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(Research Article)

Organic mulch as a potential management option for sweet potato weevil (*Cylas puncticollis*) in sweet potato production

Oso Adeola Abiola * and Onipinla Bosede Olabimpe

Department of Crop, Horticulture and Landscape Design, Faculty of Agricultural Sciences, Ekiti State University, Ado-Ekiti.

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Abstract

Sweet potato farmers in Nigeria faced the challenge of heightened infestation of the roots by *C. puncticollis* particularly in the dry season. During this season, soil cracks facilitate the weevil entry, which tunnels into the roots and decreases its quality and market value. Mulch contributes to pest suppression in crops by producing volatile compounds, making pest accessibility challenging. In this study, the potentials of four organic mulches were explored in the management of *C. puncticollis*. The experimental design was completely randomized with two blocks (covered and uncovered) each comprising four categories and a control. Manures (poultry and cow dung), wooden materials (sawdust and wood chips), plant materials, (*Ocimum gratissimum* and *Lantana camara*), and plant wastes (oil palm bunch refuse and oil palm fiber) were screened in a multi-choice mesocosms against *C. puncticollis*. In the uncovered experiment, the potato roots were left exposed to simulate cracked field soil. For the covered experiment, the roots were covered with 2 cm of soil, mimicking field conditions where soil remains over developing storage roots. Results showed that for the covered-manure mulch, feeding punctures counted on poultry manure (1.5) and cow dung (2.0) treated roots were significantly lower than the control (3.8). For the uncovered-manure mulch, a significantly lower number of feeding punctures (7.1 and 7.7) were observed on poultry manure and cow dung-treated roots compared to the control (11.5). Overall, lower numbers of feeding punctures and weevils were observed in the mulch-treated roots compared with the control. It is recommended that mulching with organic materials can be an effective strategy in the integrated management of sweet potato weevil, particularly during dry periods when soil cracking can facilitate pest access to the storage roots.

Keywords: *Cylas puncticollis*; Feeding Punctures; Sweet Potato; Organic Mulch; Management.

1. Introduction

Sweet potato (*Ipomea batatas* L. (Lam)) is a versatile and under-exploited food crop with more than 90 million tonnes annual production [1]. It is the fifth most essential food crop on a fresh weight basis in developing countries after rice, wheat, maize and cassava [2]. Sweet potato is a crop which almost every part of sweet potato can be eaten and these parts may vary in terms of the nutrients, bio-actives, non-nutrients, and antinutrients composition [3]. As a drought-tolerant crop, sweet potato provides nutritional advantage to the rural and urban dwellers enhancing food and nutritional security. Despite the nutritional benefits and economic demand for sweet potatoes, the storage roots are threatened by sweet potato weevils (*Cylas puncticollis* Boheman), causing low yields or quality losses [4]. The larvae of these weevil feed and tunnel in the roots which results in the production of terpenoids and phenolic compounds. These compounds cause storage roots to develop an unpleasant smell and bitter taste, ultimately making the roots inedible [5]. In Nigeria, infestation of the storage roots by these weevils happens during the dry season when high temperatures cause the soil surface to crack, exposing the tubers. A wide range of management strategies of the sweet potato weevil have been documented but they are less affordable in developing countries. Hence the need to develop low-cost

