

Integrated Pulse Beetle Management In Stored Pulses Seeds: A Review

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ABSTRACT

Pulses are very important part of human diet. Variety of pulses we are producing across the India. Poor storage management and lack in pre storage care and management create problems in viability and vigour of seeds during storage of seeds. Pulse beetle is very serious and cosmopolitan insect deteriorate qualitative attributes as well as viability of seed. There are several methods of pulse beetle control including physical, chemical, use of botanicals and use of resistant varieties. Among these methods use of botanicals and resistant varieties are safe and cheapest method of pulse beetle control.

Key words: Pulse beetle, Pulses, Insect, Chemical, Physical, Biological.

Introduction

India grows diverse pulses crops under wide range of agro-climatic conditions. The developed crop production technology and arrival of new plant varieties enhanced pulses production in India. Pulse beetle are commonly occurring and considered to be the most serious insect pest of stored pulses viz., black gram, green gram, red gram and chick pea and beans, peas, cowpea and soybean. The pulse beetle journey begins from farm and end in storage. The pulse beetle is not causing only quantitative loss but also losses germination, vigour and unfit for sowing. Farmer storing their produced pulses seed either in bag, locally available container and loose in the room where they are also living, unable to fumigate the produce for the control of this pest. There is no remedial measure to manage the pulse beetle. Under such circumstance, unprotected stored pulses seeds suffer heavy losses. They destroy completely the endospermic portion of seed and leaving only the seed coat thus seed losses completely its viability. It causes weight loss, decreased germination and reduction in commercial value of the seed. Sever infestation happened due to *C. maculatus* in West Africa and damage was 100 per cent Lienard & Seck, 1994). In village level no proper and good storage facilities so that reason in case of cow pea 90 per cent infestation was due to attack of cow pea weevil (Alebeek, 1996).

Different species of pulse beetle

Order: Coleoptera, Family : Bruchidae

Callosobruchus chinensis, *C. maculatus*, *C. analis*, *Bruchus affinis*, *B. phaseoli*, *B. emerginatus*, *B. pisorum* , *B. albocallosus*.

Identification

Fatima *et al.*, (2016) reported that *Callosobruchus chinensis* larva is identified by its creamy white and oval and flabby body. The adult beetle measuring 3-4 mm in length, oval,

chocolate or radish brown and has long serrated antennae. There is a pair of the hind margin of thorax, a spine on each of the inner and outer edges of the inner and outer edges of the end of hind femur and truncate elytra, not covering the pygidium.

They also identified *Callosobruchus maculatus* emarginated type of eyes, small (3-mm long) orange-brown beetles with a body that tapers towards the head. Their wing covers (elytra) are slightly shorter than their abdomen.

Life cycle

In summer season it completes its life cycle in 25 to 34 days and in winter season it completes its life cycle in 45 to 50 days (Ghosh and Durbey, 2003). Active season for pulse beetle is summer and *kharif* larval stage found in winter season as hibernation. Last week of March is for emergence of adult from larva and reproduce next generation. Ahmed *et al.*, 2018 concluded that adult lays eggs on seeds but they not feed the seeds. Egg lying on seeds is varies with different pulses. Ahmed *et al.*, 2018 found that maximum egg laid on chickpea as compare to black gram while on lentil and mung bean medium eggs laid it's because of maximum surface area present on chickpea for egg deposition. It means morphological feature of seed and seed coat affect the association of pulse beetle. Chakraborty and Mondal (2016) reported maximum egg laying found in kidney bean because of availability of maximum area for egg laying.

A day after, the female starts laying small, oval, scale like eggs which are glude to grain. In *C. chinensis*, more than one eggs laid on a grain. The life cycle is completed inside the seed with the mature larva excavating underlying seed tissue, leaving a visible 'window' just below the seed testa, within which it pupates and encloses. The average life span of an adult is 5-20 days, the insect passes through 7-8 overlapping generation in year.

