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COMPARATIVE ANALYSIS OF DIFFERENT STORAGE CHEMICALS (PHOSPHINE, PERMETHRIN POWDER AND PIRIMIPHOS METHYL 2% DUST) ON POST HARVEST PEST OF COWPEA *Callasobruchus maculatus (Fab.)*

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ABSTRACT

The study was conducted in the Entomology Laboratory, College of Agriculture, Maiduguri, to determine the effectiveness of three insecticides (Permethrin, Phosphine and Pirimiphos methyl) on *Callasobruchus maculatus* a post harvest pest of stored cowpea. The experiment was 2 × 4 factorial laid out in Completely Randomized Block Design (CRBD) (i.e four treatments under two regimes) replicated three times. The treatments were T_1 (Permethrin) T_2 (Phosphine), T_3 (Pirimiphos methyl) and T_4 (control). The weight of 200 seed-sample each was placed in a plastic container. Ten unsexed *C. maculatus* adults obtained by sieving infested cowpea in a local market, were introduced into each of the twenty-four containers. At the end of the two and four months of storage, the results revealed that the weight loss for the beans subjected to the different treatments showed weight loss of 29.48% of its initial weight for control, while percentage loss in weight for permethrin was 16.33%; phosphine 9.68% and pirimiphos methyl 20.26%. The results also showed that after the two months of storage, the weight (46.67g) of cowpea treated with phosphine was significantly more than those treated with permethrin (42.67g) and pirimiphos methyl (42.0g) while that of control recorded the lowest (36.67g). There was significant difference between the mean number of undamaged seeds for the four treatments in regime one (two months). The highest number of undamaged seeds of 146.6 was recorded in container treated with phosphine; 110 in container treated with permethrin; 109 in container treated with pirimiphos methyl and the least (84.3) seeds was that from the control. Therefore, phosphine was found to be more effective against the stored cowpea beetle.

KEYWORDS:-, Borno State, *Callosobruchus maculatus*, Chemicals, Cowpea, Storage, Duration of storage.

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INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp) is an important grain legume crop in Nigeria. About 90% of the estimated (4) million hectares of land put under cultivation annually in Nigeria for this crop is in savannah zone (Raheja, 1988). The protein content of pulse crops makes them an important staple food crop for human nutrition in developing nations (Akryod and Dought, 1996). Cowpea provides the cheapest and richest source of plant protein to

man and animals and is supposed to be poor man's meat (Singh and Pandey 2001). It is also good source of minerals and vitamin. Nigeria, Brazil and Niger Republic are among the major producers of cowpea and it account for over 70% of world crop. Africa produces 75% of the world's crop and Nigeria is responsible for 58% of the entire African production (Parli, 1986; Okonkwo, 1989). The average annual production of cowpea in Nigeria has been estimated at 900,000 tonnes, grown mainly as a secondary crop in association with staples such as maize, sorghum, millet and cassava (Singh *et al.*, 1989; Onyido *et al.*, 2011). Other countries with significant area and grain production in West Africa include Benin, Togo, Ghana, Mali, Burkina Faso and Senegal (Singh *et al.*, 1997).

Cowpea (*Vigna unguiculata* (L.) Walp), is one of the 18,000 species of Fabaceae (Leguminoseae) or bean family (Okigbo, 1996). It is commonly called Southern pea and it probably originated from West Africa. There are large numbers of distinctive forms of cowpea and their growth habits vary from spreading, to bush and climbing cultivars. The most common flower colours are pink, violet, pale blue, yellow and white and the species are largely self-pollinating. There is considerable variation in pod shape, colour and texture and between 8 – 20 seeds are found per pod (Alphen and Visser, 1990). It is mostly grown in the arid and semi arid zones. Yield on traditional farms ranges between 100 – 250 kg/ha (Jackai and Daoust, 1986). Cowpea crops are important supplementary foods with high protein content (Akryod and Dought, 1996) and containing about 11.0% water, 32.4% protein, 56.8% carbohydrates, 1.3% fat; 5.9% fibre and 3.5% ash depending on the cultivars (Rachie and Silvester, 1977). However, insect pest cause about 20 – 30% damage to stored cowpea in Nigeria (Booth, 1987), so about 32,000 tonnes of cowpea produced annually are lost or damaged by insect pests in storage (Caswell, 1998).

