ASSESSMENT OF STORED-PRODUCT INSECT PEST IN EXPORT-BOUND PRODUCE FROM GOVERNMENT LICENSED WAREHOUSES IN LAGOS STATE, NIGERIA

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ABSTRACT: The study examined stored product insect pest in export-bound produce in government licensed warehouses in Nigeria. Four government licensed export bound warehouses (Isolo, Ijora, Ilasamaja and Mile 2) within Lagos metropolis were assessed for storage pest of cocoa, ginger and sesame. These produce were treated with methyl bromide at the rate of 48g/cm^3 for 72hours; aluminum phosphide at the rate of 33g/1000cc and untreated control used for comparison. The assessment was conducted in the laboratory using completely randomized design (CRD). Pests on produce and warehouse, weight loss in produce and efficacy of the treatment used were assessed respectively. Ten pests were predominant on cocoa, six on ginger and two on sesame. The populations of insects differ significantly ($p \leq 0.05$) in each warehouse assessed while no significant difference was obtained in the population of mites. The population of live and dead insects and mites increased as the days after pesticide application increased. The population of live insects in untreated samples was significantly higher (3.84) than those treated with aluminum phosphide (0.85) and methyl bromide (0.13) of dead insects. Population in samples treated with aluminum phosphide was significantly higher (13.89) compared with methyl bromide treated (11.00) and the untreated (5.15) samples. Significant weight loss of 13.2percent, 3.74percent and 1.71percent were recorded in untreated produce. The weight decreased significantly as the days increased. Two mites were predominantly in sesame. Effectiveness of the chemical showed on the treated produce. More pest population occurred in Mile 2 warehouse.

KEY WORDS: Licensed warehouse, storage pest, produce, insect/mites, pesticide application

Agriculture is an important sector of Nigerian economy as it contributes more than 30% of the Total Gross Domestic Product (GDP). Its accounts for over 70% of each of the non oil exports, employment, and provide over 80% of the local food consumption (Adegboye, 2004). However, growing and harvesting a crop is not enough battle but there are several procedures a farmer must go through before marketing, which includes harvesting, processing, packaging, storage and transportation. Unfortunately each of these steps can pose a lot of problems to farmers and usually resulted into partial or total loss of the crops (Nwaubani & Fasoranti, 2008).

Storage process in particular is the most worrisome aspect of agriculture. Any operational mistake made during storage could lead to physical, biological and mechanical deterioration of quality of produce (Odeyemi & Daramola, 2000). Grain storage plays an important role in the ability of any nation to feed its citizens. In predominantly agricultural countries, there is usually an abundance of food immediately following harvest. Where appropriate storage technology is available, the surplus is usually stored against the period of scarcity (IITA, 2007).

In countries where food storage has been perfected, such as in the United States of America and parts of Europe, periods of scarcity have practically ceased to exist, as food is made regularly available irrespective of harvest times. In many developing countries, the periods of food shortage can mean extreme starvation when food intake may drop below levels required for normal daily function (Parkin, 1965). Storage also ensures that the farmer has sufficient grains in reserve for the next planting season. If inappropriately stored, grains suffer considerable losses in quality, quantity and viability, leading to severe shortages in the next season (FAO, 2007).

Stored product insect pests may appear anywhere in storage during transportation or in processing plant materials. They spread throughout the World, travelling Agricultural commodities, wood packing materials and other means of transportation. They easily adapt themselves to new environments and readily become established (Howe, 1965).

FAO, (1987) has estimated that the amount of food damage by insect each year would be sufficient to feed several people. Many countries depend on agricultural produce of various types for their international trade (Daley, 1965; FAO, 1969). Problems relating to the marketing of agricultural produce are traceable to their deterioration due to insect pests' infestation (FAO, 2006).

In government licensed warehouses the problem of insect pests is a continual struggle between warehouse regulators and insects with each warehouse, having its own peculiar associated problem (Voices, 2006). Warehouses are sited based on source of produce e.g.; Cocoa in Ondo State, Ginger in Kaduna, Benue and Kano States. Sesame seeds in Kogi, Benue and Kano States. Insect pests commonly associated with these stored produce are; *Araecerus fasciculatus, Lasioderma serricorne (*cigarette beetle*), Trogoderma granarium (*Khapra beetle*)*, and *Plodia interpunctella (*Indian meal moth) (F.A.O., 1999; Yusof, 2001).