Nature of Damage

Bruchids are cosmopolitan insect able to eat all kinds of food (Chakraborty *et al.*, 2015). This is primary pest of stored pulses. Chakraborty *et al.*, 2015 concluded that bruchids laying eggs on seed surface during field condition and carried out in storage. Adults and larva feed pulses cotyledon and embryo axis and it makes unable to germinate. The grub penetrates grains and feeds on inner content and damage embryo axis and cotyledon. Infested seeds are not useful for sowing. Temperature 30°C and relative humidity 70% is favorable condition for damage. Vyas, 2014 reported that grain damage, loss in germination and weight loss due to pulse beetle in cow pea at different stages, result revealed that maximum grain damage, loss germination and loss in weight was recorded at 180 days of storage period. Maximum damage occurred when favorable condition i.e. optimum temperature 30°C and relative humidity 70%. Bruchids in stored seed are a major problem because of their ability to re-infest stored seed.

Maximum time infestation depends on morphology of seed coat smooth textured seed coat also favors association of pulse beetle in lentil and mung bean Teotia and Singh (1968). Result of storage study of different pulses seeds of Ahmed *et al.*, (2018) proved that size of seeds doesn't matter, texture and diameter of seed coat affect the infestation of pulse beetle.

Preventive Measures

- **Hygiene and sanitation-** Before storing the pulses seeds in an ideal storage/ godown, it is important to ensure that the seeds are dry, clean, cool, wholesome and free from any

obnoxious odour. Alice (2014) reported that high relative humidity inside the storage house and dried seed causes production of mold and insects which eggs carried out from field like pulse beetle. The storage structure should also be neat and clean and reasonably air tight so that control measures may be possible. Threshing floor or yard should be clean, free from any insect infestation, away from the vicinity of village or granaries to avoid horizontal and cross infestation, as bruchids move from these source to infest grains on threshing floor or yard. Increase in moisture content and relative humidity increase the risk of insect and fungal infestation (Nattudura, 2017). Zero proper cleaning and hygiene condition of bins year after year pass the chain of infestation (Sallam, 2019).

- **Proper stacking-** Keeping the bags of seeds over well stacked wooden hips is called as stacking (Sallam, 2019). Proper stacking also helps in grain protection. Stack properly on the dunnage (wood/ plastic) 0.5 meter away from the walls and floor in the lines keeping 0.5 meter space between two lines and 0.2 meter open space toward the roof. Do not stack more than 10 bags vertically.
- **Disinfestations of storage container, structure and stores-** It is very difficult task to store pulses seeds than cereals because pulses deteriorate very rapidly than cereals (Mills, 1994). Clean and disinfest bags by dipping in the boiled water and drying under sun, when re- used. If one can afford, treat the old gunny bags by dipping in cypermethrin 0.01% or fenvarlerate 0.01% or malathion 0.1% for 10 minutes and dry them completely under sun. Treat all the inner surface and walls of the storage structures and godowns either by Malathion (50 EC) or Fenitrothion (50EC) using 5 ml of any insecticide in one liter of water. Fumigate with aluminium phosphide @ 21-30 g. Seed storage in well impervious type of containers protect the seeds from unwanted moisture and ultimately reduce risk of fungal growth and insect infestation. Kamara *et al.*, (2014) reported that cow pea seed storage in glass bottle and plastic container protect the seeds from weevil and pulse beetle. Alice *et al.*, (2017) reported that already presence of insects like pulse beetle increase the respiration rate in storage containers and ultimate it increases heat, that heat will produces moisture content of the stored seeds.

Curative Methods

- **Ecological method-**
- **a) Storage temperature-** Temperature ranging from 25- 35⁰C accelerates the development of pulse beetle and above 40⁰C and below 15⁰C retards reproduction and development, while temperature above 45⁰C and below 10⁰C kills the pulse beetle/ bruchids. Heating of the pulses to 50⁰C may be lethal to pulse beetle but it is not advisable because the seeds may lose their viability. Alice *et al.*, 2013 reported that exposure of black gram seeds before storage to different periods of cold treatment and result revealed that 4⁰ C cold treatment for 24 hour suppress the growth and infestation of pulse beetle. Moreover, if exposure of black gram seeds to sunlight for different periods also gave better result to control adult and infestation of cow pea weevil in black gram. Bajiya, 2009 reported that the egg laying potential hikes with increase in temperature range from 20⁰ to 30⁰ C and deducing after 35⁰ C.
- **b) Seed moisture content-** Pulses seeds should be stored below 12 percent moisture content escape from the attack of pulse beetle. Seeds are hygroscopic in nature and it absorb moisture very fast as compare to other commodity (Agarwal, 2017)

