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RESEARCH ARTICLE

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Evaluation of cultural control practices in the management of sweet potato weevil (*Cylas formicarius*) (Apionidae : Colepotera)

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ABSTRACT : The sweet potato weevil, *Cylas formicarius*, constitutes a major constraint to sweet potato production and utilization in Africa. Host plant resistance/tolerance, mulching and varying harvesting dates could provide an approach that fits well into an integrated pest management programme of this insect pest. In this study, a trial was conducted to evaluate the effect of host plant, mulching with freshly harvested, dried and chopped up aerial parts of elephant grass (*Panicum maximum*), and the manipulation of harvesting date, on crop damage by the sweet potato weevil. *Cylas formicarius* incidence was observed to decrease with increase in mulching level. Also, significant cultivar variation with respect to *Cylas formicarius* tuber damage and the total number of tubers produced were recorded. Karur local (White) and Arun (White) were observed to be significantly less susceptible to the sweetpotato weevil. Harvesting date was also significantly different, with respect to the number of damaged tubers. More tubers were damaged when harvesting was delayed. Hence, using Karur local (White) or Arun (White), coupled with mulching at the rate of 3-5t/ha and harvesting at 104 DAP resulted in increased number of tubers and reduced sweetpotato weevil infestation in the field.

KEY WORDS : *Cylas formicarius*, Sweet potato, Mulching, Harvesting date, Tuber damage

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INTRODUCTION

Sweet potato (*Ipomoea batatas*. Lam.) is a staple food for a large proportion of the population in many parts of sub-Saharan Africa, Stathers *et al*., 2003; Muyinza *et al*., 2012 and Rukarwa *et al.*, 2013 and the third most important food crop in Sierra Leone after rice and cassava. It is grown in all parts of the country mainly by resource-poor farmers and mostly as subsistence crop for food security and to supplement household income by sale to local markets and urban centres (IMF, 2011). By far the most important production constraint of the sweet potato worldwide is plant damage caused by sweet potato weevils, *viz.*, *Cylas* spp. (Fuglie, 2007; Kiiza *et al*., 2009 and Rees *et al.*, 2003). Sweet potato weevils

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are a particularly serious problem under dry conditions because the insects, which cannot dig, reach roots more easily through cracks that appear as the soil dries out. *Cylas* spp. can damage every harvestable part of the sweet potato plant, with devastating consequences for poor farmers, leading to lower income and reduced food security. (Nottingham and Kays, 2002; Magira, 2003 and Anyanga *et al*., 2013). The weevil species are *Cylas formicarius* Fab. The female sweet potato weevil lays eggs singly in cavities excavated in either the vines or the accessible roots of sweet potato. The developing larvae tunnel while feeding within the vine or root and are the most destructive stage. Plants may wilt or even die because of extensive stem damage, and damage to the vascular system can reduce the size and number of storage roots. While external damage to roots can affect their quality and value, internal damage can lead to complete loss. Losses of marketable yield as high as 60–97 per cent have been reported (Magira, 2003).

Technologies to sustainably manage these weevils would boost sweet potato production dramatically and impact positively on the livelihoods of millions of poor farmers. One approach that has been targeted is host plant resistance. (Jackson and Bohac, 2006; Stevenson *et al.*, 2009 and Muyinza *et al*., 2010). Progress toward resistance-based management of sweet potato weevil in the United States has been more successful and owes much to the apparent presence of higher levels of multiple insect species resistance in some varieties, including against *C. formicarius*. But, identifying resistance to species of *Cylas* that is of a "dynamic" rather than an "escape" nature (Stathers *et al*., 2003) has been less fruitful. To determine the incidence and severity of *Cylas formicarius* and subsequent damage to sweet potato crop under natural infestation pressure, and to evaluate the effect of mulch cover, host plant tolerance/ resistance and the manipulation of harvesting dates on these parameters and other yield components of sweet potato.

