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Insect pests of sweet potato in the Sudan savanna zone of Ghana

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Abstract
Sweet potato (*Ipomea batatas* L. Lam) is the third most important root and tuber crop in Ghana, cultivated largely in Sudan and coastal savanna zones of the country. Yields are marginally low owing to low soil fertility, pests and diseases infestation and absence of improved planting materials. Innovations on soil fertility management and improved varieties have been available but research on pests and disease problems have remained relatively neglected. This study was therefore designed to identity the pest associated with the crop and the damage they cause. Farmer interviews, field observations and destructive sampling were conducted in 2013 and 2014 in five districts of the Upper East Region in the Sudan savanna. *Cylas spp*, *Acrea acerata*, *Bemisia tabacci*, termites and grasshoppers all attacked the crop with the first two being most important. *Cylas spp* occurred in over 90% of farms damage estimates revealed that it caused 30.8% and 41.4% damage to vines and roots respectively during the 2014 cropping season.

Keywords: *Cylas spp*, insect pests, integrated pest management, *Ipomea batatas*, Sweet potato.

1. Introduction
Sweetpotato, *Ipomoea batatas* (L.) Lam., is an important staple food crop contributing to household income, food, and nutritional security in Africa. The tubers are rich in fibre, vitamins A, B, C, riboflavin, copper, pantothenic acid and folic acid [1].
In Ghana, the crop is grown by small scale farmers largely in the Upper East (UE) and Central regions which together produce an estimated 93603 metric tonnes annually [2]. The total land area put under the crop is about 73,400 ha [3] making it the third most popular root crop and tuber crop after cassava and yam.
Despite its potential to contribute towards poverty alleviation, food security and improved nutrition especially among impoverished rural households, the crop has received relatively less research attention than its peers. Yields on farmer fields are therefore usually way below the optimum for the crop as reported from research stations. Poor access to improved varieties, pest and disease infestation and low soil fertility are largely responsible for the low on-farm productivity.
Available literature shows that insect pests can constitute a serious constraint to increased and sustainable production of sweet potato in many parts of Africa [4]. The composition of the pest complex associated with the crop has also been reported from many locations. For instance, West [5] reported over 100 arthropod pest species associated with the crop in the Carribean and more recently [6], in a world review, listed 270 insect species as pests of the crop both in the field and in storage [7] have even produced a comprehensive list and descriptions for the main pests of sweet potato globally. The major insects found on the crop include leaf feeders, stem and vine feeders, root feeders, virus transmitters and flower feeders. Of these, the sweet potato weevils *Cylas spp* are the most damaging and have thus received the greatest research attention [6, 7].
Comprehensive studies on the pest profile of sweet potato in Northern Ghana are scanty though preliminary observations suggest that insects probably cause appreciable damage to the crop annually on farmers' fields. For instance, [8] studied pests associated with frafra potato in the UER and indicated that most of the insects they encountered also attacked and probably preferred sweet potato where the two crops are grown together as is often the case in the area. The current study was therefore designed to establish the identity, distribution and relative abundance of the various insects attacking sweet potato as a prelude to developing integrated management strategies for those causing significant damage and yield losses.

2. Materials and methods

Surveys were conducted during the rainy seasons of 2013 and 2014 in 5 districts located in Sudan savanna of Ghana, namely Kasena –N, Bongo, Nabdam, Talensi and Bawku West. In each district, 10 – 15 farms, separated by at least 5 km were selected randomly along major motorable roads for the exercise. Selected farms were visited at least twice during the vegetative period and again at harvest for pest sampling using combinations of visual observation as well as non-destructive and destructive sampling procedures. For each farm therefore, information was collected on the identity and relative abundance of insects as well as the nature and extent of damage where possible. Pests were identified using combinations of voucher samples collected earlier by [8] and photos contained in [7]. For all insect pests observed, infestation rates were recorded as the percentage of farmer fields in which the pests occurred, while the within-field occurrences were expressed as relative abundance scores 1 – 5, where 5 = pest occurs in large numbers with visible damage in the field and 1 = pest occurs rarely with no visible damage [8]. In 2014, the extent of damage caused by C*ylas spp* was assessed on each farm. Three 2 m^2 quadrats were randomly created in each field at maturity from which all plants were harvested and vines and roots examined for damage by the insect. Damage levels were expressed as percentage of damaged vines or tubers over total numbers harvested in all quadrats for the farm. Owners of the various farms were also asked about their views on *Cylas spp* as sweet potato pests.

