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Salvaging Egg Infested Cowpea *Vigna unguiculata* (L.) Walp. Grains from *Callosobruchus maculatus* (F) (Coleoptera: Chrysomelidae) Total Damage by Exposure to Sun in Sudan Savanna Maiduguri, Nigeria

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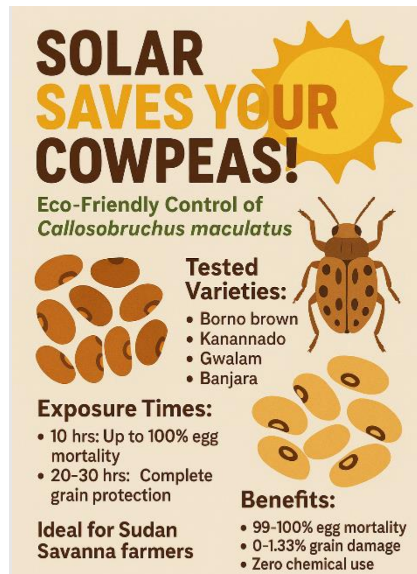
ABSTRACT

The effect of sun exposure to eggs laid by C. maculatus on cowpea grains was conducted on four cowpea varieties Borno brown, Kanannado, Gwalam and Banjara. Ten grams' grains of each variety were weighed into a 200 ml glass jar in three replicates for four levels of treatments. Grains were infested with three pairs of sexed male and female adult C. maculatus (1-2 days old), they were left for 5days to lay eggs and afterward removed. Number of eggs laid on grains was counted and records taken. Egg infested cowpea grains of each variety were transferred into perforated 200 ml tin containers and exposed to the sun for10, 20, and 30hours respectively while the check (control) was left on the Laboratory shelf under ambient temperature and relative humidity conditions without exposure to the sun. After the solar exposure, all treatments were returned to the shelf. Number of adults that emerged from grains in each replicate during F1 generation was counted, while percentage and severity of grain damage were calculated. Both initial and final grain moisture content were also determined. Data on all variables were computed and subjected to Analysis of variance (ANOVA) Using Statistix v10.0 significantly different means were separated using Tukey Honestly Significant Difference (HSD) at 5% level of probability. The result showed that cowpea grains riddled with C. maculatus eggs (1-5 days old) exposed to solar radiation for 10, 20 and 30 hours could be prevented from further deterioration and damage; as it reduces or completely inhibited adult emergence. Solar exposure of cowpea grains could therefore be cost effectively employed by farmers as a management strategy against the cowpea bruchid, at least in Sudan Savanna Agro-ecological zone of Nigeria under which the experiment was conducted.

Keywords: *C. maculatus, grains, sun exposure, eggs, damage*



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INTRODUCTION

The cowpea bruchid, *Callosobruchus maculatus* (F.) has engaged researchers for close to half century in proffering effective, sustainable management strategy with less hazardous effect on man and the environment. It is a major post-harvest field-to-store insect pest of cowpea, that causes substantial cowpea percentage grain damage that range from 57.90 - 90% and weight loss of 23.90 - 42.17% in the absence of protective measures (Juma'a *et al*., 2022; Kabir and Gaya, 2019). The Cowpea (*Vigna unguiculata* (L.) Walp.) is an important cheap source of dietary protein and income for many farmers and the less privileged in Sub-Saharan Africa. It increases soil fertility through plant residue and nitrogen fixation and enhances the sustainability of cropping system. The dry grains are a rich source of some essential nutrients, it contains about 25% protein and 64% carbohydrate; it is also a good source of calcium, iron, vitamins and carotene (Kabir and Gaya, 2019; Adedire and Akinneye, 2003). Over 5.4 million metric tons of cowpea grains are produced globally, Africa produces about 5.2 million tons, Nigeria is the largest producer and consumer and accounts for 61% of total production in Africa and 58% worldwide (Agro-Nigeria, 2017). Grain merchants, household and farmers have to contend with infested stored cowpea grain once attacked by the cowpea bruchid, they could be forced to sale at low economic value, consume, or find other means of saving the grains from complete damage and loss (Dauda *et al.,* 2014).

