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Effect of planting dates on the population dynamics of *Cylas puncticollis* and sweet potato storage roots damage in South Western Cameroon

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ABSTRACT
The sweetpotato *Ipomoea batatas* L. (Convolvulaceae) is one of the most important food crops in Africa and the world. The weevil, *Cylas puncticollis* (Fabricius), is the most destructive field and storage insect pest of sweet potato in Africa. Because of the cryptic feeding nature of the very destructive larval stages, chemical control is often not effective. A field study was therefore designed to determine the effects of different planting dates on infestation and damage of various sweet potato cultivars by the weevils in South Western Cameroon. Ten sweet potato cultivars were planted in different months i.e April and July for the wet season and October and January for the dry season in 2012 and 2013. The vines and storage roots were observed for *C. puncticollis* damage. Results showed a significance difference on the percentage infestation and yield ($P < 0.05$) amongst the various planting periods with the least infestation registered for the July (0.3%) while the highest infestation was realized in the January planting (9.22%). The highest yield was obtained from the April planting (7.22 tons/Ha) and the lowest was recorded for the October planting (4.92 tons/Ha). Differences in vine damage amongst the planting periods were not significant at ($P > 0.05$). Delayed harvesting during the rainy season led to only slight (9.1%) increase in *C. puncticollis* infestation at 135 DAP while the infestation was high during the dry season at harvest and further increased as harvesting was delayed more than 90 DAP. Sex ratio of weevils throughout the wet and dry seasons showed a higher ratio of females.
Key words: Sweetpotato *Cylas puncticollis*, Planting dates, Percentage infestation.

INTRODUCTION:

Sweetpotato,*Ipomoea batatas* (L.) Lam.(family: Convolvulaceae) is a herbaceous perennial plant native to South America. It is widely cultivated the world over and ranks as the seventh most important crop after wheat, rice, maize, Irish potato, barley, and cassava (Hironori *et al.,* 2007) with high content of β-carotene, that can be converted by the body to vitamin A. Currently, it is an important crop in Africa where it features prominently as a staple human food in many countries (Stevenson *et al*., 2009); it is also processed as a snack food and for animal feed. Sweet potato is a highly nutritious vegetable rich in energy, dietary fibre, biologically active phytochemicals, vitamins and minerals which renders it as good functional food ingredient (Brinley *et al*., 2006). The B-carotene fortified orange-fleshed varieties are used to combat vitamin A deficiency and hence blindness in children. Sweet potato also serves as a cash crop and hence supplements family income, contributes to improved food security, health, and overall livelihoods in Africa and other developing nations.

In Cameroon, sweet potato is a major subsistence food crop cultivated in almost all the agro-ecological zones, from the hot, humid forest region of the south to the colder, drier northern grassland zone, stretching from sea level to 2000m above sea level (Ngeve *et al,* 1992). Production in Cameroon was estimated to be 175,000 tons in 2004 which is still very low despite the rich soils and suitable climatic factors of the country. Sweet potato is a warm-weather crop that grows best at temperature above 24^0C, abundant sunshine and a well distributed rainfall of about 750 – 1000 mm per annum (Ngeve *et al,* 1992). The crop is very popular in tropical developing countries due to its wide adaptability and enormous potential for preventing malnutrition.

Sweet potato in Cameroon is grown mainly in the wet season between March and July with a second crop grown between August and November (Ngeve *et al,* 1992).

In spite of the importance of sweet potato in alleviating rural poverty, health and food security in Africa, its increased and sustainable production is seriously hampered by the sweet potato weevils; *Cylas sp* (Coleoptera: Apionidae) particularly, *Cylas puncticollis* Boheman and *C. brunneus* Fabricius (Andrade *et al*., 2009). The weevils believed to be native to Asia live primarily on the sweet potato and other plants of the genus *Ipomoea* i.e. morning glories (Gregory, 1992). Most of its damage is through infestation of mature sweet potatoes. The larvae tunnel the vines, crowns and storage roots and those cryptic habits render them difficult to control (Sutherland, 1986). Storage roots yield losses caused by the weevils of up to 73% have been reported in Uganda (Smit, 1997).).

Adult feeding, oviposition, and larval tunneling on storage roots impart a bitter taste to the crop. Therefore, even low levels of infestation can reduce root quality and marketable yield because the plants produce unpalatable terpenoids in response to weevil feeding (Stathers *et al*., 2003).