* Corresponding author: Oso A. A

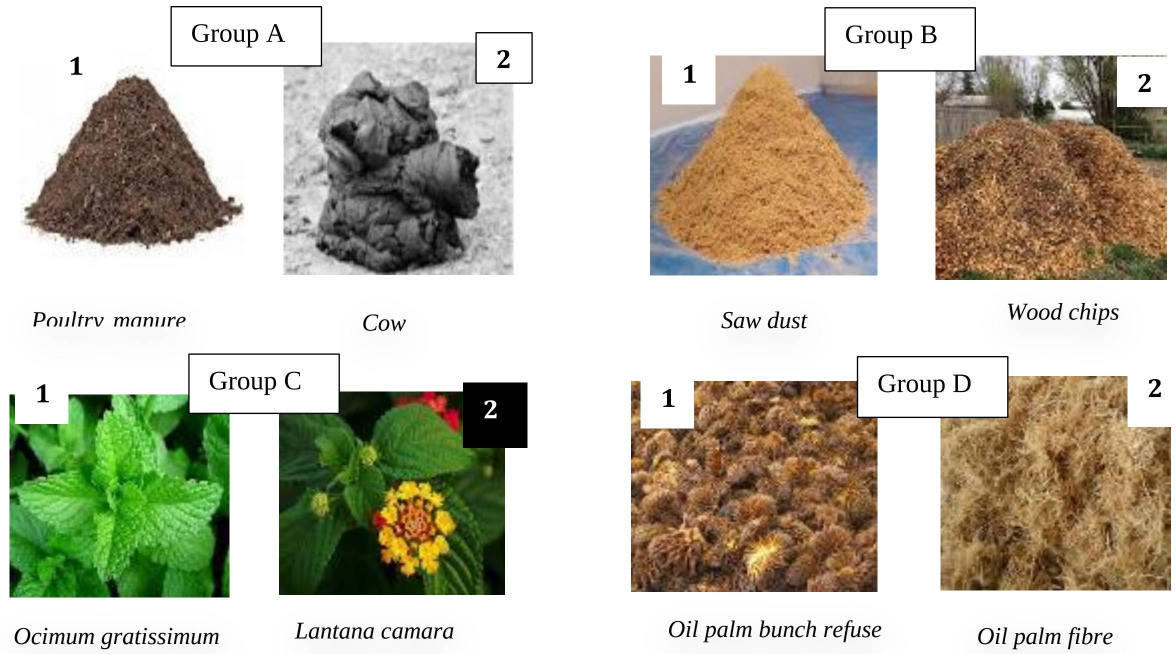
strategies potentially including pest-deterring mulches of locally-available and affordable materials. Mulches have been used to reduce incidence of lesser corn stalk borer on bean [6], to suppress pest population in pepper [7], and to reduce pest attack in sweet potato under natural infestation [8]. The ability of mulches to contribute to pest suppression through phenomena like creating a physical barrier to pest access to vulnerable crop parts or making host plant detection more challenging as a result of the chemical composition and volatile production by mulch material has received much less attention. The present study aimed to explore a range of organic mulch treatments to determine their potential utility for sweet potato weevil management, specifically by preventing their movement through layers of mulch and reducing levels of infestation in storage roots.

2. Materials and Methods

The study was conducted at the Laboratory of the Department of Crop, Horticulture and Landscape Design, Ekiti State University, Ado-Ekiti. *Cylas punticollis* adults were obtained from a continuous insect culture maintained in the laboratory. *C. punticollis* were reared using sweet potato roots placed in plastic containers covered with plastic mesh, and secured in place with a rubber band at 28 ± 2 ^{0}C, 70-80% relative humidity, and 11h light and 13 h dark photoperiod.

2.1. Experimental Layout

The experimental design followed a completely randomized design with two blocks (covered and uncovered), each containing four groups: group A (cured poultry manure and cured cow dung), group B (sawdust and wood chips), group C (*Ocimum gratissimum* and *Lantana camara*) and group D (Oil palm bunch refuse and Oil palm fibre). Each group had two treatments (the mulch materials and one control), replicated three times, resulting in a total of twelve experimental units per block, and 24 experimental units overall.



Sources- A 1 : https://bachatkart.in/poultry-manure, A2: https://www.indiamart.com/proddetail/fresh-wet-cow-dung, B1: https://www.indiamart.com/proddetail/saw-dust-dry-2851066693433.html, B2: https://www.heritageflowerfarm.com/why-we-use-wood-chips-for-mulch/, C1: https://www.researchgate.net/publication/368677435, C2: https://en.wikipedia.org/wiki/Lantana_camara, D1:https://www.alfalaval.com/globalassets/documents,

Figure 1 Different types of organic mulch materials

2.2. Experimental Procedure

The mulch screening took place in mesocosms made from plastic plant pots (21 cm in diameter, 16 cm in depth). The pots were filled halfway with dried soil, and a 90 mm diameter Petri dish base was placed in the centre of each pot's surface. The area around the dish was divided into three equal sections, and in each section, 50 g of air-dried loamy soil was added, followed by 50 g of potato root placed on top of the soil. Each potato root was then covered with a layer of mulch, except for the third section, which served as the control. In the uncovered experiment, the potato roots were left exposed to simulate cracked field soil. For the covered experiment, the roots were covered with 2 cm of soil, mimicking field conditions where soil remains over developing storage roots. Twenty adult *C. puncticollis* weevils were placed in the central Petri dish of each pot and allowed to disperse into the mulch treatments. A 20 cm diameter net was secured to the top edge of the pots with elastic bands to prevent the weevils from escaping.