Physical Methods

1. Use of Solar heat- The use of solar energy has long been practiced as one of the effective methods for minimizing pulse beetle infestation stored pulse seeds. All the stages of pulse beetle in infesting mung, pea, gram seeds etc. could be killed by exposing to heat for varying period at temperature of or by exposing to solar heat for hr. with the diurnal temperature varying from 37 - 54°C. It has also been observed that viability of the treated grains may not adversely affected. Ghaffar and Chauhan (2002) examined the level of accumulation of temperature in polythene bags and its effect on bruchid survival and infestation in the pigeon pea seed contained in them. Bruchids in all the solarized bags died without laying eggs whereas no damage recorded in the solarized bags. This indicated that seed solarization was effective as a means of protecting seeds from bruchid damage. Application of solar heat for insect control deduces the production of eggs and affects the moment of insects due to desiccation it is called as low humidities and this conclusion was advocated by Chapman, 1982. Lale, 1998 reported that exposing seeds for 3 hours under sun light successfully deduced adult emergence of *C. maculatus*.

2. Mixing of inert dust and sand- Some inert dusts abrasive and scars the cuticle causing desiccation and starvation, but actual efficiency depends on the particle size, particle hardness, particle shape and form, humidity. Finer particles have higher the insecticidal efficacy because coarser particle do not stick to insect or the seeds. The farmers in village mix sand, clay ash etc. with the seeds which make difficult task and causes physical injuries; blocks mouth part, lodges in the joint of beetle. Sand as 40-60 mm top layer on seeds has most effective in reducing the oviposition as well as egg hatching. Inert dusts particularly based upon silica content are gaining importance as storage protectants. The main reason behind this is that they induced egg mortality by desiccation (Golob, *website*). Ash or any other fine dust block the spiracles of the insects and result into death due to suffocation. Insect die when they lose about 30 percent of their total body weight. Alice and Shrikant (2013) reported that use of fly ash, activated clay and talcum powder useful showed great result for controlling adult of pulse beetles because it suffocate the body of insect. Mahmoud *et al.* (2010) reported adults of *Callosobruchus maculatus* (F.) and *C. chinensis* (L.) were exposed to broad bean seeds treated with kaolin-based particle film dusts (powder) at different concentrations 1.0, 0.8, 0.6, 0.4, 0.2, 0.1, 0.05, 0.025% w/w and untreated control. After six months of storage of the treated seeds, kaolin powder still could protect the broad bean seeds against *C. maculatus* and *C. chinensis* attacks.

3. Mechanical cleaning

Broken and cracked grains promote attack of pulse beetle. Hence, screening and sieving out such seeds reduce the insect infestation and gives better appearance to it. Regular screening of seeds done away from the stores to avoid any reinfestation. Screenings should be destroyed immediately. Bags should be used for screening not be used again unless disinfestations.

4. Radiation method

Giving full attack of ionizing ultraviolet light (wavelengths of 10e 400 nm, photon energies of 3e124 eV) having ability to kill and prevent pulse beetle infestation on pulses (Faruki

et al., 2007). The possibility of thermal disinfecting various products by ionizing radiation. In 1916 Ranner proved that X-rays prevent the development of embryo and young larvae of this beetle. Change in chemical composition of cell, disturb its normal functioning, metabolism division and consequently kill the cells. Ionizing radiation sterilizes the pests, lower their viability and finally lead to their death. Application of 0.25 KGy gamma rays was effective for killing *C. maculatus* in green gram (Darfour *et al.*, 2012). Seed treatment with radiations had no effect on germination and vigour of seeds (Enu and Enu, 2014).

