



Efficiency of Non-Chemical Storage Approach for Cowpea Against Bruchids: A Mini-Review

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Abstract

Cowpea (Vigna unguiculata (L.) Walp.) is one of the most important grain legumes grown by small-scale farmers in jigawa state, Nigeria. The crop served as food and animal fodder as well as income through sales. Despite the importance of the crop, stored cowpea suffers damage by insects. Bruchid (Callosobruchus maculatus) is the most serious post-harvest insect in stored and its infestation starts in the field as a result of improper management then becomes more prevalent in storage. Damage by Bruchids has been reported reducing the degree of usefulness and making the cowpea seeds unfit for human consumption that caused rejection of farmer's cowpea in export market trade. These have become necessary for Jigawa Agricultural Research Institute (JRI) came into the issue. A study in the major rural cowpea markets across the state was conducted and the methodology involved surveys and interviews. The finding revealed the use of pesticides chemicals by farmers in dealing with bruchids is not advised, because it constitutes a high economic and health risk, emphasis on the safe storage of produce should be considered. The non-chemical method of cowpea storage is the most effective, eco-friendly, and durable approach to limit the losses associated with this pest. The main objectives of this review are to guide small-scale farmers on some selected non-chemical methods of bruchids control that are cost less and also to alert the state Government with information so that to come up with action.

Keywords: Cowpea, Bruchids, Post-harvest loss, non-chemical methods

1. Introduction

Post-harvest loss of food grown by jigawa small-scale farmers in Nigeria is a very serious problem. Inadequate storage facilities, poor harvesting techniques, lack of resources, and a host of other factors are responsible (Murdock *et al.*, 1997). Losses of food to insects and rodents in storage have resulted in a massive economic loss that caused the rejection of farmer's cowpea in export market trade (JRI, 2019). The most important insect pests of stored cowpea are called bruchids and adult bruchids are often known as weevils (*Callosobruchus maculatus*). These insects infest the crop in the field and the infestation can get worse in storage (Murdock *et al.*, 1997). Cowpea leaves, seeds, and pods are the essential parts and consume as food while, the crop residue gives feed to livestock as well as cash incomes to farmers (Sulaiman, 2000). Traditionally, the crop is consumed directly as a nutritious meal at homes and restaurants, it can also be combined with cooked rice or prepared as cowpea cake made from mashed and fried seed popularly known as 'Kose or Akara and Moi-Moi sold along the roadside (Hakeem *et al.*, 2012). Despite the importance of the crop, the majority of farmers lose their entire cowpea production to insect damage in storage. Storage losses include lost income because of a decrease in grain quality. In the year 2019, surveys and interviews were conducted by jigawa Agricultural research institute (JRI) across the major markets of the state and the estimated number of damaged cowpea grain by store insect bruchids is between 15 to 70%. The use of pesticides chemicals by farmers in tackling bruchids is not advised, because it constitutes a high economic and health risk, emphasis on the safe storage of produce should be considered. These have become necessary for

JRI to guide farmers on some selected non-chemical methods of bruchids control that are simple in use. A combination of physical, cultural, and biological are to discuss as a means of control.

1.2 LIFE CYCLE OF BRUCHID AND ITS INFESTATIONS ON COWPEA

Infestation of cowpea grain by bruchid starts in the field at a low level (Murdock *et al.*, 1997). In the granary, the female lays her eggs on cowpeas especially in warm conditions, when temperatures are above 25 °C for several days. The eggs hatch in about a week, there it feeds, grows, and develops passing through four larval and one pupal stage. This takes about four weeks. As soon as an adult female emerges from the seed, she finds a male and mates. She then begins laying her eggs on other cowpeas. About 30 days later the new generation of adults appears, popping out of their seeds and leaving a little round hole. Each pair of adults then begins its new generation. Each female is prolifically producing some 100 offspring (half males, half females). After two or three months of storage, a granary of cowpea grain that initially had only a few cowpea bruchids can contain thousands. Since each new adult leaves a hole in the cowpea grain in which it developed, the entire store of grain is riddled after a few months. In this way, cowpea weevils can turn a high-value, virtually insect-free store of cowpea grain into smelly and worthless powder within a short period (Murdock *et al.*, 1997).

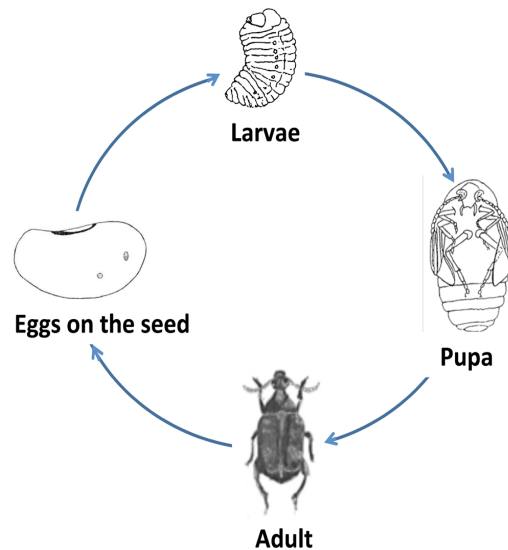


Fig 1. The life cycle of the cowpea bruchid (Source: FAO, 2003)