Chemical synthetic insecticides have been and are still the most desired method of stored product insect pest control, largely due to the quick and complete protection it offers. The negative effects of these chemical insecticides are of serious concerns, as some are persistent in the environment, causes development of resistance, killing of non- target organisms and contamination of water, in addition to poor knowledge of application by farmers which often lead to misuse of these chemicals (Dauda *et al.,* 2012; Akinkurolere *et al*., 2006). As part of the quest for an alternative to chemical insecticides, research efforts are currently being focused on eco-friendly control methods among who is a solar radiation treatment (Lale and Vidal, 2003; Alice, *et al.,* 2013). The utilization of heat for stored products protection is based on the knowledge that arthropod pests die when exposed to high temperatures because of their limited physiological capacity to thermo-regulate (Murdock *et al.,* 1997).

In the developed world hot air is passed through bulk grain to disinfest grains in silos, this may be un- affordable in Sub-Saharan Africa, where most farmers are peasants. The utilization of sun radiation which is readily available in the Arid, Sudan and Sahel savannah agro-ecologies, where day time temperatures obtained in the open can sometimes reach 40°C could be a cheap strategy to manage *C. maculatus.* Most reports in literature focused on the effect of solar radiation on egg-laying capacity, juvenile stages and adults *C. maculatus*; little has been reported on its effect on egg infested cowpea grain. The study assesses the effect of sun exposure to eggs of *C. maculatus* on cowpea grains.

MATERIALS AND METHODS

Source of cowpea grains and determination of grain moisture content

Un-infested cowpea grains of four varieties namely: Borno brown, Kanannado, Gwalam and Banjara were obtained from Biu, Borno state Nigeria. The grains were sorted out, cleaned from dirt and sterilized in a Gallenkampoven at 60°C for 3 hours to disinfest the grains from hidden infestation, according to (Allotey and Azalekor, 2000). The grains were air exposed and allowed to equilibrate with the Laboratory conditions for 72 hours before determining initial moisture content of the grains since it is known that grain are hygroscopic in nature, they can absorb or desorb moisture depending on the prevailing conditions they are exposed to. The initial moisture content was determined before experimental set up, while final moisture content of grains was also determined at the end of the experiments immediately after data collection, as described by Lale (2002)**.**

Laboratory and solar radiation temperature and relative humidity

Laboratory temperature and relative humidity were determined using digital Thermo-hygrometer and it ranged from 27°C -35°C and 21-42% Relative humidity. Solar radiation temperature obtained in the open during days of grain exposure in the Months of March to April were obtained from the Federal Meteorological Station in Maiduguri and it ranged from 30°C - 41°C and 18 - 35% Relative humidity.

Insect culture

A culture of *C. maculatus* was established in a kilner jar using 500g grains of variety Borno white cowpea after sterilizing according to (Allotey and Azalekor, 2000). Fifty pairs sexed male and female adult *C. maculatus* obtained from an infested stock of cowpea were used to infest the grains with the aid of an aspirator. Insect culture rearing was conducted under ambient laboratory conditions 27°C -35°C and 21 -42% Relative humidity

Experimental procedure

Ten grams' grains of four cowpea variety Borno Brown, Kanannado, Gwalam and Banjara was separately weighed into 200ml glass jar in 3 replicates The grains in each replicate was infested with three (3) pairs opposite sex adult *C. Maculatus* 1–2 days' old obtained from the culture

Table 1: Percentage moisture contents (mc) of cowpea grains before experimental set up and at the end of experiment

Parameters	Cowpea varieties			
	Borno Brown	**Banjara**	**Gwalam**	**Kanannado**
Initial moisture content (%)	7.50	7.04	7.08	7.04
Final moisture content (%)	14.06	13.20	13.78	12.17

Table 2: Mean number of eggs laid on cowpea grain by *C. maculatus*.

	Cowpea varieties			
Exposure hrs	**Borno Brown**	**Banjara**	**Gwalam**	**Kanannado**
0	38.33	25.33	11.00	11.67
10	24.67	26.67	6.00	14.67
20	33.00	28.33	7.00	21.67
30	37.67	26.33	13.67	11.67
SE ±	9.64	5.51	5.17	6.53
HSD (P≤0.05)	22.24	12.71	11.92	15.07

with the aid of an aspirator. *C. maculatus* adults were removed 5 days after infestation and the number of eggs laid on grains was counted with the aid of a hand lens. Egg infested cowpea grains were transferred into perforated 200 ml capacity tin container sand exposed to different hours of solar radiation10 hrs, 20 hrs, and 30 hrs. The control (0 hrs) grains were not exposure to the sun but kept on the Laboratory shelve under ambient temperature and humidity conditions 27°C -35°C and 21 -42% Relative humidity. The sun exposed grains were afterward taken back to the Laboratory and kept under ambient conditions. The number of adults that emerged from each replicate was recorded daily throughout the first filial generation. Percentage grain damage and severity of grain damage were calculated using the formulas:

$$Percentage\ grain\ Damage = \frac{Number\ of\ Damaged\ grains\ (DG)}{Total\ number\ of\ grains\ (TG)} \times 100$$

$$Severity\ of\ grain\ Damage = \frac{Number\ of\ adults\ that\ emerged(AE)}{Total\ number\ of\ grains(TG)} \times 100$$

