Effect of Sowing Depths on *Cylas* spp Infestation on Some Sweetpotato Varieties

E. D. Boamah[1], A. Oppong[2], and D. B. Boakye[3]
[1]CSIR - Plant Genetic Resources Research Institute. P.O. Box 7, Bunso.
[2]CSIR - Crops Research Institute. Box 3785, Fumesua-Kumasi.
[3]Kwame Nkrumah University of Science and Technology, Kumasi

Corresponding author: boamahduk@yahoo.com

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Abstract

The effect of sowing depths on Cylas spp infestation of four sweetpotato varieties 'Sauti', 'Okumkom', 'Santompona' and 'Faara' was determined in a field trial at Kwame Nkrumah University of Science and Technology. Data on number of leaves and branches on upper plant canopy (top 30cm), vine thickness, internode length, soluble sugar and dry matter content were taken and correlated with Cylas spp infestation. A two-factorial experiment was conducted using four sweetpotato varieties and three sowing depths in a Randomized Completely Block Design with three replications. The incidence of Cylas spp on the upper canopy of sweetpotato varieties after sowing increased from 2nd,3rd to the 4th month. There was significant increase in the incidence of weevil ($P<0.01$) with time on the four sweetpotato varieties. The tuber stalk length of the four sweetpotato varieties measured at harvest was highly significant ($P<0.01$).There was a negative correlation between percent tuber infestation and the three sowing depths. The level of tuber infestation of the four sweetpotato varieties by Cylas spp decreased with increasing depth of sowing. This may explain why sweetpotato varieties with long tuber stalk had the least incidence of Cylas spp. The results also indicated that the sweetpotato variety which had the highest number of leaves and branches, as well as the thickest vine had the highest incidence of vine infestation at 5% level. The sweetpotato varieties used had varying levels of soluble sugar and percent dry matter was also significant ($P<0.05$).

Key words; Cylas spp, dry matter, soluble sugar, sweetpotato,

Résumé

L'effet de l'ensemencement des profondeurs sur infestation de Cylas spp de quatre variétés de patate douce 'Sauti', 'Okumkom', 'Santompona' et 'Faara' a été déterminée dans un essai sur le champ à Kwame Nkrumah University of Sciences and Technology. Les données sur le nombre de feuilles et de branches sur la canopée supérieure de la plante (en haut de 30cm), l'épaisseur de la vigne, la longueur internodale, sucre soluble et la teneur en matière sèche ont été prises et en corrélation avec l'infestation de Cylas spp. Une expérience de deux factorielles a été réalisée en utilisant quatre variétés de patate douce et trois profondeurs de semis dans une étude de conception bloqué complètement randomisée avec trois répétitions. L'incidence de Cylas spp sur la canopée supérieure des variétés de patate douce après le semis a augmenté de 2em, 3em au 4em mois. Il y avait augmentation significative de *l'incidence des charançons (P <0,01) avec le temps sur les quatre variétés de patate douce. La longueur du tubercule de la tige des quatre variétés de patate douce mesurées à la récolte était hautement significative (P <0,01) .Il avait une corrélation négative entre pourcentage de l'infestation des tubercules et les trois profondeurs de semis. Le niveau de l'infestation de tubercule des quatre variétés de patate douce par Cylas spp a diminué avec la profondeur du semis. Cela peut expliquer pourquoi les variétés de patate douce avec une longue tige de tubercules ont le moins d'incidence de Cylas spp. Les résultats indiquent également que la variété de patate douce qui avait le plus grand nombre de feuilles et de branches, ainsi que la plus épaisse de la vigne ont eu la plus forte incidence de l'infestation de la vigne au niveau de 5%. Les variétés de patate douce utilisées avaient différents niveaux de sucre soluble et pourcentage de matière sèche a également été significative (P <0,05).*