In Papua New Guinea, it has been observed that the intensity of sweetpotato weevil infestation varies between the wet and dry seasons; the weevil caused economic damage in areas with a marked dry season or in unseasonably dry years. The weevil is a problem wherever the crop is grown and often worse during dry times. It is reported to be most serious in areas with a marked dry season (Bourke, 1985). Moisture/rainfall is generally known to influence sweetpotato weevil incidence and damage level in Papua New Guinea (Sutherland 1985; Powell *et al*., 2000). High levels of weevil incidence generally correspond with lower rainfall levels. The weevils generally fail to penetrate wet soils but easily do so on dry soils. Wijmeersch (2000) reported that in parts of Papua New Guinea with well spread high rainfall, weevil damage is usually not a problem. Given that most sweet potato producers in Cameroon are small scale resource-poor farmers coupled with that sweet

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potato is not considered a high value crop currently, very few producers can afford using relatively costly synthetic insecticides on the crop. This underscores the importance of seeking for effective, low-cost and eco-friendly sweet potato weevil management methods. Therefore the objectives of this study were to test the effects of planting sweet potatoes on different dates on the storage root yield and damage by *C. puncticollis*.

MATERIALS AND METHODS

Study site

The study was carried out at the Teaching and Research Farm of the University of Buea situated in the South-West Region of Cameroon. Buea is situated at 4° 9' 34" north, and 9° 14' 12" south and has a tropical equatorial climate. The site has two major seasons consisting of a wet season between March and November and a dry season from November to March. Average temperature ranges from 18 – 29^{0}C with an average annual precipitation of 4,030 mm. The soils are rich volcanic soils very suitable for agricultural activities.

Periodic Planting and Method

The following ten sweet potato varieties were used in the study; Jewel, SPK Kakamega, Zapello, Jonathan, Buea local, Bokito, Tanung, IRAD 112, Mbouda and TIb1.The choice for these 10 varieties was based on origin diversities in a bid to also verify their adaptabilities with regards to weevil infestation in Cameroon (see table (i) bellow) . Vines were cut at lengths of 50 cm and planted on ridges at an equidistance of 50 cm with the middle portion buried about 10cm deep into the soil. Each bed was 30 cm high, 2 m wide by 5m long and 50 cm apart. Normal agricultural practices of weeding and cultivation (i.e. earthing up the ridges) were used. Plantings were done in April and July (early and late rainy season plantings respectively), October and January (early and late dry season plantings respectively). Each planting was completely harvested three months later and another planting followed. Varieties and planting dates were considered as treatments. The experiment was laid out as randomize complete block design with four replications. Each plot measured 5 m × 2 m. During each harvest, 4 storage roots and vines of each variety were randomly harvested, taken to the laboratory, washed with tap water and the storage roots assessed for percentage damage and yield.

Table 1: Accessions and areas of collection

Accession N°	1	2	3	4	5	6	7	8	9	10
Pedigree	Jewel 44039	SPK Kakamega	Zapello	Buea Local	Bokito	IRAD 112	Mbouda	TIB1	Tainung	Jonathan
Area of collection	USA	USA	Kenya	Cameroon	Cameroon	Cameroon	Cameroon	Cameroon	Kenya	USA

Damage assessment

The percentage damage was determined by considering damaged when a weevil oviposition puncture was visible. Storage roots with oviposition punctures were taken to the University of Buea Life Science Laboratory and stored in plastic buckets covered with plastic mesh. After a week of storage, the storage roots were split longitudinally into 4 quarters and each further chopped and observed for any larvae or galleries. A storage root was considered to be 100% damaged if all the 4 quarters had galleries or larvae similar to the method of Vayssiéres *et al*. (2009b) for fruit fly damage assessment in Guava. Four vines from each variety of about 40 cm long each were collected using a sharp knife. The collected vines were then cut into quarters in the laboratory and each piece observed visually for damage by adult weevils; 100% damage was considered if all the quarters were damaged by sweet potato weevils.

Yield Assessment

The yields for each variety were calculated by weighing 4 randomly harvested storage roots of each variety from experimental plots considering the area. Storage root yield was determined from the actual area of each plot which provides a good estimate of true yield (Romani *et al*., 1993; Neppl *et al*., 2003). For the 2013 planting, harvesting and scoring of storage roots infestation was done 30, 45, 60, 75, 90, 120 and 135 days after planting (DAP).