Fig 2. Cowpea damaged by bruchids (Source: Murdock *et al.*, 1997)



2. BRUCHIDS CONTROL

2.1 Chemical Control

Dusting, spraying, and fumigation are the methods of using insecticides on stored produce. Insecticides usually show some degree of toxicity to humans, animals, and poultry. Therefore, it must be used with caution as most farmers in the rural do not read the manufacturer's instructions. Insecticides tend to lose their persistence, or effectiveness with high humidity, high temperature, time, and sunlight (Adedire *et al.*, 2011). Stored chemicals must be protected from these factors to ensure their continued effectiveness. Insects can develop physiological and behavioral resistance to insecticides. Excessive or inappropriate use of chemicals will lead to the insects becoming resistant (Adedire *et al.*, 2011).

Insecticidal dust mostly involves using an admixture of dilute dust at 2.5- 15 ppm active ingredient, depending on the purpose and the insecticide. The appropriate quantity of dust is measured into a perforated tin or plastic bag and sprinkled onto the product. The dust is mixed more effectively by shaking it with the grain. There are several problems with this type of insecticide. This method is only suitable for dry conditions; it is also difficult to obtain accurate dosage and a thorough admixture (Amevoin *et al.*, 2007). Sprays differ with the type of storage facility used. This application allows the insecticide sprayed directly onto the grains. Most small-scale farmers cannot afford Knapsack and the technique also needs a highly ventilated environment and trained personal (JRI, 2019).

Chemicals used to attack insects through their respiratory system are known as fumigants. The grains are placed in the drum, plastic bags under tarpaulins, or plastic sheets. After the addition of the chemical, the grains must be kept in airtight conditions for at least three days for Phostoxin (Ohiagu, 1985). Fumigants can be very dangerous if incorrectly used; they should not be used in domestic living areas. Another problem is that they have no residual action. Safety must be a primary consideration. All fumigants can kill people as well as insects, and some may cause serious disorders in humans who are exposed to low concentrations over a long time (JRI, 2019). Consequently, stocks of fumigant should not be kept in stores where people are working. Fumigation should only be carried out by trained staff operating under proper supervision (JRI, 2019).

3. NON-CHEMICAL CONTROL

Chemicals have been banned by countries that signed the 2001 Stockholm Convention; an international treaty that aims to eliminate or restrict the production and use of pesticides in agricultural products. Literature Review, which is based on studies conducted by a multi-university research team in Toronto, concludes, "People should reduce their exposure to pesticides because of links to serious illnesses. Results of this study found evidence of serious health risks such as cancer, nervous system diseases, and reproductive problems in people exposed to pesticides. The most at-risk population are people who are directly exposed to pesticides. This includes agricultural workers who apply pesticides, and other people in the immediate area during and right after pesticides are spread (FAO, 2003). Therefore, some selected management on the safe storage of grains that is costless and free from the chemical is to discuss here.

3.1 Field Hygiene and Proper Harvesting

How a crop is handled during harvesting will determine the extent to which it's predisposed to bruchids attack. A crop like cowpea, usually harvested and dried on the bare ground may also easily get attacked by bruchids present on the ground. To prevent this, the field should be properly sanitized and the crop should also be harvested at the right time when it matured. The length of days to maturity varies among cowpea cultivars therefore, several hand pickings are advised to prevent shattering and damage to pods and seeds by insects (Singh *et al.*, 1990). (Emechibe, 1991) reported that, regular weekly harvests of cowpea reduce bruchids attack by two-thirds when compared with a single final harvest.



3.2 Repeated Cultivation of Host Plants

Repeated cultivation of the same crop or susceptible crop species on the same piece of land supports the rapid buildup of bruchids attack (Murdock *et al.*, 1997). (Caswell, 1994) reported that, in Mexico, intercropping cowpea with maize reduced the abundance of the bruchids, probably because of the shade given by the maize canopy.

3.3 Storing Un-Threshed Cowpea Pod

Bruchids attack in granaries was reduced by 50% when cowpea was stored in the pod, compared to threshed cowpea stored in sacks. The pod acting as a physical barrier (Caswell, 1994).

3.4 Control by Temperature Regulation

High temperature due to direct solar radiation, may kill the developing larvae in the seed (Murdock *et al.*, 1997). Heating the infested seed to a temperature of 63°C for 15 minutes, destroyed bruchids at any state, and vice versa, all stages of bruchids will be killed when subjected to temperatures of 0° or less for 32 days. (Togola *et al.*, 2018) reported that, the storage life of cowpea depends on its moisture content before storage. The lower the moisture, the better the quality of seed in storage. (Boukar *et al.*, 2012) added that, use of cold room store of the International Institute of Tropical Agriculture (IITA), Kano Station to exposure of -18°C for 24 hours daily services, has substantially reduced pest number by more than 99%. For small-scale farmers, this technique is not very appropriate due to the high cost of achieving low temperatures therefore, the design of conventional stores to promote cooling by aeration is proper.