Mots clés: Cylas spp, matière sèche, le sucre soluble, la patate douce,

Introduction

Sweetpotato (*Ipomoea batatas* (L) Lam) is the fifth most important food crop in developing countries (CIP, 2010). Sweetpotato has been cultivated for many years in Ghana, being particularly important in the Northern and the coastal regions of the country where it is grown for both domestic consumption and as a cash crop (Missah and Kissiedu,1994). The crop can be successfully cultivated on marginal soils with low pH and poor fertility (IITA,1982). The vines and leaves are mostly used as feed for livestock and also used as a cover crop for soil improvement. Sweetpotato contains about 100 micrograms of carotene per gram with fair quantities of ascorbic acid and B vitamins. Compared with the Irish potato, sweetpotato has higher dry matter, starch sugar, crude fibre and fat content, but low in protein (Horton *et al.*1989). The crop is attacked by a number of insect pests some of which seriously affects the market value of the crop. Important among the insect pests is the sweetpotato weevil, *Cylas* spp (Allard 1991: Sutherland1985). *Cylas formicarius* (Fabr), *Cylas brunneus* (Fabr) and *Cylas puncticollis* (Bohe) are the three main species occurring in the genus *Cylas* (Wolfe,1991). *C formicarius* is the main pest species in Asia, U.S.A and Oceania but in Africa it has only been recorded in Natal (South Africa) and on the Kenyan coast (Parker *et al.,* 1990). *C. puncticollis* is larger than the two other species. (Thèberge,1985). *C. brunneus* resembles either of the two species but is often smaller with a reddish brown pronotum. Both *C. puncticollis* and *C. brunneus* occur in West and Central Africa, (Magenya and Smit 1990).Yield losses of 60-90% as result of feeding by the weevil have been reported (Ho,1970; Subramanian *et al.*,1970; Mullen,1984; Janssen *et al.,* 1987). In Ghana *Cylas* infestation has been reported in all the agro ecological zones where sweetpotatoes are cultivated. (PPRSD, 2000). The underground feeding habits of the larvae and nocturnal activity of adults makes it difficult for farmers to control the sweetpotato weevil. They apply broad spectrum insecticides three to five times during the growing season in order to obtain effective control of the weevil (Yen *et al.*,1982). This practice increase production cost and is also harmful to the environment as well as consumers. Effective control or management of *Cylas* spp that is environmentally friendly and cost effective should be explored

The study aimed at determining sowing depths that will minimize incidence of sweetpotato weevil and provide information on the weevil during cultivation.

Methodology

The experiment was conducted on a field at the Grounds and Gardens section of the Kwame Nkrumah University of Science and Technology, Kumasi, Ghana. Vines of four released sweetpotato varieties namely 'Sauti', 'Okumkom', 'Santompona' and 'Faara' were obtained from CSIR-Crops Research Institute at Fumesua, Kumasi, Ghana. The experimental layout consisted of a randomized complete block design of 12 treatments (4 sweetpotato varieties x 3 sowing depths). The sowing depths were 2.5 cm, 5 cm and 10 cm.The experiment was replicated 3 times. There were 12 plots per block and each plot measured 3m by 1.5m and consisted of 4 rows of ten plants per row, with a spacing of 30cm within rows and 0.5m plots. Data was taken on 15 randomly selected plants in the two middle rows in each plot. Data on the incidence of *Cylas* spp was collected 2, 3, and 4 months after vine establishment. Vine thickness (mm), internode length (cm), number of leaves and branches on upper canopy (30 cm) were recorded 3 months after vine establishment. At harvest, data on, number of infested vines, length of tuber stalk, number of infested tubers at each sowing depths, percent dry matter content and soluble sugar content of the four sweetpotato varieties was collected. The experiment was conducted in both 2002 and 2003 minor seasons and reviewed in 2015. The data was subjected to analysis of variance (ANOVA) using Genstat Edition.9 (VSN).

Results

Morphological characterization of sweetpotato varieties

Vine thickness

'Sauti' had significantly ($P<0.01$) thicker vines as compared to the other 3 varieties. Although there was no significant difference between the vine thickness of 'Santompona' and 'Faara' their vines were significantly thicker than those of 'Okumkom' (Table1).

Internode length

The analysis of variance on internode length of the four varieties showed significance at ($P<0.05$). 'Santompona' had a significantly shorter internode length compared with the other three varieties (Table1).

Number of leaves and branches on terminal 30 cm

Differences in number of leaves and branches on the terminal 30 cm from the vines of four sweetpotato varieties were highly significant ($P<0.01$). 'Sauti' had the highest number of leaves and branches and 'Okumkom' had the least. There was no significant difference

Table1: Mean vine thickness, internode length, number of leaves and branches and percent vine infestation of four sweetpotato

Varieties	*Internode Length (cm)*	*Mean vine thickness (mm)*	*Mean number of leaves*	*Mean number of branches*	*Mean percent vine infestation (%)*
Sauti	6.0b	7.9c	16.0c	5.0c	47.9c
Okumkom	5.7b	4.7a	8.3a	2.1a	21.8a
Santompona	4.7a	6.1b	11.4b	3.0b	43.1bc
Faara	5.6b	6.5b	11.0b	2.7b	42.0b
Lsd (0.05)	0.66	0.40	1.20	0.47	5.14
P-value	(P<0.05)	(P<0.01)	(P<0.01)	(P<0.01)	(P<0.01)
GM/SED	5.5/0.56	6.3/1.32	11.68/3.20	3.2/1.25	38.7/11.80

(P>0.05) between the number of leaves and branches on 'Santompona' and 'Faara' but they differed significantly from 'Okumkom' and 'Sauti' as shown in (Table1).