Sex ratio and population dynamics

As from 30 days after planting (DAP), pit-fall traps were placed in the experimental plots. The pit fall traps were 10 cm in diameter and 15 cm deep and buried in the soil such that the edge of the container flushed with the ground surface. To avoid escape, the traps were half filled with water and 10g of detergent added. The traps were placed at an equidistance of 10m apart and 20 traps were placed in 400m^2 area.

Trapped adult weevils were collected once every week, taken to the Laboratory for counting and sexing. Sexing was based on sexual dimorphism of the antennae as observed under a stereo-microscope. Antennae of males are straight while those of females are round or club-shaped. Also the females are often slightly bigger than the males.

Statistical analysis:

All data were analyzed through ANOVA and graphical representations. Mean values of percentage infestation of storage roots, vines and yields were separated using Turkey's test.

RESULTS

There were significant differences in the percentage of storage roots infestation ($P< 0.05$) with the highest obtained during the dry season (January- March and October - December), and the lowest during the rainy season (April – June and July – September). The plantings done during the rainy season had low or no storage roots damage compared to the highest damage recorded during January to March (dry season). The varieties, Buea local, IRAD 112, Mbouda and Bokito had the highest percentage infestation while Tainung, Jonathan and Zapello suffered the least *C. puncticollis* damage irrespective of the 2012 growing season (table 2).

Table 2: Effect of different planting dates on percentage storage roots damage by *Cylas puncticollis* of various sweet potato Varieties.

Varieties	Planting dates / 2012			
	January	April	July	October
	Late dry season	Early Rainy season	Late Rainy season	Early dry season
Jonathan	6.5±1.3	0	0.5±0.1	1.7±0.6
Bokito 1	8.3±1.4	0.9±0.4	0.9±0.2	2.6±0.7
Tainung	6.1±1.3	0	0	1.5±0.4
Zapello 56638	7.7±1.5	0	0	1.7±0.6
Buea Local White	12.7±2.4	0	0	3.1±1.2
IRAD 112	12.4±2.1	1.7±0.6	0	3.5±1.3
SPK 001 Kakamega	10.3±2.1	0	0	2.4±0.9
Mbounda	11.7±2.4	1.6±0.5	1.2±0.4	4.3±1.4
Jewel 44031	9.3±2.7	0	0	2.4±1.2
Tib1	7.2±2.5	1.7±0.7	0.4±0.1	2.7±1.8
Overall mean	9.22^{A}	0.59^{C}	0.3^{C}	2.59^{B}

Mean % infestation±SD

	N	Mean	Grouping
Jan - Mar	10	9.220	A
Oct - Dec.	10	2.590	B
Apr. - Jun	10	0.590	C
July – Sept.	10	0.300	C

Means with the same letter in a column are not significantly different (p< 0.05) based on Turkey test.

Percentage Infestation of vines

There were slight significant differences in vine damage for the various planting periods. The highest vine damage was recorded for the January planting while that of July had the lowest (table 3).

Table 3: Effect of different planting periods on % infestation of SPW on 10 sweet potato vines Varieties

Varieties	Planting dates / 2012			
	January	April	July	October
	Late dry season	Early Rainy season	Late Rainy season	Early dry season
Jonathan	15.5±3.2	10.4±3.4	8.8±2.5	11.5±2.5
Bokito 1	12.4±3.5	12.3±3.8	10.3±3.4	11.8±2.7
Tainung	13.1±2.3	14.6±4.2	11.4±3.3	13.5±3.4
Zapello 56638	8.5±1.5	7.2±2.7	5.6±1.3	8.2±2.6
Buea Local White	17.1±3.6	15.4±3.6	12.5±3.8	14.5.1±3.2
IRAD 112	18.2±2.2	14.5±3.7	9.4±2.8	10.5±2.1
SPK 001 Kakamega	9.3±2.1	7.3±2.4	5.5±2.1	7.9.4±2.5
Mbounda	15.6±3.4	13.2±3.5	9.5±2.3	12.3±3.4
Jewel 44031	5.7±2.7	4.6±1.2	3.5±1.1	4.8±1.3
Tib1	13.1±2.6	11.8±3.4	8.5±2.2	9.7±2.8
Overall Mean	12.85^{A}	11.13^{AB}	8.5^{B}	10.75^{AB}

Mean % infestation±SD

	N	Mean	Grouping
Jan - Mar	10	12.850	A
Apr. -Jun	10	11.130	A B
Oct - Dec.	10	10.756	A B
July –Sept.	10	8.500	B

Means with the same letter in a column are not significantly different ($p > 0.05$) based on Turkey test.

