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Prostephanus truncatus (Horn) (Coleoptera: Bostrichidae) food preference, establishment and damage on selected stored products

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Abstract

Food preference, damage and breeding ability of *Prostephanus truncatus* on selected food crops which includes; *Zea mays* L., (maize), *Oryzae barthii* A. Chev (paddy rice), *Sorghum bicolor* (L.) Moench (guinea corn), *Vigna unguiculata* (L.) Walp. (Cowpea), *Manihot esculenta* Crantz, (cassava), *Dioscorea rotundata*, (yam) *Colocasia esculenta* L. (Schott) (cocoyam) and Ipomoea *batatas* Lam. (sweet potato) were conducted in the Entomology laboratory, Department of Zoology, University of Ibadan under ambient conditions of 25-28 ^{o}C and 65-85 % r.h. *Prostephanus truncatus* significantly preferred dried cassava chips and guinea corn among tuber and grain crops, respectively, in a free choice food preference studies within 24 hours of infestation. Highest percentage weight loss of 78.2% and 6.9% were recorded for dried cassava chips and guinea corn, respectively. Breeding ability of *P. truncatus* was significantly different ($p < 0.05$) in dried cassava chips than all other food crops. Neither damage nor breeding was recorded in maize grain (TZM-184) and paddy rice (IRGC-106176). In Storage, guinea corn and dried cassava chips were mostly preferred by *Prostephanus truncatus* and inflicts serious damage on the crops.

Key words: Breeding, Crops, Damage, Food preference, *Prostephanus truncatus*

Introduction

Prostephanus truncatus (Horn) is one of the major post-harvest pests of crops both at the farmers' and consumers' levels in the tropics [1]. The Larger grain borer, *P. truncatus* (Horn) is a native of Central America [2] however it has spread to several countries in both eastern and western Africa including Nigeria [3]. The larger grain borer infest and damage commodities other than maize and dried cassava chips. Wheat (*Triticum aestivum* Poaceae), rice (*Oryzae sativa* Poaceae), chickpea (*Cicer arietinum* Fabaceae), sweet potatoes (*Solanum tuberosum* Solanaceae), sorghum (*Sorghum bicolor* Poaceae) and several leguminous crops are some commodities that can host *P. truncatus* larvae and adults [4]. Nevertheless, it appears that it can only breed successfully on maize and dried cassava tuber [5]. *P. truncatus* has been considered a wood-boring species that has become adapted to stored commodities [6, 7]

Meanwhile, the level of damage of *P. truncatus* is unevenly distributed within stores [8]. In Tanzania, introduction of *P. truncatus* elevated maize losses in store to 50% from the previous average of 5% [9]; it has also been recently reported to attack stored paddy rice in Tanzania [10]. In Nigeria [11] reported high percent weight loss of 82% was recorded in dried cassava chips within 3 months of infestation.

However, stored products pests like *P. truncatus* rely on their olfactory systems to find their preferable or favorable food rather than visual signals. Volatiles emitted by food resource often are the most reliable and suitable attractant for the pest and sometimes can be a synergistic factor in host-location process [12]. Insect location of food source is determined by many factors including food resource quality, internal and external stimuli such as volatiles emitted from food sources [13].

Therefore, the aim of this study is to determine food preference of *P. truncatus* amidst the selected food crops in storage, also taking into consideration damage levels and breeding potential to reveal

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possibility of establishment of the pest. Therefore, the objective of the study was to assess *P. truncatus* alternate food preference other than stored maize and dried cassava chips. This is to justify if the pest has ability to damage and breed in the absence of its favourite substrate dried maize and dried cassava chips.

Materials and methods

All experiments were carried out in the Entomology Research Laboratory, Department of Zoology, University of Ibadan, Nigeria (7° 26′ 30″ N; 3° 54′ 00″ E) at temperature of 25-28 °C and 65-85% relative humidity using a Digital Thermo-Hygrometer ETP101.

Preparation of Prostephanus truncatus stock culture

The pest, *P. truncatus*, used for this research were collected from already infested dried cassava chips at Bodija Market (7° 26′ 09″ N; 3° 54′ 46″ E), Ibadan, Nigeria. The insects were reared on sterilized uninfected dried cassava chips (*Manihot esculenta*) in a Kliner jar capped with muslin cloth, kept in a wire netted screened cage with dimension (60 x 30 x 30) cm^3 to prevent entry of any unwanted insect and other organisms through cross infestation. Subsequently, *P. truncatus* adults were collected from this stock culture for further studies.