In Nigeria, warehouse inspection is assigned to two Federal Agencies: the Produce inspectors whose sole duty is responsible for the sanitation and grading of produce in warehouses, while Quarantine inspectors are responsible for quality control of plants/plant products for Export and Import (Phytosanitary Certification). All these roles are derived from 1951 International Plant Protection Convention (IPPC). Certificate issued by the Plant Protection Quarantine shall constitute the only guarantee of meeting International Plant Health Condition (NAQS, 2008).

In spite of the numerous governments licensed warehouses, government regulating agencies are not meeting the required standard setup by IPPC for grading and certification. Nigeria agricultural produce most often cannot stand the chance of competition in the international market, due to insect pest infestation which has resulted in situation which drastically reduced the financial returns to farmer and the foreign exchange through export (Emosairue, 2007). In view of the aforementioned problems, the objectives of this study were to identify the different types of storage pests in government licensed warehouses on designated export produce like cocoa, ginger, and sesame seeds, also to determine the level of damage in the warehouses before export and, finally to ascertain the various types of control measure at various ware houses and the duration of the treatments prior to export.

MATERIALS AND METHODS

This research was carried out at the Entomology laboratory of the Nigeria Agricultural Quarantine Service (NAQS) post-entry station located within the

National Cereals Research institute (NCRI), Moor Plantation lbadan. It is located within latitude 7°23'N, longitude 3°51'E and Altitude 172m above the sea level. **S**amples were collected randomly from four warehouses, Ijora, Mile 2, Ilasamaja, Afprint in Lagos metropolis of Nigeria. Method of collection were as follows: from the bulk stock with a measuring pan and bagged produce with the use of spears with whipped head of various length (Okunade, 2006). One hundred (100) grams each of cocoa, ginger, sesame seeds samples were collected from the warehouses in Lagos state. Replicated three times for a period of three months (August – October).

RESULTS

Table 1 highlights the effect of pesticides application on final weight of stored produce, insect pests, population and mortality over three month's period. The final weight of produce decreased significantly as the days after pesticide treatment increases. The population of live insects increased as the days after pesticides application increases while the population of dead insects also increases with increase in days after pesticides treatment.

There were no significant difference in the final weight of samples between Afprint, Ijora and Ilasa-maja compared to mile 2 with 92.12g. Population of live insects at Ijora (13.15g) and Ilasa-maja (12.31g) revealed no significant different when compare with Afprint (10.72g) and mile 2 (15.99g). Though live insects population in Mile 2 was highly significant when compared to that of Afprint (Table 2).

Results further revealed that no significant difference was observed in final weight of sesame (94.24g) and ginger (95.04g) samples compared to cocoa samples (92.04g). The population of live insects in cocoa sample was significantly higher (16.89g) than that of sesame and ginger which revealed no significant difference between both crop samples. The population of dead insects in all three samples were significantly different among themselves with ginger having the highest insect/mite population (13.34) followed respectively by cocoa (9.63) and sesame (7.08) (Table 3).

Table 4 reveals the final weight of samples in the control was significantly lower than those treated with phostoxin and methylbromide. However, final weight of samples treated with methylbromide (98.29g) was significantly higher than that of other samples (86.79g and 96.26g). The population of live insects in samples that are not treated was significantly higher (38.14) than those treated with pesticides phostoxin (0.85) and methlybromide (0.13) .Dead insects population in samples treated with phostoxin was significantly high (13.89) when compared with other samples treated with methlybromide which was significantly lower (11.00) to that of samples treated with phostoxin but significantly higher than the control (5.15).

The population of most of the insects found in the produce varied with increased number of days after pesticides application.