Storage root yield (tons/Ha)

Storage roots yields for the various planting periods showed significant differences ($p< 0.05$) with the highest and lowest yields obtained from the April and October plantings respectively. IRAD 112 had the highest yield while Jewel 44031 had the least damage ($p< 0.05$) (table 4).

Table 4: Effect of different planting periods on the yield (tons/Ha) of 10 sweet potato varieties

Varieties	Planting Periods / 2012			
	January Early dry season	April Early Rainy season	July Late Rainy season	October Early dry season
Jonathan	4.5±1.4	7.4±1.4	5.8±1.1	4.7±0.6
Bokito 1	3.8±2.1	6.8±2.1	5.6±2.3	4.3±1.1
Tanung	4.3±1.2	6.5±1.5	5.9±1.3	4.5±0.5
Zapello 56638	5.6±1.5	6.7±1.2	6.1±1.1	5.2±0.6
Buea Local White	4.1±1.9	7.1±1.9	6.2±2.2	5.1±1.7
IRAD 112	9.5± 1.4	11.2± 1.4	10.2± 2.3	8.5± 1.4
SPK 001 Kakamega	6.3±2.1	7.5±1.2	6.8±1.1	2.4±0.9
Mbounda	4.6±1.5	6.6±1.5	5.7±1.2	4.6±1.5
Jewel 44031	4.3±2.7	5.6±1.3	4.4±1.1	4.8±1.2
Tib1	4.4±1.5	6.8±1.4	5.5±1.2	5.1±1.3
Grand Periodic Mean	5.14^{B}	7.22^{A}	6.22^{AB}	4.92^{B}

Mean yield±SD

	N	Mean	Grouping
Apr. - Jun	10	7.220	A
July – Sept.	10	6.220	A B
Jan - Mar	10	5.140	B
Oct - Dec.	10	4.920	B

Each value is an average of four replicates. Means not sharing a similar letter in a line and column are significantly different ($p< 0.05$) as assessed by the test of Turkey.

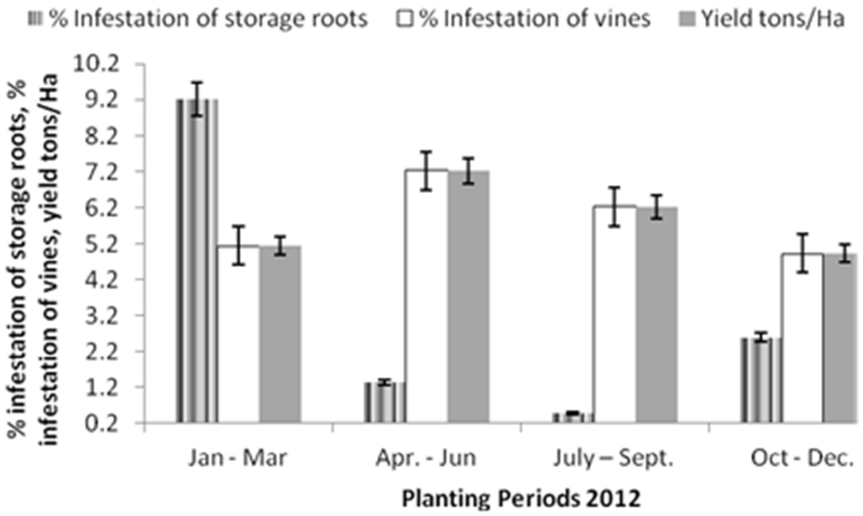

Fig 1: Mean sweet potato yield and % infestation of storage roots and vines during the different planting periods in 2012.

***Cylas puncticollis* population dynamics and sex ratio throughout the year**

The population of adult weevils increased steadily from January to March then decreased to zero in June till September. It however increased again steadily from October to December. For all the months, there was a higher ratio of females to males. The highest density was noted in the month of March (1.3 SPW/m^2) with a male**:** female ratio of 0.50**:**0.77 (figure 2).