2.3. Data Collection

After 24 hours, data was gathered by inspecting each storage root for weevils and feeding holes, which were then documented.

2.4. Statistical Analysis

The mesocosms in each treatment group were analyzed separately using analysis of variance (ANOVA) with IBM-SPSS 2020 to assess the impact of mulch treatment on the number of weevils reaching the sweet potato roots and the number of feeding holes on the roots. Tukey's test was applied to determine significant differences between the means.

3. Results and discussion

Table 1 shows the effect of poultry manure and cow dung on sweet potato weevil activity. Organic manure are waste products excreted by livestock, even in processed form [9]. The physicochemical properties of manure justify its wide use as a soil improver and organic fertilizer [10]. Manure enhances enzyme [11] and microbial activity [12] as well as the abundance and biomass of soil fauna [13]. In the covered experiment, the number of feeding holes was significantly higher in the control treatment compared to the poultry manure and cow dung treatments. In the uncovered experiment, the number of feeding holes was significantly higher in the control treatment than in the mulch treatments. The number of weevils found on the storage roots did not differ significantly across the treatments. Overall, fewer feeding holes and *C. puncticollis* were observed in the mesocosms treated with poultry manure and cow dung, indicating an inhibitory effect. Gleń-Karolczyk et al., [14] reported that increased fungal diversity by bovine manure application led to reduction of dry rot of potatoes. Through a meta-analysis, Liu et al., [15] also reported a more active and enhanced size of microbial population in manures (pig, cattle, chicken, horse) controlling plant-feeding nematode populations. The effects of organic (composted cow manure) and synthetic (NPK) fertilizers on pests (aphids and flea beetles) and predatory arthropods (anthocorids, coccinellids and chrysopids) associated with tomatoes were evaluated by Yardim and Edwards [16]. They found lower populations of aphids on tomatoes grown with organic manure than the synthetic fertilizer. They concluded that organic fertilizers may have the potential to reduce pest attacks in the long term. These documented reports suggest the efficacy of the manure mulch over the control treatment.

Table 1 Effect of poultry manure and cow dung on infestation of sweet potato fragments by *C. puncticollis*

Treatment	Covered		Uncovered	
	Feeding holes	**Number of weevils**	**Feeding holes**	**Number of weevils**
Poultry manure	1.53b	0.4b	7.13b	2.33a
Cow dung	2.00b	1.0ab	7.67b	2.67a
Control	3.80a	1.6a	11.47a	3.13a

Means within the rows followed by the same lower-case letter(s) do not differ significantly according to Turkey's multiple comparison test.

The number of feeding holes and weevils on the sweet potato storage root fragments in sawdust and wood chips mulch followed a similar pattern to the manure mulch in both the covered and uncovered experiments. In both experiments, the number of feeding holes and weevils on the sweet potato storage root fragments in the control treatments were significantly higher than in the mulch treatments, as shown in Table 2. In a recent study, Candelier et al., [17] pointed to a potential for commercial use of Atlas cedar wood extractives as biocontrol products against pathogens of ligneous agricultural crops. In agreement with documented report that organic mulch made from wood (wood chips and sawdust) when applied around a host hinders the spread of most plant-pathogenic bacteria and viruses and many fungi that infect the branches, flowers, fruit, leaves, and twigs of trees and shrubs [18], sawdust and wood chips restricted the movement of C. puncticollis in the mesocosms. Likewise, a study examined the effect of organic (wood) and inorganic (gravel) landscape mulches on subterranean termite foraging activity. They reported that the termite activity was found higher beneath the gravel mulch as compared to the wood mulch [19].

Table 2 Effect of sawdust and wood chips on the activity of sweet potato weevil

Treatment	Covered		Uncovered	
	Feeding holes	**Number of weevils**	**Feeding holes**	**Number of weevils**
Sawdust	1.47b	0.40b	7.67b	1.27b
Wood chips	2.00b	0.60b	6.87b	1.40b
Control	4.20a	1.67a	11.80a	3.80a

Means within the rows followed by the same lower-case letter(s) do not differ significantly according to Turkey's multiple comparison test.