Percentage vine infestation by Cylas spp

Percentage vine infestation by *Cylas spp* was highly significant among the varieties (P<0.01).'Okumkom' had the lowest infestation and this was significantly less than that of the other three varieties (Table1). The difference in percentage vine infestation on 'Sauti' and 'Faara' were also significant. Percent vine infestation on 'Santompona' was similar to that of 'Sauti' and 'Faara'.

Correlation between sweetpotato morphological characters and percent vine infestation.

There was a highly significant correlation between vine infestation and vine thickness, number of leaves and number of branches ((P<0.01), respectively. Correlation between percent vine infestation and internode length was negative and non-significant (Table 2).

Table 2: Correlation co-efficient between morphological characteristics of sweetpotato varieties and percent vine infestation of *Cylas* spp

Morphological Characteristics	*Percent vine infestation*
Vine thickness	0.838***
Internode length	-0.057
Number of leaves	0.804***
Number of branches	0.657***

Cylas spp population dynamics at 2,3and 4 months

The incidence of *Cylas* spp on the four sweetpotato varieties increased from the 2nd month after planting through the 3rd to the 4th month (Figures 1-3). *C. puncticollis* and *C. brunneus* were the weevils that were recorded. There was a population increase of *Cylas puncticollis* on 'Sauti' from the 2nd through to 4th month after vine establishment and this was significantly different (P<0.05) from the other three varieties. 'Faara' had the highest number of *C. brunneus* which differed significantly from the other three varieties during the 4th month. In all instances, population of *C. puncticollis* and *C. brunneus* on the four varieties increased with time. (Figures 1 and 2).

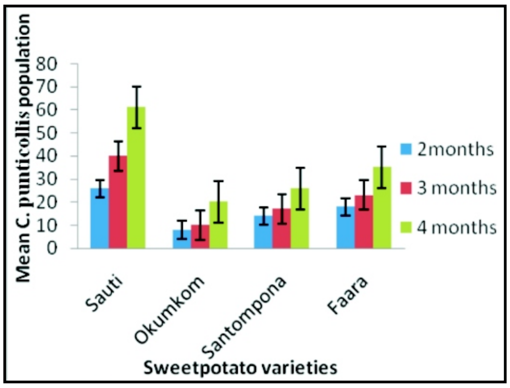

Fig.1: Population of *C. Punticollis* on sweet 4 potato varieties at 2nd, 3rd and 4th months after planting

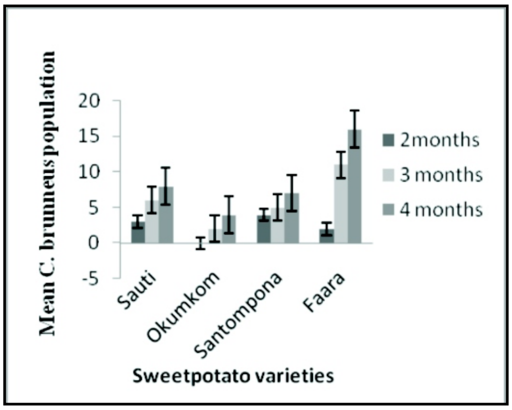

Fig. 2: Population of *C. Bruneus* on 4 sweetpotato varieties at 2nd, 3rd and 4th months after planting

Table 3: Mean tuber stalk length of the four sweetpotato varieties

Sweetpotato Varieties	*Mean tuber stalk length(cm)*
Sauti	3.98a
Okumkom	3.20a
Santompona	5.43a
Faara	10.80b
Lsd (0.05)	2.5
P-value	(P<0.01)
GM/SED	5.85/3.43

Table 5: Mean percentage dry matter and soluble sugar

Varieties	*(%) Dry Matter (g)*	*% soluble sugar*
Sauti	35.89b	28.0c
Okumkom	33.10a	26.0a
Santompona	34.25ab	27.5b
Faara	38.02c	30.0d
Lsd (0.05)	1.75	0.41
P-value	(P<0.05)	(P<0.01)
GM/SED	35.32/2.14	27.88/1.65

Table 4: Mean percentage tuber infestation of four sweetpotato varieties by *Cylas spp* at the three sowing depths

Varieties	*Mean tuber infestation at various sowing depths*		
	2.5cm	5.0cm	10.0cm
Sauti	60.10b	42.10b	31.55b
Okumkom	58.45b	43.55b	32.50b
Santompona	54.55b	36.00b	29.90ab
Faara	37.50a	24.15a	20.96a
Lsd (0.05)	10.20	7.63	10.11
P-value	(P<0.05)	(P<0.05)	(P<0.05)
GM/SED	52.65/10.36	36.45/8.82	28.73/5.28

Tuber stalk length of the four sweetpotato varieties

Differences in tuber stalk length of the four varieties were highly significant (P<0.01). 'Faara' had the longest stalk and this differed significantly from all the other three varieties. There were no significant differences among 'Sauti', 'Okumkom' and 'Santompona' (Table3).