The cowpea bruchid, *Callosobruchus maculatus* has been named as the most important pest of stored legumes especially cowpea (Singh and Jackai, 1985). It is a field to store pest with infestation capability of up to 100% within 3 – 5 months of cowpea storage under traditional condition (Caswell and Akibu, 1989). Estimates have shown that over 30 million US dollar is lost as a result of cowpea damage in Nigeria (Jackai and Daoust, 1986; Udo and Epidi, 2009). A larva of the bruchid can consume between 5 – 10% of a seed. Furthermore, insect damaged seeds usually have their germination potential reduced or get completely destroyed (Justice and Bass, 1999) and may be rendered unsightly and unmarketable (Raheja, 1989).

One important limiting factor on cowpea production in Nigeria is insect pest attack and numerous studies have showed that the usually low seed yield associated with the crop could be increased several-fold when insect pests are controlled (Booker *et al.*, 1992). Nigerian farmers store cowpea for a period ranging from four to six months. Cowpea beetle (*Callosobruchus maculatus*) is the most serious insect pests attacking cowpea in most part of the World and it is prevalent in areas where cowpea grain is grown. Although various synthetic insecticides have been developed over the years for the control of *C. maculates*, the cost of purchase and widespread development of resistance in insects pests are still issues of great concern (Abulude *et al.*, 2007; Udo, 2011). Effective storage method will grossly improve both quantity and quality (market value) of cowpea, thus necessitate this study. The study therefore was designed to investigate the effectiveness of different cowpea storage chemicals (insecticides) on the control of cowpea beetle *Callosobruchus maculatus.*

METHODOLOGY

Study Area
The study was conducted at Entomology Laboratory, College of Agriculture, Maiduguri. The College is located in Jere Local Government Area of Borno State. Geographically located on latitudes $11^0$40'N and $12^0$05'N and longitudes $13^0$10'E and $13^0$50'E

Materials
The materials used in the study include; Container, infected cowpea, phosphine, Permethrin and Pirimiphos methyl. The seeds for the experiment were obtained from the local market and the cowpea variety was Borno brown. Ten insects (*Callasobruchus maculatus*) were introduced into each container.

Methods
The experiment was divided into two regimes; the first regime was conducted in two months and second regime in four months. Containers treated with various chemicals were used. The treatments were:-

1. T_1= container, cowpea plus Permethrin
2. T_2 = container, cowpea plus phosphine
3. T_3 = container, cowpea plus Pirimiphos methyl
4. T_4 = container and cowpea (Control)

Treatments and Experimental Design
The experiment was laid out in a Completely Randomized Block Design with four treatments replicated three times under two regimes. The treatments are; T_1 = Permethrin, T_2 = phosphine, T_3 = Pirimiphos methyl, T_4 = Control. The first regime was two months of storage while second regime was four months. 200 cowpea seeds without any *C. maculatus* feeding/emergence holes from the market were selected, weighed and placed in a plastic container. Ten unsexed *C. maculatus* adults obtained by sieving infested cowpea were introduced into each of the twenty four containers. The mouth were closed and then stored for 8 weeks (2 months) and 16 weeks (4 months) intervals. The containers were kept under fluctuating laboratory conditions and *C. maculatus* allowed to go through 2.5 generations with a total duration of 60 days and 5 generations with total of 120 days based on the developmental period of 24.3 days reported by Pessu and Umeozor, (2004) and Umeozor 2005) under similar laboratory conditions. Twelve containers were left undisturbed till the end of 2.5 generations while another set of twelve were left undisturbed till the end of 5 generations. At the end of 60 days (2.5 generations) and 120 days (5 generations), seeds for each container were removed, the number of *C. maculatus* feeding/emergence holes on the 200 seeds per container was counted and the seeds weighed; all the data were recorded (Umeozor, 2005).