Of all the insects observed in the produce only *Carpophilus dimidiatus*, *Cryptolestes ferrugineus*, *Araecerus fasciculatus*, and *Oryzaephilius mercator* had similar population at 30, 60,90 days after pesticides application (0.02,0.17, 1.00, 0.47, 0.86, 1.36, 0.07, 0.83, 0.36, 0.27, 2.19). While the population of *Polyphagotarsonermus latus* was highest of all the insects and mites population, population of *Carpophilus dimidiatus* was the smallest. All the insects had their least population at 30days after pesticides application. At 30 and 60 days after pesticides application (APA), no significant difference was observed in the population of the two mites and insects such as *E. cautella, C. cephalonica, T. castenum T. confusum, C. obsolatus,* and *A. advera* (intercepted). However, at 90 days significant difference was observed in the population of the two mites and these insects when compared to that of 30 and 60 days. *C. ferrugineus, A. fasiculatus* and *O. mercator's* populations showed no significant difference while *O. surinamensis* and *T. granarium* were highly significant at 30, 60 and days APA (Table 5).

The population of *Polyphhagotarsonernus latus*, *Tyroguluphus farinae*, *Corcyra caphalonica*, *Tribolium confusum*, *Carpophilus obsolatus*, *Ahasverus advera*, *Oryzaephilus mercator*, *Oryzaephilus surinamenses* were similar at all locations. The population of *Lasioderma serricorne* in Mile 2 was the highest (6.33) of insects found, while population of *Corycyra* in Afprint was the least. However, only *Tribolium confusum* has the largest population of insects in Ijora others have largest population in Mile 2 (Table 6). The populations of *E. cautella C. cephalonica, L. sericons, C. dimidiatus, T. mauritanicus, A. advera, C. ferrugineus, A. fasculatus* and *T. granarium* in cocoa, ginger and sesame are significantly different while no significant difference was observed in *C. obsolatus* and *O. surinamensis* (Table 7).

The population of insects and mites in produce treated with methyl bromide and Phostoxin tablets did not reveal any significant difference but were highly significantly different from the population of insects observed in the untreated produce. Table 8, revealed that the population of the mites and insects were significantly higher in the untreated produce compared with produce treated with methyl bromide and phostoxin.

No significant difference was observed in the two mites' *P. latus* and *T. farina* in the Untreated produce, Methyl bromide (MB) treated cocoa produce and Phostoxin treated cocoa produce. Significant difference was noticed in sesame untreated produce, Methyl bromide (MB) and phostoxin treated produce. For ginger, no significant difference was observed in both treated and untreated produce. A highly significant difference was observed in Methyl bromide (MB) treated cocoa produce when compared with phostoxin treated and untreated cocoa produce in *E. cautella, C. cephalonica, T. castenum, L. serricornes, C. dimidiatus, T. mauritanicus, A. advera, C. ferrugineus,* and *A. fasciculatus*. On sesame, no significant difference was observed among *E. cautella, T. castenium, T. mauritanicus, C. ferrugineus* and *O. mecator* in untreated, Methyl bromide (MB) and pH treated produce. On ginger, no significant difference was noticed among the treatment insects.

There was high significant difference in the treated Methyl bromide (MB) cocoa among *E. cautella, T. casteneum* and *L. serricorne* when compared with *C. caphalonica, T. confusum, C. obsolatus, A. advera* and *O. mercator* as compared with pH treated cocoa and untreated cocoa produce.

For Sesame and Ginger treated Methyl bromide (MB) produce, significant difference was observed in the treated Methyl bromide (MB), phostoxin produce and the untreated produce among all the insect pests considered in the experiment (Table 9).

DISCUSSIONS

The result of this study revealed 14 insect pests and 2 mites associated with the crop used for the experiment.

It is obvious that the population of insects/mites in the produce increases with increasing number of dates after pesticides application. This can be attributed to the fact that the toxicity of the chemical deceases with increasing pesticide application days thereby reducing the efficacy of the pesticides on the insects and mites as discussed by Banks et al. (1983).

The least weight of sample that was obtained in Mile 2 can be linked to the poor lysine level of the environment in the warehouses which provides favourable environment for the insects and mites growth and developments. Also in Mile 2 the larger number of dead insects and mites that were obtained can be linked to the fact stated by Howe (1965) that insects easily adapt themselves to new environments and readily become established.

Of the three produce sampled, cocoa has the least weight and the highest number of life insects. These could be as a result of cocoa produce that might look more palatable to the insects (Ivbijaro, 2009).