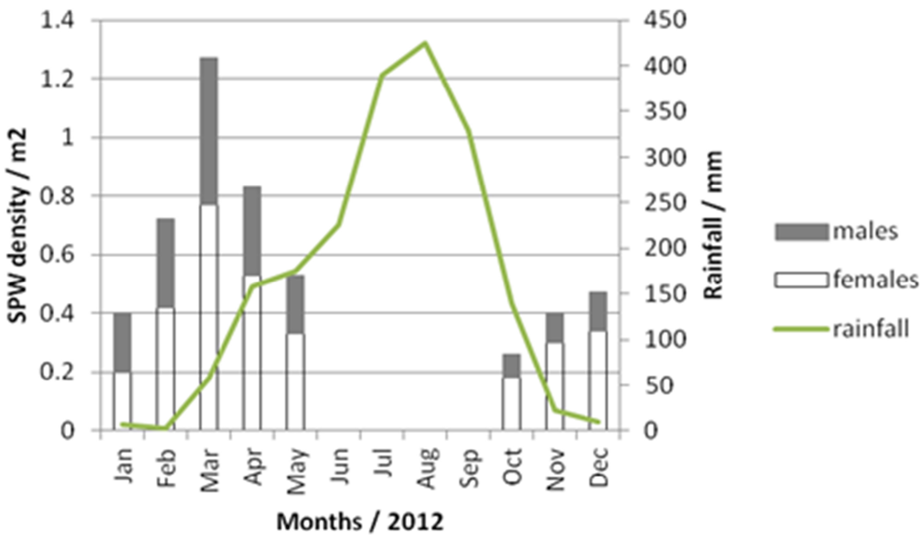

Fig 2: Monthly population dynamics and sex ratio of *Cylas puncticollis* on Sweet potato weevils in the South West agro-ecological region of Cameroon.

Sweet potato storage roots damage at different days after planting

There was no weevil damage on the storage roots from 30 to 75 days after planting (DAP) during the rainy season. At 90 DAP, there was less than 1% damage but this increased slightly to a maximum of 5% at 135 DAP. During the dry season *C. puncticollis* infestation was evident as from 30 DAP and increased steadily to about 12% at 135 DAP.

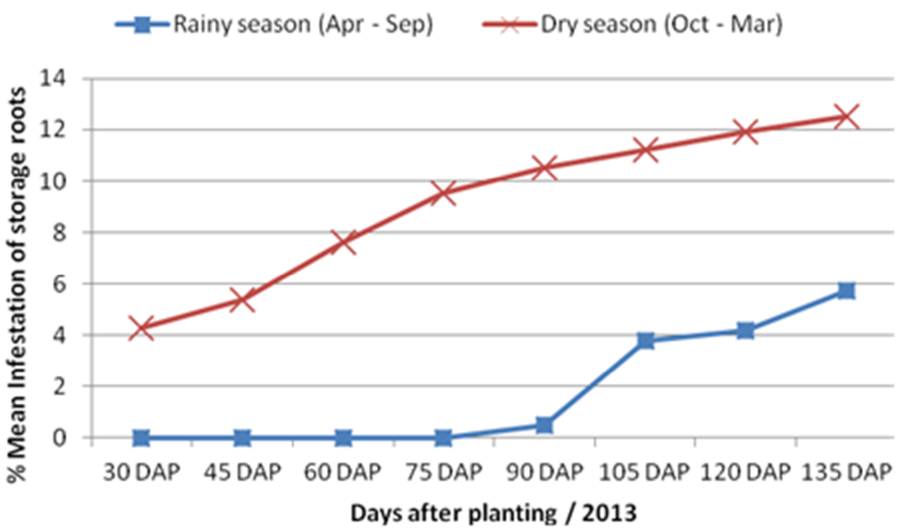

Fig 3: Effect of harvesting days on percentage damage of storage roots by sweet potato weevils during the rainy and dry seasons in 2013.

DISCUSSIONS

There was higher damage by *C. puncticollis* on sweet potato storage roots during the dry season possibly because weevils find it difficult to penetrate wet soils compared to dry soils which they readily penetrate deep (Teli and Salunkhe 1994). In contrast, during the rainy season, the soil is compacted and crevices that opened during the dry season are closed thereby hindering access to the roots. This is similar to observations in Papua New Guinea where high levels of weevil incidence generally corresponded with lower rainfall levels (Sutherland 1986). Bourke (1985) also observed that the weevil caused economic damage in areas with a marked dry season or in unseasonably dry years. High soil moisture content during the rains may also cause high weevil mortality due to diseases which are more prevalent during moist conditions.