Analytical Tools
The weight loss was determined by calculating the difference in weight of the cowpea seeds before and after the experiment for the different treatments. Data collected on variables like post- experimental weight, full damaged seeds, half damaged seeds, undamaged seeds, number of dead and live insects were subjected to Analysis of Variance (ANOVA), while mean separation was by Least Significant difference (LSD)

RESULTS
The results of weight lost, level of damage of cowpea seeds by the *Callasobruchus maculatus* and number of insects dead and alive after two and four months of storage with Permethrin, Phosphine and Pirimiphos methyl are presented.

The results of weight loss in table 1 when subjected to different treatments showed that after two months of storage, control lost 29.48% of its initial weight, while permethrin was 16.33%; phosphine 9.68% and pirimiphos methyl 20.26%.

The bean when subjected to the same four treatments for four months showed that 62.41% of the initial weight of control was lost due to *C. maculatus* infestation. Lost of 36.67% of initial weight was observed in permethrin, 18.72% in phosphine and pirimiphos methyl recorded 30.97% lost in weight. The ratio of rate of deterioration or loss in weight showed that control was 1:2.12; permethrin 1:2.25; phosphine 1:1.93 and pirimiphos methyl 1: 1.53.

Table 1. Percentage lost in weight for two and four months of storage

Treatment	Two Months			Four Months			
	Initial weight	Final weight	% lost	Initial weight	Final weight	% lost	Ratio
Control	52	36.67	29.48	52.33	19.67	62.41	1:2.12
Permethrin	51	42.67	16.33	52.67	33.67	36.67	1:2.25
Phosphine	51.67	46.67	9.68	51.67	42.00	18.72	1:1.93
Pirimiphos	52.67	42.00	20.26	51.67	35.67	30.97	1:53

Table 2 shows significant (P<0.05) variation between the weights of the stored cowpea. After two months of storage, the weight of cowpea treated with phosphine (46.67g) was significantly (P<0.05) different from those treated with permethrin (42.67), pirimiphos methyl (42.0g) and control (36.67g).

When the cowpea was treated with the same insecticides for four months, it was also observed that phosphine recorded the highest weight of 42.0g. There was significant variation in the weights of the cowpea for the four treatments. Cowpea treated with phosphine had weight of 42.0g which is highest fallowed by pirimiphos methyl with 35.67g; permethrin with 33.67g and control with the lowest value of 19.67g.

Table 2. Mean weight of cowpea stored for two and four months

Treatment	Means for Two months	Means for four months	F-ratio	F-ratio
Control	36.67^{b}	19.67^{c}	3.56***	16.21*
Permethrin	42.67^{ab}	33.67^{b}		
Phosphine	46.67^{a}	42.00^{a}		
Pirimiphos	42.00^{ab}	35.67^{ab}		
Grand Mean	42.00	32.75		
C.V	8.99	12.37		
LSD	7.54	8.10-		

Table 3 showed no significant (P>0.05) difference between the mean number of full damaged seeds when treated with the insecticides for two months. The mean number of full damaged for control was 79.33, while permethrin recorded 79.00, pirimiphos methyl 78.67 and phosphine 43.00 and were not significantly (P>0.05) different from each other.

After four months of storage however, the results showed that the number of full damaged seeds were significantly (P<0.05) different from each other. There were 200 seeds damaged from the control (untreated), while 35 seeds from containers treated with Permethrin, 10 seeds from containers treated with pirimiphos methyl and 7.33 seeds from phosphine treated containers.