The effectiveness of Methyl bromide (MB) over other treatments was observed during the experiment. This was shown when comparing the population of live insects and that of dead insects in which methylbromide have the lowest population of living insects. Methylbromide active ingredient kills all stages of insects (eggs, larva/nymph, pupa and adult) due to long duration(lethal dosage rate) of the acting on those stored product insects when compared to the use of phostoxin tablets (Mejia, 2007). It was however observed that the two mites *Poylphagotarsonermus latus* and *Tyroguluphus farine* were more predominant in sesame seeds.

In conclusion, the treated produce during the research gave better result than the untreated produce. This signifies the effectiveness of the chemical used. In general, the location of the ware-houses plays a significant role in determining the insects and mite population rate while the longevity of the chemical used determines increasing rates of insects and mites population (Udo, 2005; IITA, 2007).

CONCLUSIONS

From this research studies the following recommendations are hereby made Phytosanitary field inspection involving plant quarantine scientists should be sought for by the consignees before embarking in buying, loading and shipment of all the agricultural commodities to meet up with the phytosanitary standards.

Intensive warehouse sanitation programs must be carried out more often at various ware houses.

Ware houses should not practice mixed storage system to avoid cross infestation of insect pests from one produce to another.

All agricultural produce meant for export should not be in ware houses for long period before shipments. Methylbromide chemical treatment is also recommended for use in ware houses in which the least population of insects were observed. There is need for research scientists, stakeholders and their trade patners in International trade to cooperate with Nigeria Agricultural Quarantine Service by adhering to sanitary and phytosanitary measures.

Agricultural warehouse information should be placed on the internet for easy accessibility. Government and private sector should always have links for information exchange for the use by the general public.

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Table 1. Effect of application of different pesticides on final weight of stored produce, insect pests population and mortality of over three month period in Lagos State, Nigeria.

Days after pesticides application	Final weight of produce (g)	Population of live insects	Population of Dead
30	99.04±1.8a	3.94c±0.4	4.78±0.3c
60	97.71±1.6b	7.57b±0.2	6.41±0.2b
90	84.58±1.3c	27.64a±0.5	18.86±1.2a

Means with similar alphabets along the same column are not significantly different at p = 0.05 (DMRT) Means of three samples ± standard deviation.

Table 2. Effect of application of different pesticides on location, final weight of stored produce, insect pests population and mortality of from different ware houses in Lagos State, Nigeria.

Locations of warehouses	Final weight of samples (g)	Population of live insects	Population of dead insects
Afprint	94.67±0.1a	10.72±1.3b	8.83±0.8bc
Ijora	94.20±0.2a	13.15±2.1ab	8.02±0.9c

Ilasamaja	94.06±0.1a	12.31±1.5ab	9.78±1.3b
Mile 2	92.12±0.5b	15.99±1.8a	13.43±1.30.7a

Means with similar alphabets along the same column are not significantly different at p = 0.05 (DMRT)
Means of three samples ± standard deviation.

Table 3. Effect of application of different pesticides on final weight of stored cocoa, sesame and ginger, insect pests population and mortality in Lagos State, Nigeria.

Types of produce	Final weight of samples (g)	Population of live insects	Population of Dead insects
Cocoa	92.04±1.2b	16.89±2.5a	9.63±0.2b
Sesame	94.25±1.3a	10.71±2.8b	7.079±0.3c
Ginger	95.04±1.7a	11.53±0.9b	13.34±0.5a

Means with similar alphabets along the same column are not significantly different at p = 0.05 (DMRT)
Means of three samples ± standard deviation.

Table 4. Effect of application of different pesticides on final weight of stored produce, insect pests population and mortality in Lagos State, Nigeria.

Types of Pesticide	Final weight of samples (g)	Population of live insects	Population of Dead insects
Control	86.79±1.3c	38.14±2.6a	5.15±0.8c
Phostoxin	96.26±1.1b	0.85±0.7b	13.89±1.6a
Methlybromide	98.29±1.2a	0.13±0.2c	11.00±1.8b

Means with similar alphabets along the same column are not significantly different at p = 0.05 (DMRT)
Means of three samples ± standard deviation.

