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Comparative studies on the Biology of *Callosobruchus maculatus* (F.) on Soya beans and Bambara Groundnut

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ABSTRACT
Two leguminous crops Soya beans and Bambara groundnut were infested with *Callosobruchus maculatus* using different quantities. The experiment was conducted in the Biological Sciences laboratory, University of Maiduguri. Completely Randomized Design with three replicates was used to compare the level of infestation by *C. maculatus* on Soya beans and Bambara groundnut using different quantities. The results showed that significantly (P=0.05) more eggs where laid on Soya beans than Bambara groundnut. Consequently, the number of adults that emerged from Bambara groundnut significantly (P=0.05) outnumbered those on Soya beans. It is clear from the experiment that Bambara groundnut is more prone to attack by *C. maculatus* as compared to Soya beans. By the emergence of many adults from Bambara groundnut, it showed that the produce is infested by *C. maculatus* which results to weight loss and decreased germination potential of the seed.

Keywords: Leguminous crop, Bambara groundnut, Days after infestation, Germination potential.

1. Introduction
Callosobruchus maculatus (F.) (Coleoptera bruchidae) is a major pest of stored legumes crops with infestation starting at pod maturity [1]. It does considerable damage to crops in the field and also causes quantitative loss to stored seed. The major pulses attacked by *C. maculatus* include Cowpea, Bambara groundnut, Soya beans and Pigeon pea.
C. maculatus is a primary pest of stored seeds and is known to cause considerable losses. The damage caused by this pest to leguminous seeds is mostly due to its larvae feeding inside the seed which results in weight loss, decreased germination potential, decrease in nutritional and aesthetic quality of the seeds and diminished market value of the seeds [2].
C. maculatus infestation normally starts with the female laying eggs on ripened pods in the field [3]. The larva burrows through the chorion of the eggs directly in the pod well and into the seeds, where the larvae develops and pupate [1].
Individual *C. maculatus* which invade the field crops may come from infested store or from frequently driven from harvesting field, infested pods or seeds, but it may also come from hidden infestation in the store [3].
Soya bean is a species of legumes native to East Asia. The plant is classified as an oilseed rather than a pulse [4]. Fat free soya bean meal is primary, low cost source of protein for animal feeds and Soya vegetable oil is another valuable product of processing the Soya bean crop. Traditional non fermented uses of Soya beans include Soya sauce and fermented beans paste.
Bambara groundnut (*Vigna subterranea* (L.) Verdcourt) is a Leguminous crop of the tribe Phaseolae, Family Leguminosae with creeping stems and branching just above ground level with tap root system that are rounded or lobed with nodules. The leaves are alternate and tri-foliate, labrous; the flowers are bisexual and the fruits are indehiscent pod of about 2.5 cm in diameter and usually one-seeded. The seeds are variously coloured from white to cream, red, black or brown, sometimes mottled, blotched or striped [5].
Bambara groundnut is an indigenous African crop and reported to have originated from north-eastern Nigeria and Northern Cameroon where the wild forms are still found [5]. The crop is grown primarily for its seeds which are eaten fresh when semi-ripe and as a pulse when dry and mature, or grounded into flour [6]. Bambara groundnut is a major source of vegetable protein in sub-Saharan Africa where it constitutes an important part of the local diet, culture and economy [7, 8]. The seed is regarded as a completely balanced food [9, 10, 11]. Bambara groundnut seeds, haulm and dry leaves have been used to feed livestock and poultry [9].

In tropical subsistence Africa, several leguminous crops in storage are prone to attack by insects pests, with bruchids (Coleoptera: Bruchidae) being the key pests [12]. In bambara groundnut, *Callosobruchus maculatus* causes major loses in storage [13]. It is a field to store pest, ranked as the principal postharvest pests of stored pulses, with a cosmopolitan distribution. *C. maculatus* can cause as much as 99% yield lost in susceptible grain legumes [13].
In Nigeria, there are limited reports in the literature on the Biology of *Callosobruchus maculatus* and the level of infestation of this pest in Soya beans and Bambara groundnut. Therefore the aims and objectives of this present research was to compare the development of *C. maculatus* on Soya beans and Bambara groundnut and to access the population of *C. maculatus* using different quantities of Soya beans and Bambara groundnut.

2. Materials and Methods

2.1 Procurement of the seeds

Clean seeds of Soya beans and Bambara groundnut were purchased from Monday market in Maiduguri. These seeds were kept in a refrigerator to ensure that there was no egg of *C. maculatus* present. Infested seeds were also procured which served as a stock culture.