The significant difference obtained and the high number of full damage seed between the two and four months period of storage was as a result of time and duration of storage. The longer the period of storage, the more vulnerable and prone the seeds become to infestation by *Callasobruchus maculatus.*

Table 3. Mean for Full Damage seeds after two and four months of storage

Treatment	Mean for 2 Months	Mean for 4 Months	F-Ratio for 2 Months	F-Ratio for 4 Months
Control	79.33[a]	200.00[a]	2.46 [NS]	41.52*
Permethrin	79.00[a]	35.00[b]		
Phosphine	43.00[a]	7.33[b]		
Pirimiphos	78.67[a]	10.00[b]		
LSD 0.05	39.38	49.48		
Grand Mean	70.08	63.08		
C.V	28.13	39.26		

The results in table 4 shows that the untreated seeds (control) had the highest number of half damage seeds of 32.33, fallowed by pirimiphos methyl with 12.33; permethrin with 10.33 and phosphine recorded 3.33, however, statistically there were not significant ($P>0.05$) difference.

There was significant ($P>0.05$) difference between the mean number of half damaged seeds when treated with the different insecticides for four months. Pirimiphos methyl (60), permethrin (59); phosphine (42) while control recorded zero. There was significant ($P<0.05$) difference between pirimiphos methyl and the other two (phosphine and permethrin) treatments.

Table 4. Means for half damage seed after two and four months of storage

Treatment	Means 2 Months	Means 4 Months	F- Ratio 2 Months	F-Ratio 4 Months
Control	32.33[a]	0.00[a]	3.22[NS]	6.47**
Permethrin	10.33[a]	59.00[a]		
Phosphine	3.33[a]	42.00[a]		
Pirimiphos	12.33[a]	60.00[b]		
Grand Mean	14.58	40.25		
C.V	82.40	47.51		
LSD 0.05	24.00	38.21.		

Table 5 revealed that there was significant ($P<0.05$) difference between the mean number of undamaged seeds for the four treatments in regime one (two months). Phosphine recorded the highest number of undamaged seeds (146.6), while permethrin had (110), pirimiphos methyl (109) while control recorded the least with 84.33.

Table 5. Means for undamaged seed for two and four months of storage

Treatment	Means 2 Months	Means 4 Months	F-Ratio 2 Months	F-Ratio 4 Months
Control	84.33[b]	0.00[b]	2.68[NS]	8.43**
Permethrin	110.00[ab]	105.67[a]		
Phosphine	146.6[a]	144.00[a]		
Pirimiphos	109.00[ab]	130.00[a]		
Grand Mean	112.50	94.92		
C.V	24.18	40.98		
LSD 0.05	54.34	77.72		

Table 6 is the mean number of dead insects when subjected to different treatments where the number of dead insects (bean beetles) in each treatment were not significantly (P>0.05) different from each other after the two months of storage. The control (84.33), pirimiphos methyl (86.67) permethrin (52) and phosphine (39.67) were not significantly (P>0.05) different from one another.

After four months of storage the seeds in regime two (four months) showed significant (P<0.05) difference between the number of dead beetles in untreated (control) container (368) and that of permethrin (64.67); phosphine (36.33) and pirimiphos methyl (66.67).

Table 6. Means for Dead insect after two and four months of storage

Treatment	Means 2 month	Means 4 month	F-Ratio 2 months	F-Ratio 4 months
Control	84.33[a]	368.00[a]	1.45[NS]	31.33*
Permethrin	52.00[a]	64.67[b]		
Phosphine	39.67[a]	36.33[b]		
Pirimiphos	86.67[a]	66.67[b]		
Grand Mean	65.67	133.92		
C.V	51.48	36.20		
LSD 0.05	67.54	96.85		

Table 7 shows the number of live insects after two months of storage and there was significant (P<0.05) difference between the various treatments for number of live insects. The highest was in the control (79.33), while permethrin (43.67); phosphine (3.67) and pirimiphos methyl recorded zero.