Table 5. Insect and mite pests population associated with stored produce treated with different pesticides over three month period in Lagos State, Nigeria.

s/no.	Population of insect and mite species	Days after pesticide application 30	60	90
1	*Polyphagotarsonernus latus*	0.50±0.6b	1.57±0.9b	10.99±2.4a
2	*Tyroguluphus farina*	0.18±0.2b	0.52±0.6b	4.10±1.3a
3	*Ephestia cautella*	0.72±0.7b	1.22±1.1b	2.30±1.0a
4	*Corcyra caphalonica*	0.04±0.02b	0.14±0.24b	0.52±0.4a
5	*Tribolium castenum*	1.57±1.3b	1.59±0.8b	6.14±1.6a
6	*Tribolium confusum*	0.45±0.5b	0.27±0.7b	1.89±0.9a
7	*Lasioderma serricornes*	2.12±2.5c	3.13±2.2b	8.17±3.4a
8	*Carpophilus obsolatus*	0.04±0.03b	0.16±0.3b	0.69±0.5a
9	*Carpophilus dimidiatus*	0.02±0.01a	0.17±0.4a	1.00±0.4a
10	*Tenebroides mauritanicus*	0.46±0.5c	0.82±0.7b	1.39±0.8a
11	*Ahasverus advera*	0.02±0.01b	0.17±0.3b	0.64±0.4a
12	*Cryptolestes ferrugineus*	0.47±0.4a	0.86±0.5a	1.36±0.8a
13	*Araecerus fasiculatus*	0.41±0.3a	0.67±0.7a	0.83±0.4a
14	*Oryzaephillus mercator*	0.36±0.23a	0.27±0.6a	2.19±1.3a
15	*Oryzaephillus surinamenses*	0.38±0.4c	0.93±1.0b	1.89±1.1a
16	*Trogoderma granarium*	1.00±1.1c	1.45±1.3b	2.25±1.6a

Means with similar alphabets along the same column are not significantly different at p ≤0.05 (DMRT)
Means of three samples ± standard deviation.

Table 6. Insect and mite pests population associated with stored produce treated with different pesticides across different pre-shipment ware houses in Lagos State, Nigeria.

S/No.	Population of insect and mite species	Location of warehouses			
		Ijora	Ilasamaja	Afprint	Mile 2
1	*Polyphagotarsonernus latus*	4.142±0.15a	4.15±0.25a	4.28±0.3a	4.83±0.6a
2	*Tyroquluphus farina*	1.57±0.1a	1.38±0.12a	1.69±0.14a	1.75±0.17a
3	*Ephestia cautella*	1.15±0.06b	1.36±0.2b	1.10±0.2b	2.02±1.1a
4	*Corcyra caphalonica*	0.20±0.1a	0.27±0.2a	0.17±0.1a	0.30±0.3a
5	*Tribolium castenum*	3.07±0.8ab	2.83±0.5b	2.60±0.3b	3.93±1.3a
6	*Tribolium confusum*	0.94±0.2a	0.86±0.6a	0.83±1.2a	0.85±0.3a
7	*Lasioderrma sericones*	4.06±1.5b	4.46±1.1b	3.01±1.5c	6.33±2.1a
8	*Carpophilus obsolatus*	0.23±0.1a	0.29±0.3a	0.26±0.2a	0.40±0.3a
9	*Carpophilus dimidiatus*	0.30b±0.1	0.38±1.4b	0.18±2.3b	0.72±0.5a
10	*Tenebroides mauritanicus*	0.59±0.4b	0.93±0.8b	0.67±0.5b	1.36±1.5a
11	*Ahasverus advera*	0.26±0.1a	0.28±0.1a	0.20±0.1a	0.38±0.1a
12	*Cryptolestes ferrugineus*	0.70±0.5b	0.85±0.6b	0.75±0.5b	1.30±0.5a
13	*Araecerus fasiculatus*	0.48±0.4b	0.54±0.3b	0.60±0.1b	0.94±0.7a
14	*Oryzaephillus mercaton*	0.88±0.6a	1.06±0.4a	0.69±0.2a	1.14±0.8a
15	*Oryzaephillus surinamenses*	1.05±1.1a	1.11±0.2a	0.90±0.17a	1.27±1.6a
16	*Trogoderma granarium*	1.37±1.3b	1.44±0.3b	1.52±1.2ab	1.93±0.1a

Means with similar alphabets along the same column are not significantly different at $p \leq 0.05$ (DMRT) Means of three samples ± standard deviation.

Table 7. Insect and mite pests population associated with stored cocoa, sesame and ginger treated with different pesticides across different pre-shipment ware houses in Lagos State, Nigeria.