There were no significances in vine damage among planting dates probably because the weevils were unable to penetrate the soil to infest the storage roots. It is possible that during the rainy periods the soil became compacted leading the weevils to resort to feeding and ovipositing on the vines.

The highest and lowest storage root yields were obtained from the April (7.22 tons/Ha) and October (4.92 tons/Ha) plantings, respectively. This could result from the differences in the amount of rainfall during these periods since water is an important factor in crop growth and yield. This is similar to the finding by Martin (1987) who attributed differences in the response to planting dates to differences in their responses to day-length, rainfall, temperature and light intensity. April is the onset of the rainy season; at that time the plants had enough water for optimal growth while sweetpotatoes planted in October which is the onset of the dry season (a likely time of dwindling availability of water to the plants) were unable to support optimal growth and root yield. The observed yield increases are similar in potato production where well-scheduled irrigation schemes are maintained throughout the growing season (Boujelben et al., 2001; Deblonde & Ledent, 2001; Faberio et al., 2001; Chowdhury et al., 2001; Panigrahi et al., 2001; Ferreira & Carr, 2002; Kashyap & Panda, 2003; Shock et al., 2003; Yuan et al., 2003.).
Planting period during the early rainy season registered higher yields than the late rainy season probably because during the late rainy season, there is reduced sunlight hours accompanied by reduced photosynthetic activities. Excess water in the soil at this period of late rainy season may also lead to water logging and this stresses up the plants resulting in leaf necrosis which reduces starch production. This is consistent with a study conducted by Frederick et al.(1996) on the effect of water-logging on the growth and yield of sweet-potato where root and shoot growth declined tremendously during water-logging.

The storage roots were not damaged by weevils between 30 to 75 DAP during the rainy season probably due to the high rainfall which compacted the soil thus hindering entry by the weevils. As from 90 DAP the storage root damage increased steadily to a peak 135 DAP probably due to development of storage roots that cracked the soil for weevil penetration. During the dry season, there was higher storage roots damage which peaked at 90 DAP and started declining around 135DAP. This is consistent with the studies of Ashebir, (2006) who observed that yield loss was high towards the dry season due to low soil moisture and possibly high soil crack. Hence, the weevil pest problem is particularly serious under dry conditions because the insect can reach the root more easily through the cracks that appear as the soil dries out; therefore sweet potato cannot be stored safely in-the ground for long period during the dry season. The longer harvesting was delayed, the greater the likelihood that infestation would increase, even during the rainy season as the dry season approaches (see Figure 3). The reverse is the case with dry season infestation. Therefore delaying harvesting of roots may be helpful in one case but not in another. Also, if the harvested roots are going to be stored, whatever infestation that is present will multiply in storage and over time the end result will be the same irrespective of harvest time. Given this, it would be advisable to harvest as soon as the crop is mature and ready for consumption or other uses

There population of *C. puncticollis* during the rainy season was low; the highest population was recorded during the dry season. Irrespective of the season, the sex ratio of *Cylas* weevils was always in favor of females with the fremales generally twice as many as males.

During the dry season, weevil population increased most likely because the dry soil had crevices which served as entry points for the weevils thus giving them increased access to storage roots for feeding and reproduction. Wijmeersch (2000) reported that in Papua New Guinea which has a high and well distributed rainfall weevil damage is generally not a problem; however, Hartemink et al. (2000) also working in Pappau New Guinea observed that moisture/rainfall influenced sweet potato weevil incidence and damage. Most however find that high weevil incidence generally corresponds to low rainfall. The rainy season also has cooler temperature which was reported by Kimura et al. (2006) to decrease oviposition in female *Cyclas spp.*

CONCLUSION AND RECOMMENDATIONS

In the South West Region of Cameroon, *C. puncticollis* damage on sweet potato was quite low during the rainy season. Therefore planting the crop between April – June for the rainy season and October – December for the dry season can be a sustainable way to obtain good yields coupled with low *Cylas sp*. damage. Also harvesting of storage roots should take place before 100 DAP since our findings show that there was increased weevil infestation after this period.

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