After the four months interval the results showed that there was no significant (P>0.05) difference between the different treatments which had the following values permethrin (71.33), phosphine (0), pirimiphos methyl (0) and control (58.00).

Table 7. Means for live insects after two and four months of storage

Treatment	Mean 2 months	Means 4 months	F-Ratio 2 months	F-Ratio 4 months
Control	79.33[a]	58.00[a]	5.04**	1.00[NS]
Permethrin	43.67[ab]	71.33[a]		
Phosphine	3.67[b]	0.00[a]		
Pirimiphos	0.00[b]	0.00[a]		
Grand Mean	31.67	32.33		
C.V	91.17	202.11		
LSD 0.05	57.67	130.56		

DISCUSSION

The stored cowpea weevil, *Callosobruchus maculatus* is well known pest of stored cowpea (*Vigna unguiculata* (L.) Walp). It start infesting mature and dry cowpea pods from the field after laying eggs on the pods, which are carried to the store where they hatch and attack the seeds. Such pest is difficult to control due to its high rate of multiplication when proper agronomic and pest management practices are ignored. The use of the three chemicals in this study, was to find out the appropriate and effective among the three.

Relevant literatures from experts in cowpea storage such as Caswell (1998), Raheja (1989), Singh and Jackai (1985), Booker *et al.* (1992) and Umeozor (2005) and other authorities had reported that apart from hermetic, drums and tin storage, such contact chemicals prove to be good alternatives though with limited time of effectiveness. The hazardous characteristics of the three chemicals however made it unwise to freely recommend to the cowpea farmers, dealers and consumers without clear warnings on how to apply them. Consumers are therefore advised to clean the cowpea with warm water, remove seed coat and wash before cooking.

In conclusion however, the findings from this study, proved that phosphine was most effective followed by pirimiphos methyl. Farmers, who do not have adequate storage facilities on their farms or in homes, may have to use perforated envelopes, treatment by layers and bag fumigation methods. This way, unwarranted hazards can be prevented at farmers, dealers and consumer levels when preparing the beans for market or consumption.

REFERENCES

Abulude, F.O., Ogunkoya, M.O., Ogunleye, R.F., Akintola, A.O., & Adeyemi, A.O. (2007). Effect of palm oil in protecting stored grains from *Sitophilus zeamais* and *Callosobruchus maculatus*. *Journal of Entomology*, 4, 393 – 396.

Alphen, J. J. M., & Visser, M. E. (1990). Super parasitism as an adaptive strategy for insect parasitoids. *Annual Review of Entomology*, 35, 59 - 79.

Akryod, W. R., & Dought, J. (1996). Legumes in human nutrition FAO nutritional studies NO.19. 138p.

Booth, S. A. (1987). Biology and chemical control of *Callosobruchus chinesis* (L) (Coleoptera: Bruchidae). *Phillip Entomology*, 2,167 – 182.

Booker, R. H., Mummigati, S.G., Ragunathan, A.N. & Oyenuga, V.A. (1992). Observation on three bruchids associated with cowpea in Northern Nigeria. *Journal of Stored Products Research*, 3,1– 15.

Caswell, G.H., & Akibu, S. (1989). The use of pirimiphos methyl to control bruchids attacking selected varieties of stored cowpea. *Tropical Grain Legume Bull*, 17 (18), 9 -11.

Caswell, G.H. (1998). Storage and conservation of grain legumes both in rural areas and for commercial operation in urban areas. Paper presented at AFO experts consultation on grain legume processing held at Central Food Technological Research Institute, Mysore, India.

Jackai, L.E.N., & Daoust, R.A. (1986). Insect pests of cowpea, *Annual Review of Entomology*, 31, 95–119.

Justice, O. L., & Bass, L.N. (1999). Principles and practices of seed storage. Castle House Publications Ltd, 289p.

Okigbo, B.N. (1996). Welcome address in tropical grain legume bulletin, World Cowpea Research Conference Report; 5 – 9.