Where: DG = is the number of grains with holes per replicate, AE =is the number of adult that emerged from grain per replicate, TG = is the total number of grains in each replicate respectively.

Experimental design and data analysis

The Experiment was arranged in a Completely Randomize Design (CRD). Data on number of eggs laid, number of adult that emerged, percentage grain damage and severity of grain damage were computed and subjected to analysis of variance (ANOVA) Using Statistix v10.0, significantly different means were determine using the Honestly Significant Difference (HSD) at 5 % level of probability.

RESULTS AND DISCUSSION

Initial and final percentage moisture content of cowpea grain moisture contents

Table 1 showed the initial grain moisture content (mc) of cowpea grains which ranged from 7.04 to 7.50% mc. There was however a slight elevation of the final moisture contents of grains of the different cultivars which ranged from 12.17 to 14.06%. The increase in grain moisture contents could possibly indicate high level of respiratory activity by the beetles**.** The final grain moisture contents (15%) was however higher this could lead to deterioration of grains through mold development and subsequent grain caking could be possible.

Callosobruchus maculatus eggs laid on cowpea grains on different varieties

There was no statistical significance (P>0.05) in mean number of eggs laid on grains of each replicate of the cultivars (Table 2). This implied that grains of each cultivar were liable to infestation by the cowpea bruchid equally. Report has shown that number of egg laid by *C. maculatus* depends on the environment of exposure of insects and varieties or substrate presented to the cowpea bruchid (Moumouni, 2014). The present result indicated no difference in eggs laid by the beetle on the grains of the four cowpea cultivars; at least under the prevailing conditions they were screened.

Adult *C. maculatus* that emerged from cowpea grains exposed to sun at different duration

The mean number of adult *C. maculatus* that emerged from the control grain sample ranged from 4.67 to 37.0 and they were significantly (P≤0.05) higher than those from solar exposed grains, it was observed that 50 – 100% of the eggs developed in to adult after 28 days. In the treated grains, regardless of the number of hours of exposure to solar radiation, less than 1% of the eggs developed in to adults. Also there was no statistical significance in the mean number of adults that emerged from treated grains in relation to varieties (Table 3). Alice *et al*. (2013) observed 100% *C. maculatus* egg mortality on black gram seed exposed to solar radiation for different hours (4, 8, 12, 16, 20, and 24 hrs.). The present study also showed

Table 3: Mean number of adult *C. maculatus* that emerged from cowpea grains exposed to the sun.

	Cowpea varieties			
Exposure hrs	Borno Brown	Banjara	Gwalam	Kanannado
0	37.00	9.67	5.67	4.67
10	0.00	0.00	0.67	1.00
20	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00
SE ±	7.49	0.62	0.78	1.18
HSD (P≤0.05)	17.28	1.44	1.80	2.72

Table 4: Mean Percentage damage by *C. maculatus* to cowpea grains exposed to the sun.

	Cowpea varieties			
Exposure hrs	Borno Brown	Banjara	Gwalam	Kanannado
0	33.33	14.00	9.00	7.33
10	0.00	0.00	0.67	1.33
20	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00
SE ±	7.93	2.17	0.93	3.21
HSD (P≤0.05)	18.29	5.01	2.17	7.39

the insecticidal effect of solar radiation on *C. maculatus* eggs on grains of the cowpea cultivars, this implied that 1-5 days old eggs and or instar larva infested cowpea grains could be salvaged from complete damage and loss by *C. maculatus,* by exposing such grains to solar radiation day time temperature range from 30°C- 41°C and 18-25% Relative humidity obtained in the open, for as low as 10 hours. There was 99% - 100% inhibition of the egg development to adult stage in grains of the cowpea varieties. The result further showed that C. *maculatus* eggs were amenable to the effect of solar radiation.