3. Results

In order of importance, Sweet potato weevils (*Cylas spp* Coleoptera: Curculionidae) and sweet potato butterfly *(Acraea acerata)* were the most frequent with infestation rates of over 90% in all fields sampled in both years (Table 1). Adult *Cylas spp* (mainly *C. formicarius*) and also larvae were observed on leaves, vines and more predominantly, tubers, on which they damaged the epidermis and produced scars and typical round punctures and tunnels that often contained fecal material and frass. *Acrea acerata* larvae are greenish black, covered dense hairs and were often found feeding on the leaves in hordes covered by protective webs. They mainly damaged the upper leave surfaces but in some severe cases leaves were eaten down to the midribs. Several species of grasshoppers and crickets were also found with the crop causing mild to severe defoliation in many farms sampled. Other foliage feeding insects included aphids (*Aphis cracivora.* Homoptera: Aphididae whiteflies (*Bemisia tabacci*), leafhoppers (*Empoasca spp.* Homoptera: Aleyrodidae), tortoise beetles (*Aspidiomorpha* spp Coleoptera: Chrysomelidae) and the sweet potato hornworm (*Agrius convolvuli* Lepidoptera: Sphingidae*).* Adults *Aspidiomorpha* spp, as the name suggests, are tortoise-shaped and brightly coloured. Larvae of *A. convolvuli)* typically possess a "horn" on the top of the head and are thus easily identified. Subterranean pests associated with the crop included termites (mainly *Microtermis* spp), white grubs and millipedes. These damaged the tubers and other underground portions of plants. These subterranean pests had moderate to very high infestation rates (40 – 80%) in most districts, though relative abundance scores were usually low and are probably serious enough problems to require in-depth research and control.

Studies on vine and tuber damage caused by *Cylas spp* showed that at least 53% of owners of farmers surveyed in all the districts recognized the insect as important constraint to sweet potato production. Apart from Nabdam district which had a relatively low rate, at least 70% of farmers in the other 4 districts mentioned *Cylas spp* as pests attacking their crop, with a regional mean of 76% (Table 3). Mean vine and tuber damage were 30.8% and 41.4% with ranges of 25 – 39% and 33 – 50% respectively (Table 3), confirming the status of the insect as a key pest of sweet potato in the study area.

Table 1: Key insect pests observed at the various survey sites (2013)

	Kasena-Nankana West (11)*		Talensi (10)		Bawku West (12)		Bongo (15)		Nabdam (15)	
Insect pest	**I R**	**Mean RAS**	**I R**	**Mean RAS**	**I R**	**Mean RAS**	**I R**	**Mean RAS**	**I R**	**Mean RAS**
Cylas spp	90.0	3	100.0	3	83.3	3	93.3	4	80.0	2
Acrea acerata	90.0	3	100.0	3	100.0	3	93.3	4	100.0	4
Alcidodes sp	36.4	1	30.0	1	33.3	1	33.3	1	20.0	1
Bemisia tabacci	100.0	2	100.0	2	91.7	2	93.3	2	80.0	2
Empoasca spp.	81.8	1	80.0	1	66.7	1	60.0	1	53.3	1
Aspidiomorpha spp	37.3	1	40.0	2	33.3	1	26.7	1	46.7	1
Grasshoppers/crickets	100.0	3	100.0	3	100.0	3	100.0	3	100.0	3
Termites	72.7	3	70.0	3	75.0	3	60.0	3	60.0	3
White grubs	81.8	2	70.0	2	83.3	2	66.7	2	40.0	1
Millipedes*	81.8	3	90.0	2	83.3	2	86.7	3	60.0	3

**Figures in brackets are number of farms sampled. I R = infestation rate (%); Mean RAS = relative abundance scores (1 – 5) averaged for the location*

Table 2: Key insect pests observed at the various survey sites (2014)