Test food crops

Tested food crops in this research were obtained from International Institute of Tropical Agriculture (IITA) and Bodija market Ibadan. The food crops and their sources are presented on Table 1. The grain crops were dried maize, cowpea, paddy rice and guinea corn, while the tuber crops were dried cassava, yam, sweet potato and cocoyam.

Table 1. Sources of food crops

Food crops	Botanical names	Variety	Source
Maize grain	*Zea mays*	TZM-184	IITA
Cowpea grain	*Vigna unguiculata*	TVU-3629	IITA
Paddy rice grain	*Oryzae barthii*	IRGC-106176	IITA
Guinea corn grain	*Sorghum bicolor*	…………	Bodija Market
Cassava tuber	*Manihot esculenta*	TMS 4(2) 1425	IITA
Yam tuber	*Discorea rotundata*	TOR-2776	IITA
Sweet potato tuber	*Ipomoea batatas*	………….	Bodija Market
Cocoyam tuber	*Colocasia esculenta*	…………..	Bodija market

Free-choice food preference test

Description of free-choice food preference chamber:

A Free Choice Food Preference Chamber (FCFPC) was used to test food crops preferred by *P. truncatus* as described by [14] with some modifications (Fig. 1). The FCFPC is a flat-bottom cylindrical perspex glass dish, 198mm in diameter and 35 mm in height, its' floor was divided into 4 equal parts using perspex glass strips of 8mm in breadth. A dark 50 mm diameter circle was fixed at the center to form a landing platform for *P. truncatus*. The FCFPC was covered with a tightly fitted lid with bored four holes of 14 mm diameter apart, covered with small piece of muslin cloth to permit free flow of air and 78 mm distance apart from each other on the lid with fifth hole covered with cover slip of the same dimension at the center of the lid.

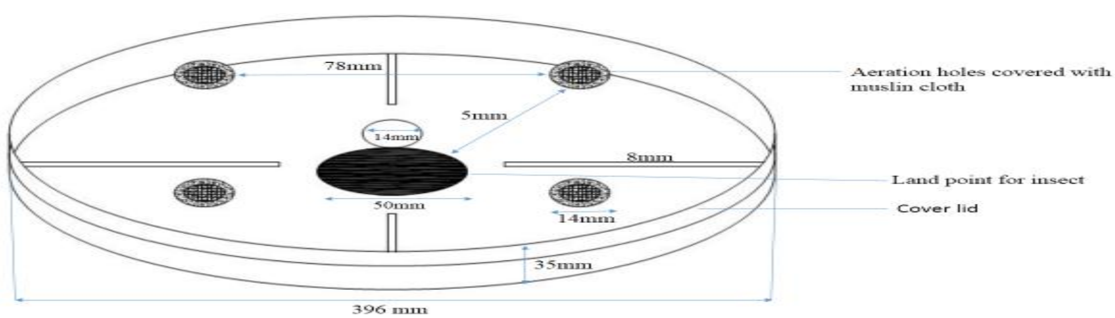

Figure 1. Schematic representation of the Free-Choice Food Preference Chamber (FCFPC)

Free-choice food preference test experimental set-up

Two experimental set-up were used for this. First was on grain crops and the second was on processed tuber crops separately. Four grains and processed tuber crops of 10 g each were placed separately per chamber in the FCFPC. Maize grain and dried cassava tuber served as a reference media. All food crops were sterilized using Gallencamp hot box oven at 60 °C for one hour to prevent any pre-infestation and contamination before the experimental set up. Fifty unsexed *P. truncatus* adults starved for 15 hours were introduced through the central hole of the lid onto the platform and covered with glass slip. The insects were allowed to move to any food crop of their choice and number of insect pest *P. truncatus* observed at specific periods of 1, 3, 5 and 24 hours were recorded. All experiments were replicated four times.

