madam with a value of 29.7 (Table 4). Tuber widths were highest in clones 87/37 and 87/06 with mean values of 4.7 and 5.4 cm respectively, while Njala wonder and Njala white had smaller widths with values of 3.0 cm and 2.9 cm respectively. Tuber cortex was thickest in 87/131 and thinnest in 93/03 with mean values of 8.7 mm and 1.2 mm. Madam and 84/16 had the highest number of tubers per plant with mean values of 6.0 and 6.7 respectively, Ropot 2 and 93/03 had the lowest with values of 2.8 and 2.2 respectively. Percent dry matter weight was higher in 93/04, TiS 2532 and 93/03 with

Table 2
Mean number of weevils recovered from 40 plants for the different clones

Clone	Number of larvae	Number of adults	Total number of weevils
Njala white	52.3	2.5	54.8
84 / 16	53.0	1.8	54.8
87 / 06	41.8	3.8	45.5
82 / 123 (Red)	107.3	16.8	124.0
84 / 17	108.0	7.5	115.5
82 /123 (White)	35.8	1.0	36.8
87 / 131	87.3	7.5	94.8
Madam	126.3	14.0	140.3
Tis - 2532	54.8	2.8	57.5
Ropot 2	71.5	0.8	72.3
93 / 04	23.8	4.0	27.8
82 / 144	78.3	9.5	87.8
Njala wonder	55.5	0.0	55.5
87 / 37	112.5	15.3	127.8
93 / 03	34.3	0.8	35.0
LSD (5%)	59.85	9.87	64.78
CV (%)	40.1	78.3	37.4

1. LSD = least significant difference for any two means in a given column.
2. CV = coefficient of variation for the means in a given column.

Table 3
Mean weights of tubers produced and damaged per 40 plants for the different clones

Clone	Wt. of tubers produced (kg)	Wt. of damaged tubers (kg)	Wt. of damaged tubers (%)
Njala white	1.64	0.24	14.6
84 / 16	1.80	0.50	27.8
87 / 06	2.10	0.40	19.0
82 /123 (Red)	1.98	0.78	39.4
84 /17	1.74	0.44	25.3
82 / 123 (White)	1.50	0.30	20.0
87 / 131	1.16	0.36	31.0
Madam	1.58	0.58	36.7
Tis - 2532	1.36	0.26	19.1
Ropot 2	1.79	0.39	21.8
93 / 04	0.79	0.09	11.4
82 / 144	1.58	0.28	17.7
Njala wonder	0.88	0.18	20.5
87 / 37	2.20	1.00	45.5
93 / 03	1.16	0.16	13.8
LSD (5%)	0.24	0.13	5.58
CV (%)	27.1	60.0	41.5

1. LSD = least significant difference for any two means in a given column
2. CV = coefficient of variation for the means in a given column

Table 4
Morphometrics recorded for harvested tubers of the sweet potato clones used

Clones	Neck lengths (cm)	Depths (cm)	Lengths (cm)	Widths (cm)	Cortex thickness (cm)	No. of tubers / plant	Dry matter (%)
Njala white	9.3	9.5	11.6	2.9	1.8	4.5	32.1
84 /16	4.5	5.4	11.0	4.1	1.8	6.7	34.8
87 / 06	3.6	5.6	8.6	5.4	1.6	3.4	32.4
82 /123 (Red)	7.6	7.3	11.8	4.0	1.9	4.5	32.9
84 / 17	3.7	4.2	12.0	4.6	2.2	4.3	34.6
82 / 123 (White)	4.5	5.3	11.6	4.1	2.0	4.3	33.7
87 / 131	4.6	6.2	11.8	3.2	3.7	4.5	33.9
Madam	3.1	6.5	8.2	3.7	3.8	6.0	29.7
Tis 2532	4.1	4.6	9.5	3.7	1.7	4.6	37.1
Ropot 2	4.7	7.0	11.5	4.2	2.2	2.9	32.3
93 / 04	5.2	6.7	8.2	3.5	3.2	4.3	36.9
82 / 144	4.6	7.0	11.9	3.8	2.4	2.9	34.5
Njala wonder	5.1	9.7	11.0	3.0	1.5	4.1	36.2
87 / 37	3.3	6.7	10.9	4.7	2.4	4.7	33.4
93 / 03	5.7	8.4	8.8	3.9	1.2	2.2	39.3
LSD (5%)	0.43	0.43	0.64	0.43	-	1.07	2.79