EXPERIMENTAL METHODS

The trial was conducted during two cropping seasons (2011 and 2012) at Pandit Jawaharlal Nerhu College of Agriculture and Research Institute, Karaikal. The experiment was laid out in a Randomized Complete Split Plot Design with three replications. The main plot factor was the harvesting date (90, 104, 118 and 132 DAP) with mulching, using freshly harvested, dried, chopped up aerial parts of elephant grass (*Panicum maximum*) (0, 1, 3 and 5t/ha) and sweet potato cultivars (Co 3, Villupuram local (Red), Karur local (White) and Arun (White) in a split plot design. The plot size was 14.4 m^2 with each plot having four ridges 1 m apart and 3.6 m long. Forty-eight apical vine pieces 30 cm long were used for planting at a spacing of 30 cm apart within the ridge (giving 12 plants per ridge). Planting was done on the 8th September, during the 2011 cropping season and on the 10th September, during the 2012 cropping season. The mulching material was applied immediately after sprouting. This material was kept till after harvest. At harvest, the plant stand at either end of the ridges in each plot was discarded. The two middle rows were harvested per plot. Weeding was done as and when necessary until the crop was harvested.

Data collection and analysis :

Weevil damage to sweet potato roots was visually assessed and scored for external weevil damage using a scale of 1 to 5; where 1 ¼ 0–20 per cent; 2 ¼ 21–40 per cent; 3 ¼ 41–60 per cent; 4 ¼ 61–80 per cent and 5 ¼ 81–100 per cent. A root was considered to be weevil damaged if it bore characteristic dark scarred spots on the surface of the root – a typical symptom of weevil penetration and feeding. Those roots lacking any surface damage were considered to be uninfested. 1 Storage roots from the surviving plants on each ridge were carefully dug up, collected and weighed to obtain the overall root weight per plot. The harvested roots were sorted into weevil-damaged and undamaged roots; the combination being weighed to obtain the total weight of roots with any damage. This weight was, thereafter, expressed as a percentage of the overall fresh weight of all the roots (clean and damaged) per plot (Muyinza *et al.*, 2012). Data collected during the two seasons were subjected to two-way ANOVA and means were separated using the DMRT (Duncan multiple range test) methods, at 0.05 level of significance.

EXPERIMENTAL RESULTS AND ANALYSIS

Number of damaged tubers, harvesting time and mulching levels with respect to sweet potato varieties The number of tubers damaged with respect to sweet potato variety was significantly (P = 0.05) different across the two cropping seasons, with Villupuram local (Red) recording the highest number of damaged tubers followed by the Co 3 and Arun (White), whilst the lowest damage was incurred by Karur local (White). The number of tubers damaged was significantly higher during 2012 cropping season compared to 2011 cropping season (Table 1). Regarding harvesting time, more tubers were damaged when harvesting was delayed across the two cropping seasons (Table 1). With respect to mulching levels, significant differences (P = 0.05) were recorded in the number of tubers damaged with the application of the mulch material. The application of the mulch material at a rate of 5t/ha registering the least number of tubers damaged followed by 3t/ha and 1t/ha, whilst the highest number of damaged tubers were recorded in the unmulched plots during the two cropping seasons (Table 1).

Total number of tubers :

Relating to the number of tubers, significant differences (P= 0.05) were recorded with respect to sweet potato variety across the two cropping seasons,

Table 1 : Number of damaged tubers, harvesting time and mulching levels with respect to sweet potato variety

Number of damaged tubers		
Sweet potato variety	2011 cropping season	2012 cropping season
Co 3	5.23b	10.56 b
Villupuram local (Red)	8.95a	15.39 a
Karur local (White)	2.47 c	8.51 c
Arun (White)	4.25b	8.52 b
Harvesting time (days)		
90	1.84b	5.79b
104	3.44b	6.77b
118	7.74b	10.04b
132	8.83a	21.16a
Mulching level (t/ha)		
0	8.82a	15.72a
1	5.73b	11.82ab
3	4.64b	9.04bc
5	2.46c	6.35c

In each category, means in the same column with different superscripts are significantly different (P = 0.05).

Table 2 : Total number of tubers, harvesting time and mulching levels with respect to sweet potato variety

Number of tubers		
Sweet potato variety	2011 cropping season	2012 cropping season
Co 3	32.12b	23.68c
Villupuram local (Red)	9.02c	40.21b
Karur local (White)	21.08b	36.39 c
Arun (White)	34.96a	52.84a
Harvesting time (days)		
90	20.75a	38.87a
104	22.75a	37.66a
118	23.88a	38.56a
132	22.99a	38.13a
Mulching level (t/ha)		
0	19.452b	34.34a
1	20.72b	35.41a
3	22.41ab	41.36a
5	25.256a	42.19a