Evaluation of Damage and Breeding Potentials of Prostephanus truncatus on Different Food Crops

Un-infested samples of different grains and processed tuber crops (cut into cubes of about 4 cm^3, and sun dried to form dried chips) were used to determine the damage and breeding potentials of *P. truncatus*. The processed food crops moisture content was determined using dry oven method by [15]. Five (5) and Twenty (20) grams of grains and processed dried cassava chips cubes were weighed into 5ml and 20 ml specimen bottles respectively using Mettler weighing balance 9230 (Max 600g x 0.01g) SOEHNLE PROFESSIONAL. Each specimen bottle containing grain and tuber crops were infested with unsexed 6 and 10 adult *P. truncatus* respectively, collected from stock culture medium. The experimental set-up was left in the laboratory for 8 weeks undisturbed. Thereafter, food crops were sieved out with sieve of mesh size 0.55 mm and live and dead adults were recorded. Fragment and frass produced by *P. truncatus* infestation were used to determine percentage weight loss, which was calculated according to [16] using the formula:

% weight loss = (Initial Weight of sample before infestation – Final weight of sample after infestation) ÷ (Initial Weight of sample before infestation) X 100

The damage and breeding rate was assessed by determining the following parameters from each food crops: (i) total number of live adults (ii) total number of dead adults (iii) percentage weight loss of the crops.

Statistical analysis

All analyses were subjected to Analysis of Variance (ANOVA). Significant differences between means were determined by Least Significant difference (LSD) at 5% probability level.

Results

P. truncatus Food Preference Test:

Among the grain crops, guinea corn was significantly preferred by *P. truncatus* at 1, 3, 5 and 24 hours compared to other grain crops investigated, including maize grain which served as a reference. While for tuber crops; dried cassava chips (reference media) was better preferred than other tuber crops and the preference choice was significantly different (Fig. 2)

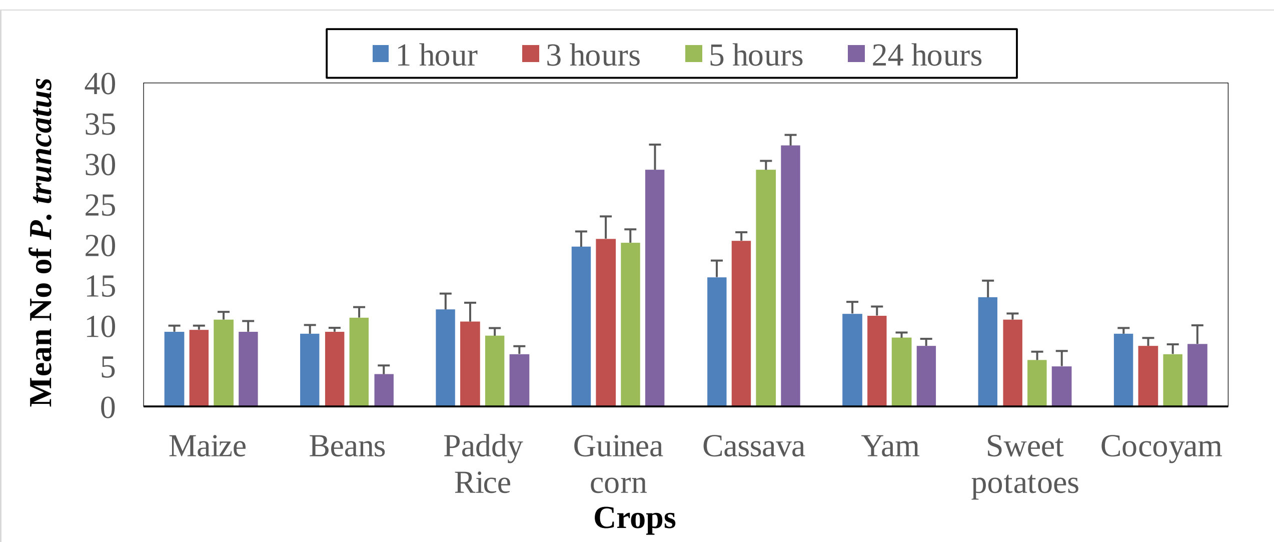

Figure 2. Number of *P. truncatus* movement to different food crops at different hours after infestation.