Sowing depths effect on percentage tuber infestation of sweetpotato varieties by *Cylas* spp

Significant differences existed between four sweetpotato varieties and three sowing depths with regard to *Cylas* spp infestation on the tubers. The percentage infestation was least on 'Faara' at the three sowing depths. Apart from the 10 cm sowing depth in which there was no significant difference (P<0.05) in percentage infestation between 'Santompona' and 'Faara', *Cylas* spp infestation of Faara was similar in the other three varieties at 10 cm sowing depth but differed significantly from 'Sauti' and 'Okumkom' at depths 2.5 cm and 5 cm.

Percentage dry matter and soluble sugar content

The analysis of variance for both percent dry matter and soluble sugar was significant at (P<0.05) and (P<0.01) respectively. 'Faara' had highest percentage in dry matter as well as soluble sugar and differed significantly from all the three varieties with *Okumkom* having the least percentage in both.

Discussions

The lower vine infestation of *Okumkom* could be attributed to difficulty of *Cylas* spp in mining through the vines of small size. This phenomenon is supported by studies conducted by Kokorom *et al.* (1994) who demonstrated that *Cylas* prefers infesting varieties with medium vine thickness as compared to varieties with very small and woody vines. The variety 'Sauti' possesses medium vine thickness and this explain the high level of *Cylas* infestation in this variety 'Sauti', which had the highest number of leaves and branches, had the highest vine infestation whilst 'Okumkom' the least number of leaves and branches had the least infestation. This could be explained by the variation in the micro-climate within the canopy. 'Sauti', which had more leaves, provided shelter from the sun rays for the foraging weevil during the day. 'Okumkom', with few leaves, could not provide enough cover to protect the weevils and this might have accounted for the low infestation.

Kokorom *et al.* (1994) demonstrated in their studies that sweetpotato varieties or clones with long internodes usually had long vines. They indicated that long vines might not be preferred by the weevils because of the relatively long distances the weevils have to tunnel before reaching the tubers. *Sauti* which had the longest internode also had the highest infestation. It may be inferred from this observation that internode length may not affect vine infestation by *Cylas* spp.

Tuber infestation of all four varieties decreased with increased sowing depths.This confirms the findings of Remoraza (1978) Burdeous and Gapsin (1980) and IITA (1985) that the deeper the tubers are buried in the soil the lower the weevil infestation.

According Teli and Salunkhe (1995), tubers with long stalk length have lower infestation. This phenomenon agrees with the results of this study. *Faara* with the longest tuber stalk length, had the least *Cylas* infestation. Thus the shorter the tuber stalks length of the sweetpotato the easier it is for infestation to occur. Allard *et al.* (1991) described the following techniques that have been used in the management of *Cylas* spp. in sweetpotato: selecting deep-rooting cultivars, with long necks between the roots and the stems (which are less susceptible because the adult weevil cannot burrow downwards more than 1cm).

Allard *et al.* (1991) explained in their work that *Cylas* weevil breed in both the stem and roots of sweetpotato but in the first months of growth only stem is available. The larvae prefer tunnel in the soft pith, but not in the vascular bundles which are usually too fibrous to allow the larvae to tunnel. Only a small number of larvae are therefore able to survive in the stem, resulting in a slow build up of weevil population in the 2nd, 3rd to 4th month.

C. puncticollis and *C. brunneus* were the only species observed in the study. This confirms the finding of Magenya and Smit (1990) who reported that these two species are confined to West and Central Africa.

Studies by Kays *et al.* (1993) showed that sucrose appears to act as a feeding stimulant for the sweet potato weevil but when it is in high concentration feeding tends to decline. Singh (1973) also indicated that sweetpotato cultivars with high dry matter tend to be more infested by the *Cylas* spp. This study suggests that other factors may influence the feeding response of the *Cylas* spp as the infestation rate of the sweetpotato varieties are not linked to the soluble sugar content or dry matter content.

Conclusion

Varieties with higher numbers of leaves, branches with and thick vines appear to have highest vine infestation. 'Sauti' which possess the greatest number of leaves, branches and thickest vine had highest level of *Cylas* infestation whereas 'Okumkom' which had the lowest vine infestation also had the least number of leaves, branches and thin vines.

Sowing depth influences tuber infestation. The lower the sowing depth, the higher the tuber infestation. Tuber stalk length also influences tuber infestation by *Cylas* spp. 'Faara' with the longest stalk length had the lowest tuber infestation.

Recommendations

Breeding for varieties resistant to weevil infestation is an important strategy for the management of *Cylas* spp. Such breeding programmes should incorporate characters such as early maturing varieties and long tuber stalk.

Furthermore, the apparent influence of soluble sugars on *Cylas* spp infestation in this study is preliminary. It is suggested that concentrations of sucrose, fructose and glucose in the varieties studied should be further investigated

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