Similar report by Doumma (2006) also indicated 100% egg mortality of *C. maculatus* in cowpea grains when expose to sunlight for 2hrs. Ajayi and Lale (2001) also observed that sun exposure was effective against *C. maculatus* eggs on Bambara groundnut grains expose in clay pots and polypropylene sacks. Lale and Vidal (2000) still reported that exposing grains bearing eggs of *C. maculatus* and *C. subinatatus* to temperature of 50°C especially for 4 or 6 hrs completely suppressed adult progeny development through total mortality of eggs; these reports concur with the present findings where total inhibition of adult emergence was even achieved with 41° C in higher dose of 20 and 30 hours' sun exposure.

Percentage damage by *C. maculatus* to cowpea grains exposed to the sun

Table 4 Showed that the mean grain damage of the un-treated grains was significantly (P<0.05) higher than those from grains of each variety exposed to various duration of solar radiation (10 hours, 20 hours and 30 hours). Percentage grain damage were zero in grains exposed to solar radiation for 20 hours and 30 hrs in each of the varieties and also in Borno brown grains exposed for10 hrs. There were however no significant (P>0.05) differences in percentage grain damage among the varieties. These results showed that cowpea grains riddled with *C. maculatus* eggs exposed to solar radiation reduces damage to 1.33% or complete (100%) inhibition of grain damage. In Sub-Saharan agricultural system most farmers' production is at the subsistence level, exposing freshly infested cowpea grains to solar radiation will cost effectively reduce or eliminate damage and loo to cowpea grains. Lale, (1998) earlier reported Nigerian savanna to be characterized by abundant sunshine virtually throughout the year, but particularly during the hot season, in the months of March to May when daytime temperatures in the open commonly reach 50°C and relative humidity are as low as 10 –20%; this is also the area where the bulk of the cowpeas consumed in Nigeria and beyond is produced (Lale, 1998) which fall in the region where the present study was conducted.

Severity of grain damage by *C. maculatus* to cowpea grains exposed to the sun

Table 5: Mean severity of grain damage by *C. maculatus* to cowpea grains exposed to the sun.

	Cowpea varieties			
Exposure hrs	Borno Brown	Banjara	Gwalam	Kanannado
0	89.05	24.33	14.00	17.33
10	0.00	0.00	0.67	3.67
20	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00
SE ±	18.53	2.07	2.21	4.22
HSD (P≤0.05)	42.72	4.77	5.10	9.72

Mean severity of grain damage of un-treated grains were significantly (P<0.05) higher than those from grains exposed to the sun. Severity of grain damage was zero in grains exposed to solar radiation for 20 hrs and 30 hrs for Banjara, Kanannado and Gwalam varieties and also in Borno brown grains exposed for 10 hours. There was also no statistical significance (P>0.05) in severity of grain damage among grains exposed to the sun (Table 5). The result showed that cowpea grains exposed to 10 to 30 hours' solar radiation were effective in complete suppression or reduction of the severity of grain damage which range from 0 – 1.33**.** The efficacy of the solar radiation appeared to be dependent on duration of exposure**,** with longer duration periods of 20 and 30 hours having higher impact on the eggs.

Conclusion

The result has generally showed that cowpea grains of variety Borno brown, Banjara, Gwalam and Kanannado exposed to solar radiation of day time temperature range from 30°C - 41°C under 18- 35% Relative humidity obtained in the open for 10, 20 and 30 hrs were effective in either complete inhibition or reduction of C. *maculatus* adult emergence that ranged from (0 -1.0) with 99-100%suppression of eggs that developed to adult stage. Percentage grain damage was also completely suppressed or drastically reduced to (0-1.33%), similarly, severity of grain damage was completely inhibited or highly reduced (0-3.67). The result showed that cowpea grains riddled with freshly laid *C. maculatus* eggs could cost effectively be prevented from complete damage by exposure to solar radiation from10 to 30 hours there by salvaging and ensuring the availability of grains that would have been lost; or sold at lower price. Eggs on cowpea grains of all the varieties are amenable to the effects of solar heat however, grains of cultivar BORNO brown and Banjara appeared to be better candidates in response to solarization; as they totally inhibited egg emergences, and had zero (0%) percentage grain damage and severity of grain damage at all durations of solar exposures. Grains of cultivar Gwalam and Kanannado exhibited that trait after 20 and 30 hours' exposures only, implying that they relatively need longer exposure period of more than 10 hours to achieve that.