Breeding and damage potentials of P. truncatus after 8 weeks of infestation on grain crops:

The highest mean population of live adults (4.3 ± 0.5) were recorded on guinea corn followed by cowpea (0.3 ± 0.3). While no live insect was recorded in paddy rice and maize grain, all insect pests introduced were found dead and did not breed in both crops (Table 2). Also, the mean dead adult of *P. truncatus* was significantly high in maize grain and paddy rice where all the insects introduced died before the end of eight weeks. These were followed by cowpea, while the lowest number of dead *P. truncatus* was recorded in guinea corn (1.8 ±0.48) (Table 2).

Meanwhile, mean percentage weight loss (6.9%) recorded in guinea corn *Sorghum bicolor* was significantly different ($p < 0.05$) compared to maize grain (0.0%). No weight loss was recorded in maize grain and paddy rice, while cowpea recorded 2.4% weight loss (Table 2).

Table 2. Number of live and dead *P. truncatus* and percentage weight loss on grain crops 8 weeks after infestations in laboratory

Crops	Mean number ± S.E of *P. truncatus*		
	Live adults	Dead adults	% Weight loss
Maize	0.0 ± 0. 0^{a}	6.0 ± 0.0^{b}	0.0 ± 0.0^{a}
Cowpea	0.3 ± 0.3^{a}	5.8 ± 0.0^{b}	2.4 ± 0.9^{b}
Paddy Rice	0.0 ± 0.0^{a}	6.0± 0.0^{b}	0.0± 0.0^{a}
Guinea corn	4.3 ± 0.5^{b}	1.8 ± 0.5^{a}	6.9 ± 3.3^{c}

Each datum is a means of 4 replicates. Mean numbers followed by different letters within a column are significantly different (LSD) ($p <$ 0.05).

Breeding potential and damage caused by p. truncatus after 8 weeks of infestation on tuber crops

In tuber crops, dried cassava chips significantly had the highest (79.0 ±15.0) mean population of live adults, followed by dried yam (23.8 ± 1.5) and sweet potatoes chips 19.8 ± 3.5. While dried cocoyam chips had the lowest mean population of live adults 7.0 ± 0.9 after 8 weeks of exposure. However, mean population of dead adult *P. truncatus* was higher in dried cassava chips (9.5 ± 2.4). Dried cocoyam chips recorded the lowest dead adult *P. truncatus* (4.0 ± 0.7).

The percentage weight loss of tuber crops infested with *P. truncatus* was determined after 8 weeks of exposure. As shown on Table 3, percentage weight loss in dried cassava tuber which served as a reference media was significantly higher (78.2 ± 7.2) than other tuber crops investigated. Followed by dried sweet potato chips (60.0 ± 2.5 %) and dried yam chips (27.4 ± 8.7%). Dried cocoyam chips recorded the lowest mean percentage weight loss of (18.2 ±1.9 %).

Table 3. Number of live and dead *P.truncatus* and percentage weight loss on tuber crops 8 weeks after infestation in laboratory

Crops	Mean number ± S.E of *P. truncatus*		
	Live adult	Dead adult	% Weight loss
Cassava	79.0 ± 15.0^{c}	9.5 ± 2.4^{b}	78.2 ± 7.2^{c}
Yam	23.8 ± 11.5^{b}	8.0 ± 0.9	27.4 ± 8.7^{a}
Sweet Potatoes	19.8 ± 3.5^{b}	9.0 ± 1.7^{ab}	60.0 ± 2.5^{b}
Cocoyam	7.0 ± 0.9^{a}	4.0± 0.7^{a}	18.2 ± 1.9^{a}

Each datum is a means of 4 replicates. Mean numbers followed by different letters within a column are significantly different (LSD) ($p <$ 0.05).