S/No.	Population of insect and mite species	Types of produce		
		Cocoa	Ginger	Sesame
1	*Polyphagotarsonernus latus*	0.00±0.0b	0.02±0.1b	13.04±1.3a
2	*Tyroquluphus farina*	0.00±0.0b	0.00±0.0b	4.79±0.29a
3	*Ephestia cautella*	3.07±1.5a	1.17±1.3b	0.00±0.0c
4	*Corcyra caphalonica*	0.60±0.5a	0.10±0.5b	0.00±0.0b
5	*Tribolium castenum*	4.61±2.2a	4.71±2.5a	0.00±0.0b
6	*Tribolium confusum*	0.75±0.3b	1.88±0.7a	0.00±0.0c
7	*Lasioderrma sericones*	6.47±2.7a	6.89±3.9a	0.00±0.0b
8	*Carpophilus obsolatus*	0.77±1.8a	0.13±0.6a	0.00±0.0a
9	*Carpophilus dimidiatus*	1.02±0.8a	0.17±1.6b	0.00±0.0b
10	*Tenebroides mauritanicus*	1.87±1.2a	0.80±0.3b	0.00±0.0c
11	*Ahasverus advera*	0.72±0.4a	0.12±0.1b	0.00±0.0b
12	*Cryptolestes ferrugineus*	1.81±1.3a	0.88±1.1b	0.00±0.0c
13	*Araecerus fasiculatus*	1.20±0.6a	0.71±0.7b	0.00±0.0c
14	*Oryzaephillus mercaton*	0.77±0.8b	2.06±1.3a	0.00±0.0c
15	*Oryzaephillus surinamenses*	1.07±1.3a	2.14±2.0a	0.00±0.0a
16	*Trogoderma granarium*	1.69±1.1b	3.01±2.7a	0.00±0.0c

Means with similar alphabets along the same column are not significantly different at $p \leq 0.05$ (DMRT) Means of three samples ± standard deviation.

Table 8. Effect of different pesticides on insect and mite pests' population associated with stored produce across different pre-shipment ware houses in Lagos State, Nigeria.

S /No.	Population of insect and mite species	Types of pesticides: Methlybromide	Phostoxin	Control
1	*Polyphagotarsonernus latus*	1.55±1.4b	3.10±0.3b	8.41±0.29a
2	*Tyroquluphus farina*	0.56±0.17b	1.21±0.24b	3.02±2.7a
3	*Ephestia cautella*	0.75±0.18b	0.89±1.1b	2.59±2.4a
4	*Corcyra caphalonica*	0.04±0.1b	0.08±0.5b	0.57±0.2a
5	*Tribolium castenum*	1.69±2.5b	1.98±1.3b	5.65±2.3a
6	*Tribolium confusum*	0.42±0.15b	0.48±0.02b	1.73±0.8a
7	*Lasioderrma sericones*	2.65±2.4b	3.09±3.1b	7.66±3.5a
8	*Carpophilus obsolatus*	0.08±0.3b	0.06±0.03b	0.75±0.4a
9	*Carpophilus dimidiatus*	0.10±0.2b	0.14±0.2b	0.94±0.8a
10	*Tenebroides mauritanicus*	0.45±0.7b	0.51±0.7b	1.70±2.3a
11	*Ahasverus advera*	0.05±0.02b	0.10±0.01b	0.69±0.4a
12	*Cryptolestes ferrugineus*	0.46±0.3b	0.58±0.4b	1.65±1.1a
13	*Araecerus fasiculatus*	0.35±0.5b	0.37±0.27b	1.20±0.8a
14	*Oryzaephillus mercaton*	0.38±0.4b	0.56±0.11b	1.88±0.2a
15	*Oryzaephillus surinamenses*	0.48±0.5b	0.55±0.2b	2.17±2.0a
16	*Trogoderma granarium*	1.02±1.1b	1.10±10b	2.59±1.8a

Means with similar alphabets along the same column are not significantly different at $p \leq 0.05$ (DMRT)
Means of three samples ± standard deviation.