	Kasena-Nankana West (10)		Talensi (10)		Bawku West (13)		Bongo (10)		Nabdam (15)	
Insect pest	**I R ***	**RAS**	**I R**	**RA**	**I R**	**RAS**	**I R**	**RAS**	**I R**	**RAS**
Cylas spp	90.0	4	100.0	4	84.6	3	100.0	5	86.7	5
Acrea acerata	100.0	4	90.0	3	100.0	4	100.0	3	100.0	4
Alcidodes sp	30.0	1	40.0	1	46.1	1	50.0	1	33.3	1
Bemisia tabacci	60.0	3	80.0	3	76.9	3	100.0	3	86.7	3
Empoasca spp.	60.0	2	80.0	2	92.3	2	100.0	2	86.7	3
Aspidiomorpha spp	20.0	2	40.0	2	30.8	1	70.0	2	69.2	2
Agrius convolvuli	40.0	1	60.0	1	46.1	1	40.0	1	33.3	1
Aphis cracivora	20.0	2	50.0	2	30.8	1	70.0	2	46.7	2
Grasshoppers/crickets	80.0	3	70.0	2	100.0	4	100.0	3	93.3	3
Termites	40.0	2	60.0	2	61.5	2	60.0	2	53.3	3
White grubs	50.0	2	70.0	2	61.5	2	60.0	2	66.7	2
Millipedes*	80.0	3	90.0	3	92.3	3	80.0	3	80.0	2

**Figures in brackets are number of farms sampled. IR = infestation rate (%); Mean RAS = relative abundance scores (1 – 5) averaged for the location*

Table 3: Incidence and damage caused by *Cylas spp* on farmer's fields in 2014

*District**	*% farm owners aware of pest*	*%vine damage*	*%tuber damage*
Kasena-Nankana West (10)	*70.0*	*34.6*	*40.1*
Talensi (10)	*90.0*	*39.3*	*43.9*
Bawku West (13)	*76.9*	*32.4*	*49.8*
Bongo (10)	*90.0*	*22.7*	*33.0*
Nabdam (15)	*53.3*	*25.0*	*40.3*
Mean	*76.0*	*30.8*	*41.4*

**Numbers in brackets refer to number of farms (=farm owners) sampled*

4. Discussion

Results from the studies clearly show that insect pests can really be serious constraint to increased and sustainable sweet potato production in the UER. Of the many pests recorded, *Cylas spp*, *A. acerata*, *B. tabacci*, *Empoasca* spp, grasshoppers/crickets, termites and white grubs were all observed in more than 50% of all farms surveyed, confirming their close association with the crop. In fact, [8] studied pests of frafra potato (*Solenostemon rotendifolius*) in the same area and similarly identified *B. tabaci*, *Empoasca* spp and *Acraea acerata* as the main pests in the vegetative stage. They postulated that since *S. rotendifolius* is usually grown alongside sweet potato, the two crops probably have a similar guild of foliage feeders. The current results appear to confirm this line of thinking.

Using a relative abundance threshold of 3 as a measure of pest status, it is clear that *Cylas spp* and *A. acerata* are probably the two most important pests across the region. Similar reports have been made by many other workers who also identified *Cylas spp* and *A. acerata* as the two most important insect pests of sweet potato in West Africa [6, 7, 9]. It is estimated that severe defoliation of the crop by *A. acerata* combined with *Cylas spp* damage to vines and roots can result in 100% root yield loss, especially during long dry seasons [10, 11] while on its own, *Cylas spp* damage can be a high as as 60-97% [12, 13] or even 100% [6, 7]. *Cylas spp* infestation is also known to induce increased production of furanoterpenoids that make the tubers unpalatable thus reducing their quality and market value [14]. Though accurate and systematic yield loss assessments in the study area still need to be conducted, the preliminary estimates presented here go to confirm that the weevils are economic pests for which effective controls need to be developed and applied by farmers to reduce their damage. The proliferation of whiteflies and leafhoppers in surveyed fields should also be worrying as these are known to transmit virus diseases in many crops including sweet potato. Important virus diseases of the crop such as sweet potato mild virus (SPMMV), sweet potato sunken vein virus (SPSVV) and sweet potato disease virus (SPVD) are all known to be transmitted by whiteflies [6, 7]. In fact though not assessed, plants showing typical symptoms of virus attack (stunting, leaf distortion, mottling, chlorosis) could be observed in some fields where infestation rates of these insects were high. Even though this paper focuses on insects, it is clear from Tables 1 & 2 that millipedes abound in sweet potato fields and do some damage that also needs to be quantified.

5. Conclusion

In the Sudan savanna of Ghana, sweet potato is attacked by a number of insect pests which damage the foliage, vines and roots. Of these, *Cylas spp* and *A. acerata* appear to be the most important pests of roots and foliage respectively, usually causing some appreciable, visible damage in farmers' fields. There is therefore the need for systematic studies to understand the pest problems associated with the crop so that effective integrated crop and pest management practices could be developed to reduce losses caused to farmers annually.

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