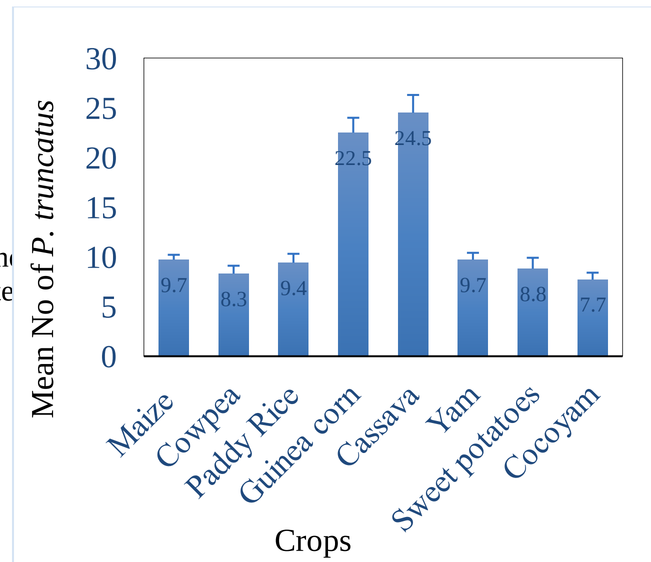

Figure 3. Number of *P. truncatus* found in each food crops within 24 hours of introduction

Discussion

Food preference is a valuable criterion in determining the probability that a stored product insect will choose a particular food product among various food fractions [17]. The stored product insect's pest, *P. truncatus* showed preference towards all the tuber and grain crops investigated, where dried cassava chips and guinea corn were most preferred. Meanwhile, factors such as food particle size, nutritional values and olfactory cue emitted by the food crops may be responsible and play an important role in food preference. This corroborates with the work of [18] who stated that stored- products pests rely on their olfactory systems to find their favorable food rather than visual signals. The fact that all the food crop products investigated were preferred suggests that these products were attractive as possible food sources and may be capable of sustaining insect growth and reproduction. This observation agrees with reports from [19] on food preferences in the flour beetles in which both species of weevils (*S. granarius* and *S. oryzae*) appeared to choose the more coarse products over the finely milled flours. Thus, it appears that texture may also play an important role in an insect's choice of one product over another. Meanwhile, *P. truncatus* was attracted to maize grain and dried cassava chips [20]. However, its preference to other crops as shown in this research work may not be a surprise since it is believed that *P. truncatus* evolved as a wood borer and wood probably still its major host [2].

The damage and breeding ability of *P. truncatus* is a determining factors on emergence and mortality which in turn affected weight loss in stored product due to pest activities. The study revealed the ability of the *P. truncatus* to damage and breed on all the tuber crops, cassava, (*M. esculenta),* sweet potato (*I. batatas),* yam (*D. rotundata),* cocoyam (*C. esculenta).* This result was similar to the research work of [21] and [22] where both research reported the ability of the insect pest to breed and reproduce on dried cassava – *M. esculenta* under laboratory conditions. This current research work also support the work [22] where it was stated that *P. truncatus* can damage and breed on dried chip sweet potatoes, yam and cocoyam. However, increase in adult population increased the feeding activities of *P. truncatus* which resulted into weight loss in all the tuber crops investigated.

In grain crops, only guinea corn and cowpea were damaged by *P. truncatus* while maize and paddy rice were not damaged. This contradicted to the work of [23] who reported that *P. truncatus* on stored maize and paddy rice were infested and damaged. In this current research work no damage, nor breeding occurred in both maize grain and paddy rice investigated. This may be due to the fact that the crops were resistance varieties against *P. truncatus* because the entire insect pest introduced died before the end of 8 weeks of exposure. This reason was stated by IITA on personal communication and that the crop was still under investigation, yet to be released to the populace.

Generally, this research work indicated that in the absence of *P. truncatus* most preferred host (maize and cassava), *P. truncatus* can subsist on other crops as its reservoir host. It is therefore imperative to take these findings into consideration when designing control program.

Conclusion

Prostephanus truncatus is a stored product pest that attacked all the storage food crops investigated, but has the ability to cause damage and breed on cowpea and guinea corn grains and all the tuber crops investigated.

P. truncatus could not damage nor breed on maize grain (TZM-184) and Paddy Rice (IRGC 106176). Therefore, there is need to control this insect pest before invading and damaging other economic crops in storage. Maize grain (TZM-184) and Paddy rice (IRGC-106176) could be released to farmers to plant and produced in large quantity for sale and consumption. These varieties of crops can also be a means of control strategy of the insect pest and other associated insect pest in storage. Future investigation could be to determine the mechanism (s) of resistance in the maize grain TZM-184 and paddy rice (IRGC-106176), to ascertain their resistance to *Prostephanus truncatus*.

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