REFERENCES

Adedire, C. O. and Akinneye, J. O. (2003). Biological activity of the Marigold, *Tithonia diversifolia*, on cowpea seed bruchid, *Callosobruchus maculatus* (F) (Coleoptera: Bruchidae) *Annals of Applied Biology*, 144:185-189.

Agro-Nigeria (2017). Cowpea production in Nigeria. https://agronigeria.com.ng/cowpeaproduction-in-nigeria/ Accessed 15.01.17.

Akinkurolere, R.O., Adedire, C.O. and Odeyemi, O.O. (2006). Lasboratory evaluation of the toxic properties of forest anchomanes, *Anchomanes difformis* against pulse beetle, *Callosobruchus maculatus* (Coleoptera: Bruchidae). *Insect Science,* 13: 25 – 29.

Alice, J., Sujeetha, R. P., and Srikanth, N. (2013). Effect of hot and cold treatments for the management of pulse beetle *Callosobruchus maculatus* (Fab.) in pulses. *Journal of Agricultural and Veterinary Science* 3(3):29-33

Allotey, J. and Azalekor W. (2000). Some aspect of the biology and control using botanicals o the rice moth *Corcyra cephalonica* on some pulse. *Journal of stored product Research* 36(3):235-243

Dauda, Z., Degri, M. M., Gadzama, U. N. and Hassan, M. (2014). Curative bioactivity of moringa (*Moringa oleifera* Lam.) seed oil against *Callosobruchus maculatus* (F.) infested cowpea (*Vigna unguiculata* L. Walp.) grain in storage *International Journal of Sustainable Agricultural Research* 1(4): 93-99

Dauda, Z., Maina, Y. T. and Richard, B. I. (2012). Insecticidal activity of garlic (*Alium sativum* (L.) oil on *Callosobruchus maculatus* (F.) In post-harvest cowpea (*Vigna unguiculata* (L.) Walp. *Journal of Biology, Agriculture and Healthcare* 2: 28-35

Doumma, A. (2006). Effects of sun exposition on population of bruchids in cowpea (*Vigna unguiculata*(L.) Walp. storage system in Niger. *Pest Management of Horticultural Ecosystems, 12(1),* 5-7

Juma'a, T. M. Ibrahim A. H. and Basem A. T. (2022). Effect of Powders of Three Plants on Some Biological Characteristics of the Cowpea Beetle *Callosobruchus maculatus* Fabricius (Coleoptera: Bruchidae) *Natural Volatiles and Essential oils*, 9(2): 148-159

Kabir B. G. J. and Gaya S. S. (2019). Management of *Callosobruchus maculatus* Fab.

(Coleoptera: Chrysomelidae) in Stored Cowpea using Varietal Resistance and Diatomaceous Earth., *Nigerian Journal of Entomology* 35: 7-18

Lale, N.E.S. and S. Vidal, (2003). Simulation studies on the effects of solar heat on egg–laying, development and survival of *Callosobruchus maculatus* (F.) and *Callosobruchus subinatatus* (Pic.) in stored Bambara groundnut *Vigna subterranean* (L.) Verdcourt. *Journal of Stored Product Research*39: 447–58

Lale, N. E. S. (2002). Stored product Entomology and Acarology in Tropical Africa Mole Publications Nigerian Limited. Maiduguri. Port Harcourt. Harare pp204

Lale, N.E.S. and Ajayi, F.A., (2001). Suppression of development of *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) in bambara groundnut seeds exposed to solar heat in the Nigerian Savanna. *Journal of Pest Science*74:133-137

Lale, N.E.S., (1998). Preliminary studies on the effect of solar heat on oviposition, development and adult mortality of the cowpea bruchid *Callosobruchus maculatus* (F.) in the Nigerian Savanna. *Journal of Arid Environments,* 40,157-162.

Murdock, L.L. Shade, R.E. Kitch, L.W., Noar, W. Chambliss, O.L., Endondo, C. and Wolfson, J. L., (1997). Post-harvest storage of cowpea in sub-Saharan Africa. In Singh, B.B., Mohan Raj, D.R. Dashiell, K.E.N. (eds), Advances in Cowpea Research IITA and JIRCAS, Ibadan, Nigeria, pp. 302-312

Moumouni, D.A., Doumma A. and Seyni I. S. (2014). Effect of solar drying on the biological parameters of the cowpea weevil, *Callosobruchu smaculatus*Fab. (Coleoptera-Bruchidae) in Sahelian area*, Journal of Applied Biosciences* 84:7723 – 7729.