2.2 Stock Culture Maintenance and Infestation Procedure

Stock cultures of *C. maculatus* were maintained on Bambara groundnut (*Vigna subterranea* (L.) Verdcourt) and Soya beans in University of Maiduguri, Biological Sciences Laboratory. A thermohydrograph was used to monitor temperature and relative humidity in the laboratory. Ambient temperature and relative humidity in the laboratory were 33.6±0.21 ^{0}C and 35.8±0.13% RH. Culture method was used in which seeds with adults ready to emerge were sorted into a kilner jar.
The previously infested stock was sieved using 2 mm mesh to obtain freshly emerged virgin *C. maculatus*. The Soya and Bambara were weighed to obtain 20 g, 40 g, 60 g, 80 g and 100 g respectively. Each sample of the two seeds was mixed up together and replicated three times to obtain a total of 15 samples. They were then infested with two males and three females of *C. maculatus*. A fine mesh net was tied with rubber band around the kilner jar bottles to prevent the bruchids from escaping.

2.3 Experimental Design and Treatment

The factorial experiment was laid out in Completely Randomized Design with three replicates. The first factor treatment comprised of the seeds of Soya beans and Bambara groundnut. The different quantities of 20 g, 40 g, 60 g, 80 g and 100 g formed the other factor.

2.4 Data Collection

Data was collected by counting the number of eggs laid on Soya beans and Bambara groundnut after every 3 days. Also adult's *C. maculatus* that emerged from Soya beans and Bambara groundnut were also counted. Data obtained were analyzed using the analytical software, Statistix 8.0.

3. Results and Discussion

3.1 Mean Number of Eggs Laid on Soya Beans and Bambara Groundnut

The mean number of eggs laid by *C. maculatus* on Soya beans and Bambara groundnut after 3, 14, and 21 DAI is shown in table 1. Results at 3 DAI showed that the mean number of eggs laid by *C. maculatus* on Soya beans ranged between 11.67–87.33 which has significantly low number of eggs as compared to the eggs laid on Bambara groundnut which ranged between 25.00–95.68. With respect to the different quantities offered to *C. maculatus*, less number of eggs was observed in 60 g whereas 40 g has the highest number laid, followed by 100 g, 20 g and 80 g respectively.
The result at 14 DAI showed that the mean number of eggs laid by *C. maculatus* on Soya beans ranged between 13.67–130.67 which has significantly high number of eggs as compared to the eggs laid on Bambara groundnut which ranged between 33.00–99.67. With respect to the quantities offered to *C. maculatus*, less number of eggs was observed in 60 g whereas 40 g has the highest number of eggs laid followed by 100 g, 20 g and 80 g respectively.
At 24 DAI, the result showed that the mean number of eggs laid by *C. maculatus* on Soya beans ranged between 13. 67–135.67 which has significantly high number of eggs as compared to the eggs laid on Bambara groundnut which ranged between 33.33–99.67. With respect to different quantities offered to *C. maculatus*, less number of eggs was observed in 60 g whereas 40 g has the highest number of eggs laid followed by 100 g, 20 g, and 80 g respectively.

Table 1: Mean number of eggs laid by C. maculatus on Soya beans and Bambara groundnut after 3, 14, and 24 days after infestation

	3 DAI		14 DAI		24 DAI	
Treatment	**Soya beans**	**Bambara**	**Soya beans**	**Bambara**	**Soya beans**	**Bambara**
20gS + 20gB	64.33	64.00	77.00	73.67	73.33	41.00
40gS + 40gB	87.33	64.00	130.67	76.67	135.67	78.00
60gS + 40gB	11.67	25.00	13.67	33.00	13.67	33.33
80gS + 80gB	44.33	33.00	53.33	40.33	55.33	41.00
100gS + 100gB	67.33	95.68	73.67	99.67	73.67	99.67
$LSD_{(0.05)}$	18.48	16.99	31.69	17.85	33.71	18.29

KEY: S – Soya beans, B – Bambara groundnut, DAI – Days after infestation.