Table 3 presents the effect of *Ocimum gratissimum* and *Lantana camara* on sweet potato weevil activity. Studies have shown that the leaves of *L. camara* possess insecticidal properties [20; 21]. In both the covered and uncovered experiments, the number of feeding holes was significantly higher in the control compared to the mulch treatments. However, the number of weevils on the storage root fragments in the uncovered treatments did not differ significantly across the treatments. Biopesticidal activity of *L. camara* have been reported against rice month *Corcyra cephalonicaa* (Stainton) (Lepidoptera: Pyralidae) [22]. The repellent and insecticidal effects of *Ocimum gratissimum* have also been proven effective on *Rhizopertha dominica* F. (Coleoptera: Bostrichydae). The insecticidal activities of *Ocimum gratissimum* and *Lantana camara* plants might be due to the insecticidal constituents like flavonoids, triterpenoids, and alkaloids (lantanine,) contained in these plants [23; 24].

Table 3 Effect of *Ocimum gratissimum* and *Lantana camara* on infestation of sweet potato fragments by *C. puncticollis*

Treatment	Covered		Uncovered	
	Feeding holes	**Number of weevils**	**Feeding holes**	**Number of weevils**
Ocimum gratissimum	1.67b	0.27b	6.67b	1.60a
Lantana camara	1.87b	0.87b	6.73b	1.93a
Control	3.80a	1.53a	11.53a	2.20a

Means within the rows followed by the same lower-case letter(s) do not differ significantly according to Turkey's multiple comparison test.

Table 4 Effect of oil palm fibre and oil palm bunch refuse on infestation of sweet potato fragments by *C. puncticollis*

Treatment	Covered		Uncovered	
	Feeding holes	**Number of weevils**	**Feeding holes**	**Number of weevils**
Oil palm bunch refuse	1.33b	0.20b	7.06b	1.67a
Oil palm fibre	1.40b	0.60b	8.73ab	2.73a
Control	3.53a	1.73a	11.60a	2.60a

Means within the rows followed by the same lower-case letter(s) do not differ significantly according to Turkey's multiple comparison test.

The number of feeding holes and weevils observed in the oil palm mulch-covered treatments were significantly lower than in the control treatment (Table 4). Oil palm bunch refuse and oil palm fibre contain large fibres due to the high nutritional content of the solid waste regularly discharged and collected at palm oil mills. In the uncovered experiment, no significant differences were found between the control and mulch treatments, except for the oil palm bunch refuse treatment, which had a significantly lower number of feeding holes. Sulaiman et al., [25] investigated the potential of mixing oil palm empty fruit bunch and oil palm mesocarp fibre as raw materials to enhance the palatability of termite bait and to find optimum concentration of imidacloprid for structural pest control. They reported the effectiveness of oil palm empty fruit bunch over mesocarp fibre as a raw material for artificial bait and as single fibre type to control structural pest. The most important components of the fibres are cellulose, hemicelluloses and lignin [26]. These ingredients enhance plant cell wall rigidity, hydrophobic properties and promotes minerals transport through the vascular bundles in plant. Hence, oil palm bunch refuse and oil palm fibre are fibrous by-products of oil palm production that create a physical barrier, deterring and limiting pest movement, thereby reducing their access to the crops.

4. Conclusion

According to the results of the study, poultry manure, cow dung, sawdust, wood chips, oil palm bunch refuse, and oil palm fibre (solid organic wastes) possessed insecticidal properties, physical barrier and feeding deterrent effect against *C. puncticollis*. Sustainable use of these materials as organic mulch improves the food security in areas where investments in synthetic insect pest control are costly for farmers to access. Although, the laboratory investigation showed higher mean number of feeding punctures in the uncovered experiment, (the potato roots were left exposed to simulate cracked field soil) when compared with the covered experiment, (mimicking field conditions where soil remains over developing storage roots). The uncovered treatments had a better performance over the control treatments. Therefore, the resource poor farmers can use organic mulch to mitigate against *C. puncticollis* particularly during dry periods when soil cracking can facilitate pest access to the storage roots.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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