Table 9. Effects of application of different pesticides on insect and mite pests of stored cocoa, sesame and ginger across different pre-shipment warehouses over a period of three months in Lagos State, Nigeria.

s/no.	Population of insect and mite species	Untreated produce			Methylbromide-treated produce			Phostoxin treated produce		
		Cocoa	Sesame	Ginger	Cocoa	Sesame	Ginger	Cocoa	Sesame	Ginger
1	*Polyphagotarsonernus latus*	0.00±0.0d	9.30±3.4b	0.00±0.0d	0.00±0.0d	25.17±4.8a	0.06±0.1d	0.00±0.0d	4.65±2.8c	0.00±0.0d
2	*Tyroquluphus farina*	0.00±0.0d	3.62±0.9b	0.00±0.0d	0.00±0.0d	9.07±1.2a	0.00±0.0d	0.00±0.0d	1.68±0.5c	0.00±0.0d
3	*Ephestia cautella*	1.64±1.64b	0.00±0.0c	1.04±0.5b	6.26±3.6a	0.00±0.0c	1.51±0.5b	1.31±0.4b	0.00±0.0c	0.94±0.1bc
4	*Corcyra caphalonica*	0.19±0.95b	0.00±0.0b	0.56±0.2b	1.51±0.9a	0.00±0.0b	0.20±0.02b	0.10±0.02b	0.00±0.0b	0.03±0.03b
5	*Tribolium castenum*	2.63±1.3b	0.00±0.0c	3.32±1.3b	8.96±4.2a	0.00±0.0c	8.00±2.3a	2.24±0.6b	0.00±0.0c	2.85±0.8b
6	*Tribolium confusum*	0.32±0.17cd	0.00±0.0d	1.11±0.7b	1.63±0.77b	0.00±0.0d	3.56±1.5a	0.29±0.3cd	0.00±0.0d	0.96±0.12bc
7	*Lasioderrma sericones*	3.76±2.7c	0.00±0.0d	5.50±3.3b	12.22±2.4a	0.00±0.0d	10.75±4.7a	3.42±1.4c	0.00±0.0d	4.54±2.3bc
8	*Carpophilus obsolatus*	0.17±0.1b	0.00±0.0b	0.03±0.01b	1.97±0.9a	0.00±0.0b	0.26±0.06b	0.17±0.1b	0.00±0.0b	0.08±0.02b
9	*Carpophilus dimidiatus*	0.38±0.3b	0.00±0.0b	0.06±0.43b	2.46±1.1a	0.00±0.0b	0.38±0.2b	0.24±0.1b	0.00±0.0b	0.07±0.01b
10	*Tenebroides mauritanicus*	0.86±1.0b	0.00±0.0c	0.68±0.66b	3.97±2.8a	0.00±0.0c	1.13±0.5b	0.78±0.5b	0.00±0.0c	0.58±0.02bc
11	*Ahasverus advera*	0.22±0.22b	0.00±0.0b	0.07±0.06b	1.85±1.85a	0.00±0.0b	0.22±0.1b	0.10±0.10b	0.00±0.0b	0.06±0.01b
12	*Cryptolestes ferrugineus*	0.96±0.1b	0.00±0.0c	0.79±1.4b	3.74±2.2a	0.00±0.0c	1.21±0.34b	0.74±0.01b	0.00±0.0c	0.64±0.64b
13	*Araecerus fasiculatus*	0.51±0.23bc	0.00±0.0d	0.58±0.5bc	2.67±0.53a	0.00±0.0d	0.93±0.6b	0.43±0.01cd	0.00±0.0d	0.61±0.02bc
14	*Oryzaephillus mercaton*	0.43±0.11c	0.00±0.0c	1.26±1.0b	1.57±0.9b	0.00±0.0c	4.07±2.7a	0.31±0.03c	0.00±0.0c	0.83±0.17bc
15	*Oryzaephillus surinamenses*	0.67±0.5cd	0.00±0.0d	0.99±0.33c	2.13±2.13b	0.00±0.0d	4.39±2.2a	0.42±0.01cd	0.00±0.0d	1.03±0.8c
16	*Trogoderma granarium*	1.11±2.2e	0.00±0.0f	2.18±2.0bc	2.74±0.88b	0.00±0.0f	5.03±3.3a	1.22±0.22de	0.00±0.0f	1.83±1.83cd

Means with similar alphabets along the same column are not significantly different at $p \leq 0.05$ (DMRT)
Means of three samples ± standard deviation.