3.2 Mean number of adults *C. maculatus* emerged from Soya beans and Bambara groundnut

Mean number of adults *C. maculatus* emerged from Soya beans and Bambara ground after 41, 55 and 66 days after infestation is shown in table 2. Results at 41 DAI showed that the mean number of adult *C. maculatus* emerged from Soya beans ranged between 0.00–0.00 which has significantly low number as compared to the adults that emerged from Bambara groundnut which ranged between 0.67–1.67. With respect to the different quantities offered to *C. maculatus*, less number of adults was observed in 60 g whereas 100 g has the highest number of adults emerged, followed by 20 g, 40 g and 80 g respectively.
The results at 55 DAI showed that the mean number of adult by *C. maculatus* emerged from Soya beans ranged between 0.00–0.00

which has significantly low number as compared to the adults that emerged from Bambara groundnut which ranged between 7.33–15.33. With respect to the different quantities offered to *C. maculatus*, less number of adults was observed in 20 g whereas 100 g has the highest number of adults emerged, followed by 80 g, 60 g and 40 g respectively.

At 66 DAI showed that the mean number of adult by *C. maculatus* emerged from Soya beans ranged between 0.00–0.33 which has significantly low number as compared to the adults that emerged from Bambara groundnut which ranged between 11.33–17.67. With respect to the different quantities offered to *C. maculatus*, less number of adults was observed in 60 g whereas 100 g has the highest number of adults emerged, followed by 20 g, 80 g and 40 g respectively. The low emergence of adults from soya bean is probably because of the hard nature of the seeds.

Table 2: Mean number of adults C. maculatus emerged from Soya beans and Bambara groundnut after 41, 55, and 66 days after infestation

Mean number of adults						
	41 DAI		55 DAI		66 DAI	
Treatment	Soya beans	Bambara	Soya beans	Bambara	Soya beans	Bambara
20gS + 20gB	0.00	1.00	0.00	7.33	0.00	11.67
40gS + 40gB	0.00	1.00	0.00	11.67	0.00	15.57
60gS + 40gB	0.00	0.67	0.00	10.33	0.00	11.33
80gS + 80gB	0.00	1.00	0.00	9.00	0.00	12.00
100gS + 100gB	0.00	1.67	0.00	15.33	0.33	17.67
$LSD_{(0.05)}$	0.00	1.05	0.00	4.49	0.46	5.23

KEY: S – Soya beans, B – Bambara groundnut, DAI – Days after infestation.

4. Conclusion

C. maculatus is a serious constraint to legumes storage that has displayed the capacity to initiate infestation from as low as 2 - 10 egg- and adult- sources [14]. The present study compares the development of *C. maculatus* on Soya beans and Bambara groundnut and its reveals that both Soya beans and Bambara groundnut are prone to attack by *C. maculatus* but Bambara groundnut is more susceptible mainly because of the large surface area and the nature of the seeds.

The life circle of the bruchids observed during the study is almost similar in both Soya beans and Bambara groundnut. It starts by laying eggs on the surface of the seeds through larvae, pupa and finally adults.

The eggs were small, glued on the grain singly but many eggs could be seen on a single grain. The eggs when freshly laid, were translucent smooth and shining, which later became yellowish and white. The duration of egg ranged from 6–7 days.

The larvae undergo four different stages of first, second, third and fourth instar larvae. The first instar larvae were formed within the eggs before penetrating the seed coat with a convenient visual marker signaling that embryonic development was nearly complete. The larvae were curve, white and had small heads. The larval period usually ranged from 8 – 9 days [15]. The second instar larvae burrowed and fed on the bean endosperm. The larval duration ranged from 3-4 days. The third instar larvae were most active and fed on the entire endosperm voraciously. The larval period ranged from 3-4 days. The fourth instar larvae were white, yellowish and C-shaped with small heads. The fourth instar larvae were similar to third instar but differed in size and shape. These fourth instar larvae seemed to become larger and fed on the entire endosperm voraciously. They burrowed into a position just underneath the seed coat prior to pupation. The duration of the larvae ranged from 4-5 days.

During the time of pupation, larval structures were broken down and adult structures developed, the rudiments of the wings appeared at the first day, appendages such as legs, antenna at the second day and at third day, eyes, mouth part, forewing, hind wing and legs with cuticular hair developed. At fourth day, almost all the parts developed but intersegmental region of the abdomen remained colorless and forewing was light green in color. The male and female pupal period ranged from 6-7 days and 5-6 days respectively.

The adults emerged by chewing and removing a circular piece of the seed coat to form a round hole. The adult elytra were shorter in comparison to the rest of its body leaving the last segment of the abdomen exposed. Adults were oval in shape, chocolate or reddish brown in color, with long and erected antennae. The adult males were smaller and possessed more rounds shapes than the females whereas female adults had dark stripes on each side of dorsal abdomen. The adult male and female period ranged from 9-12 day and 10-14 days respectively [16].

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