Chemical Method

Under the many circumstances the easiest, most rapid, and economical method of controlling pulse beetle is with insecticides, often in the form of fumigants. Among the methods chemical method of pulse beetle control is most popular and effective one. Surface spray of bags as and when the insect pest are visible are done with insecticides such as malathion, primiphose-methyl, DDVP, fenitrothion etc. Pathania and Thakur (2012) reported Malathion (0.5%), Deltamethrin (0.1%), and cypermethrin (0.0025%) were found most effective resulting in 100 per cent adult mortality after 7 days of exposure. Malathion (0.5%) was also proved to be the best in minimizing the oviposition (1.33/eggs/100 grains), seed damage (1.07%) and weight loss (0.28%).

Management of pulse beetle by using insecticides depends on time of application and concentration of that insecticide. Singh and Das (2016) advocated that application of synthetic pyrethroid and deltamethrin sprayed at early morning, afternoon, evening and late night. Resulted revealed that application of that chemicals at late night time more effective against pulse beetle because most of the insects are more active for attack at late night time. If we apply Pyrethroids in very low quantity its effective and cheapest (Nowak *et al.*, 2001). Shipp & Otton (1976) reported that application of insecticides for controlling pulse beetle before starting attack had more effective than application at infestation.

Use Botanical Products

Traditionally many of the plants are used against stored grain pest. Although promising results have been achieved in laboratory test with botanicals. the efficiency under practical storage conditions varied as lot. Most methods have limited effect but it provides satisfactory protection of the stored products when they applied properly. There are many plant species, which have toxic properties against pulse beetle of stored pulses seeds. The most commonly used plants are *Neem*, *Karanj*, *Undi*, *Castor*, *lemon grass*, *mustard*, *coconut*, *sesame*, *groundnut*, *Dharak*, *Aak*, *Datura*, *jathropa* etc.

Botanical products act as Antifeedant, ovipositional deterrent, Larvicide, growth regulator. Jacob and sheila (1990) reported that neem oil at rate of 1.0/100 g seeds caused cent percent mortality of *C. chinensis* and inhibit the oviposition and hence prevented development of subsequent generations. Seed treatment with botanicals protect the seeds without phytotoxic effect on seed and without affecting germination and seed vigour. The plant extract, oil and plant part powder are used admixture with stored commodities to protect them from insects. Kshirsagar (2010) examined insecticidal activity of *Jatropha* seed oil against *Callosobruchus maculatus* has been carried out. The eggs of *C. maculatus* were more susceptible to *Jatropha* oil and shows mortality to all selected dosage. *Jatropha* seed oil was highly toxic to the eggs of *C. maculatus*. Owolabi *et al.*, (2014) reported that oil of *M. lucida* contains monoterpens which act as both control and repellent to pulse beetle *C. maculatus*. He also advocated that continuous use

of synthetic insecticides increase the genetic resistance as well as toxicity which hazardous to human.

Resistant Varieties

The resistance of some lines of varieties to the bruchid *Callosobruchus* spp. was found to be due to the presence of variant vicilins in these seeds. The mechanism of resistant seems to involves lower rates of hydrolysis in the insect mid gut coupled with a higher capacity of binding to chitin in mid gut structures as compared to vicilins from susceptible seeds. Vyas (2004) studied different cow pea genotypes screened for their susceptibility against *C. chinensis* on the basis of overall rank values of resistance parameters, Pusa phalguni and GC-9708 were found resistant, while GC-9742, GC-4 and GC-9311 were found highly susceptible. Raghvani (1998) reported on the basis of overall rank values of resistance parameters, pigeonpea varieties GAUT 88-6 and BDN-2 were found as resistant and ICPL-87 was highly susceptible to *Callosobruchus maculatus*.

Conclusion

Pulse beetle (*Callosobruchus* spp.) is a serious pest of stored pulses seeds and grains. The white coloured eggs hatch out within 4 to 5 days and grub makes cavity inside the grain causes heavy damage in terms of seed weight and quality. This pest can be effectively managed by various physical and chemical methods along with application of botanicals also found effective against pulse beetle. The scientists / researchers also studied the variation in susceptibility in cultivars of the different pulse crops to pulse beetle in order to find out resistant varieties.

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