In each category, means in the same column with different superscripts are significantly different (P = 0.05) with 2012 cropping season recording a significantly higher number of tubers across most of the varieties assessed (Table 2). During the 2011 cropping season, on average, Arun (White) recorded the highest number of tubers (34.96), followed by the Co 3 (23.12) then, Karur local (White), whilst Villupuram local (Red) recorded the least. There were however no significant differences (P=0.05) in the total number of tubers recorded between Karur local (White) and the improved variety-Co 3. With regards to 2012 cropping season, Arun (White) again recorded the highest number of tubers (52.84), followed by Villupuram local (Red) (40.21), Karur local (White) (36.39) and the Co 3 (23.68) as shown in Table 2. For harvesting dates, there were no significant differences (P=0.05) in the total number of tuber across the two cropping seasons even though more tubers were produced during 2012 cropping season compared to 2011 cropping season (Table 2).

In the case of mulching levels, significantly (P=0.05) higher number of tubers were produced with the application of 5t/ha of the mulching material (25.25), followed by 3t/ha (22.41), 1t/ha, the unmulched plot recorded the least (19.45) during 2011 cropping season (Table 2). On the other hand, no significant differences (P=0.05) were recorded in the number of tubers across mulching during 2012 cropping season, even though more tubers were recorded during 2012 cropping season compared to 2011 cropping season.

Management practices such as cultivar selection, manipulation of harvesting date and mulching influence sweet potato weevil population and sweet potato damage in the field, as demonstrated in this study. The present study indicates significant differences in sweet potato weevil tuber damage in different cultivars across harvesting date and varying mulching levels. The consistency among the cultivars over two seasons ensures the strength of the evaluation. Tuber characteristics influenced on the severity of *C. formicarius* Karur local (White) and Arun (White) incurred the least tuber damage compared the other two varieties. Karur local (White) is a deep-rooted cultivar, which makes it difficult for the sweetpotato weevil to gain access to it even under soil moisture stress conditions. Soil cracking, exposed roots and shortest weevil distance all relate to root architecture (Stathers *et al*., 2003a and b). As *Cylas* spp. can burrow only very short distances through the soil (Stathers *et al*., 2003a) and usually rely on soil cracks to reach the roots, deep rooting can act as an escape mechanism. Stathers *et al*. (2003a and b) Arun (White) contains hard peel making it difficult for *Cylas formicarius* to puncture and hence, conferring some form of resistance. This seems to agree with Stathers *et al*., 2013 who reported strong evidence for resistance among dry-fleshed cultivars. In both cases, this form of resistance to *Cylas* is of an “escape” of nature (Stathers *et al*., 2013; Muyinza *et al*., 2009; Stathers *et al*., 2010 and Stevenson *et al*., 2009).

Sweet potato tuber damage was more than three fold higher at 132 DAP compared to 90 DAP during the two cropping seasons. This increase could be related to the enlargement of the tubers, as harvesting is delayed resulting in cracks in the soil around the sweet potato tubers and providing access for weevils. Stathers *et al*. (2013) It is possible under certain field conditions that mulching could result in low tuber damage. In our study, sweet potato weevil tuber damage was lower across mulching levels during the two cropping seasons compared to the control plots. Fewer tubers were damaged with an increase in the level of mulching material recorded. This could be attributed to the increase in moisture content, increased infiltration and reduced soil evaporation (Erenstein, 2002) around the sweet potato tuber as the mulching level is increased. These factors result into a decrease in soil cracks around the sweet potato plant, thus, making it difficult for *Cylas formicarius* to gain access to the tubers Stathers *et al*. (2013); hence, less damaged compared to the control. Applying mulch, even at low rates, can have a strong impact on the water available capacity of the soil (Mulumba and Lal, 2008). The mulching material also provides a favourable environment for the natural enemies of *C. formicarius*, thereby reducing their incidence and severity (Tillaman *et al*., 2004). The result also suggests significant differences in the number of tubers with regards to mulching level and variety. Mulching enhances mean time of tuber initiation, thus resulting into production of more tubers compared to the unmulched plot (Walworth and Carling, 2002).

Conclusion :

It can be concluded that mulching sweet potato at the rates of 3-5t/ha could reduce *Cylas formicarius* infestation in the field, decrease the number of tubers damaged and also lead to increases in yield and number of sweet potato tubers produced. Also, harvest of the crop can be delayed till 104 days after planting without significant damage due to *C. formicarius*; but beyond that, yield loss might occur due to *Cylas formicarius* infestation.

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