Okonkwo, N.J. (1989). *The linkage between male sterility and green stem in cowpea*, *Vigna unguiculata.* A paper presented at the 16th Annual Conference of the Genetic Society of Nigeria held at Anambra State University of Technology, Enugu, 9 – 13, April.

Onyido, A.E., Zeibe, C.C., Okonkwo, N.J., Ezugbo- Nwobi, I.K., Egbuche, C.M., Udemezue, O.I., & Eeanya, I.C. (2011). Damage caused by the bean bruchid, *Callosobruchus maculatus* Fabricius on different legume seeds on sale in Awka and Onitsha markets, Anambra State, South Eastern Nigeria. *African Research Review*, 5(4), 116 – 123.

Parli, L.A. (1986). Species of *Empoasca* associated with cowpea, *Vigna unguiculata* (L) Walp in Ibadan and three ecological zones, South Western Nigeria (Homoptera: Cicadellidal) *Review 2001 African*, 97, 202 – 210.

Pessu, P.O., & Umeozor, O. C. (2004). Relative susceptibility of stored cowpea, *Vigna unguiculata* Walp and Soybean, *Glycine max* (L) Merrill, to infestation by the cowpea seed beetle,*Callosobruchus maculatus* (Fab.) (Coleoptera: Bruchidae). *Indian Journal Agricultural Research,*38 (2),101-105.

Rachie, K.O., & Silvestre, P. (1977). Grain legumes. In C.L. Leakey and J.B. Wills (Eds.), Food crops of the lowland tropics. London: Oxford University Press. Pp. 41-47.

Raheja, A. K. (1988). Prospects and problems of cowpea production in Nigerian savannah, in tropical grain legumes bulletin, World Cowpea Research Conference, 78 – 85.

Raheja, A. K. (1989). Assessment of losses caused by insect pests of cowpea in Northern Nigeria *PANS*, 22, 229 – 283.

Singh, S.R., & Jackai, L.E.N. (1985). Insect pests of cowpea in Africa, their life cycle, economic importance and potential for control. In S.R. Singh and K.O. Rachie (Eds.), *Cowpea Research, Production and Utilization.* John Wiley and Sons, NY, USA. Pp. 217 – 231.

Singh, S.R., Luse, R.A., Lueschner, K., & Nangiu, D. (1989). Groundnut oil treatment for the control of *Callosobruchus maculatus* (F) during cowpea storage, *Journal of Stored Products Research*, 14, 77 – 80.

Singh, B.B., Chambliss, O. L., & Sharma, B. (1997). Recent advances in cowpea breeding. In B.B. Singh., D.R. Mohan Raj., K.E. Dashiel and L.E.N Jackai (Eds.), *Advances in Cowpea Research.* Copublication of International

Institute for Tropical Agriculture (IITA) and Japan International Research Centre for Agricultural Sciences (JIRCAS), IITA, Ibadan, Nigeria. Pp. 30 – 49.

Singh, V.N., & Pandey, N.D. (2001). Growth and development of *Callosobruchus chinensis* Linn. on different varieties. *Indian Journal of Entomology*, 63(2), 182 – 185.

, I. O., & Epidi, T.T. (2009). Biological effect of ethanolic extract fractions of *Ricinodendron heudelotii* (Baill) Pierre ex Pax against *Sitophilus zeamais* and *Callosobruchus maculatus* Fabricius on stored grains. *African Journal of Agricultural Research.* 4(10), 1080 – 1085.

Udo, I.O. (2011). Potentials of *Zanthoxylum xanthoxyloides* (Lam.) for the control of stored product insect pests. *Journal of Stored Products and Postharvest Research*, 2(3), 40 – 44.

Umeozor, O.C. (2005). Effect of *Callosobruchus maculatus* (Fab.) on the weight loss of stored Cowpea (*Vigna unguiculata* (L.) Walp). *Journal of Applied Science and Environmental Management*, 9 (1), 169 - 172.