3.5 Smoke

Traditionally in Africa, cowpea is often stored above the kitchen fire in the farmer's hut. The advantage is that the development of the insect pest is retardant and re-infestation by migration is prevented, because of the heat and smoke which act as a repellent (Emechibe, 1991).

3.6 Hermetic Storage

There are several ways to store cowpea to discourage bruchid damage. Storing the grain in two different types of airtight (hermetic) containers is to discuss; metal drums and triple bagging.

3.6.1 Metal drum

Bruchids cannot live without air. This is why, airtight containers are so effective (Farm Radio Network, 2006). In some places, old oil drums are easily available and relatively cheap. The tops of these drums have screw-type plastic lids which makes them airtight and effective at discouraging bruchids. Farmer to start by filling the drums to the top with dry threshed cowpea grain. Each drum holds about 45 to 55 kilos of grain. After filling the container, seal it, and then use peanut or another cooking oil to lubricate the edge of the closure. This ensures an airtight seal. The oil also makes it easier to remove the lid after months of storage. Filled drums can be stored for six months with very little loss to cowpea bruchids; because the drum doesn't permit air from the outside, the bruchids will eventually die.

3.6.2 Triple bagging

This method requires three clear plastic bags (poly bags) which hold fifty kilograms of cowpea. Thus the name: 'triple bagging. The plastic bags are placed one inside the other to keep out insects. Farmer to make sure, the plastic bags have no holes, because even extremely small holes will reduce the effectiveness of this method and one or two bags is not enough to ensure success. The farmer needs three or more pieces of advice to use a PICS bag. PICS Bagging (Purdue Improved Cowpea Storage) is a technology developed by Purdue University in 1987 by Professor Larry Murdock and his team. The procedure for using a triple or PICS bag is as follow:

1. Farmer to Fold back the top of the first bag and put the second bag inside of it. Then fold the second bag over the outside of the first. Next, put the third bag inside of the first two and fold it over the first two.
2. Slowly and gradually to fill the inner bag with cowpea, making sure to shift or gently rock the bags frequently to eliminate any air pockets inside. Fill the inner bag nearly to the top. Then firmly draw together

the top of the innermost bag, squeezing tightly to press air out of the bag. Gently rock the bag of cowpea, back and forth again to eliminate any air spaces.

3. After the cowpea are well settled in place, the farmer squeezes the innermost bag again to force out any air and then ties the bag closed with string or cord. Twist-up the remaining plastic above the tie and fold this plastic in two. Then tie the double-folded plastic together.
4. Farmer to repeat this tying procedure individually for each of the three bags. Then store the bags in a cool place. You can now be sure that your cowpea is safe from pest attacks.



Fig: 3. Triple bagging (Source: Farm Radio Network, 2006)

3.7 Biological Control

(Aitken, 1984) reported that, in stored products in which almost all the arthropod pest species are very widely distributed, there have been ample opportunities for similar dispersal of the natural enemies of the pest. (Aitken, 1984) also observed that cowpea imported into the United Kingdom carry many bruchids. However, these only concerns the transport of stored product pest and their natural enemies which attacked the bruchids, but research on using them for biological control is very limited. Another strategy for biological control is the modification of storage structures or techniques to make conditions less favorable for bruchids development. This method requires a thorough knowledge of the biology and ecology of the natural enemies (Kaul *et al.*, 2002).

3.8 Bio-Rational Control

The practice of adding a small quantity of vegetable oil (1-15ml per kg seed) to the grains of cowpea to protect them against insects is common in several parts of Asia. (Cruz, 1991) have proven that, oil coating is effective in controlling bruchids. The vegetables tested were of the following origin; palm oil, groundnut oil, soybean oil, etc. regardless of the source of oil, all gave protection from bruchids attack. In addition, the study further shows, oil in general, did not adversely affect the viability, palatability, cooking quality, and physical appearance of the legume seeds.

3.9 Varietal Resistance

Some factors such as high protein content, seed texture, and a pod wall factor have been linked to the resistance of cowpea varieties to bruchids (Singh *et al.*, 1990). Different cowpea was not equally susceptible to attack by bruchid. Both hardness and the seed may also be important as a barrier to bruchids entry. (Boukar *et al.*, 2012) reported that, IITA has developed a new cowpea variety that is resistant to bruchids Tvu-2027. This variety contained high levels of trypsin inhibitor and Sulphur bearing amino acid that weakened the development of larvae.



CONCLUSION

The use of Pesticides chemicals on agricultural stored produce can have negative impacts that potentially affecting the quality of the crop, and may even result in food safety issues for humans. Progressing to non-chemical is a logical step to potentially help reduce the chances of bruchids acceleration. These can improve productivity and enhance the economy particularly, the small-scale farmers. Finally, Jigawa Agricultural research institute is sincerely ready to provide the needed technical support to help fight this problem and improve people's well-being.

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