LSD = least significant difference for any two means in a given column.

values of 36.9, 37.1 and 39.3 respectively and low for Madam with a value of 29.7 (Table 4). Based on the above data on weevil counts and percent tuber damage, the fifteen clones were classified into four categories with varying levels of resistance to the weevils. Group one includes 82/123 (Red), 82/123 (White), Madam, 84/17 and 87/131. These clones had high weevil counts above 70 weevils/40 plants and high tuber damage of above 25 percent. Group two are clones with high weevil counts (above 70 weevils/40 plants) and fairly high levels of damage (20 - 24%). Clones in this category include 87/37, Ropot 2 and 82/144. Group three includes 84/16, 87/06, Tis 2532, and Njala white and Njala wonder with moderate weevil counts i.e. 45 - 55 weevils/40 plants and between 17 - 28% tuber damage . Group four includes 93/04 and 93/03 with low weevil counts i.e. 27 - 37 weevils/40 plants and below 14% damaged tubers.

Discussion

There was lack of relationship between percent tubers damaged and weevil counts despite significant differences observed for these two sets of data among the clones tested. This indicates that factors making the clones attractive for attack are different from those rendering them susceptible to damage by the weevils. Stimuli attracting insects to a crop are usually visual and olfactory while those rendering the crop susceptible are tactile, phagostimulatory and nutritive (15).Therefore, though the weevils may find clones attractive enough for infestation, the rates of consumption may thus be different for the different clones. Similar observations have been made by several workers for different crop plants and insects (3, 19, 20). Thus clonal suitability for infestation appear to be different from clonal susceptibility for damage. Alghali and Osisanya (2) working on rice resistance to *Diopsis thoracica* made a similar observation. Feeding on a crop by insects is known to involve several phases of response triggering mechanisms (8, 14, 17). Phase one involves attraction to a crop plant elicited by visual and/or olfactory cues. Phase two on the other hand is elicited mainly by tactile and phagostimulatory cues and may result in actual feeding or rejection of the plant as a food source. It is the feeding by the pest that invariably leads to damage and in turn determines the level of susceptibility. Thus while phase one must occur to trigger phase two, phase two does not necessarily follow phase one. Therefore, suitability for infestation may be different from susceptibility to damage as was observed in this and other studies (6).
Tuber characters such as neck length, placement depth, width, length, cortex thickness, dry matter contents, colour of skin and flesh, shape and number per plant appeared to have influenced the levels of damage observed among the clones. Clones that suffered least damages had white fleshed tubers and skins, which were elongated and dispersed in tuber formation. Other characters for the least damaged clones include deep tuber placements and high dry matter contents. Conversely, clones that were heavily damaged had tubers characterised by red flesh and skins, elliptical shape, short necks, shallow placement, clustered formation and low dry matter. Similar plant characters have been known to confer varying degrees of susceptibilities to *Cylas* weevils in sweet potato (10, 11, 16). These plant characters which have been associated with conferring resistance to the crop against weevil infestation could be used either as indices in field evaluation of sweet potato clones or in the gene pool in clonal improvement programmes breeding for weevil resistance as one of its principal criteria.
The fifteen sweet potato clones used in this study were categorised into four groups with varying levels of resistance to the weevils. Group 1 was the most susceptible while group 4 was the most resistant. Examples exist in the literature of wide scale utilization of resistant crop cultivars for the control of damaging insect pest species. Among the best examples of useful resistance are the control of the grape aphids, *Daktulosphaira vitifoliae* (Fitch) in France by rootstocks from USA, control of cotton jassids, *Empoasca facialis* Jacobi, in Africa with resistant cotton cultivars and the use of the resistant apple variety " Northern Spy " to control the woolly apple aphid, *Eriosoma lanigerum* Hansmann (15). Clones in groups 3 and 4 could therefore be utilized

either directly for planting the crop in the field provided they possess other desirable agronomic traits, or as materials for further evaluation to elucidate the bases of resistance for incorporation into breeding programmes. Advantages of planting such resistant clones would include environmental friendliness, i. e. pollution free/no biodegradation of soils and water parcels; simplicity, i. e. no special skills required for its application, the farmer only needs to plant the materials; cost free except for acquisition of planting materials and compatibility with other control options in an integrated pest management programme.

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