EVALUATION OF INDIGENOUS TECHNIQUES AGAINST PULSE BEETLE 
CALLOSOBRUCHUS MACULATUS (F.) IN BLACK GRAM

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ABSTRACT

Indigenous techniques viz., match boxes @ 10 no, lime powder @ 15 g, camphor @ 1 g, common salt @ 200 g, cow dung ash @ 80 g, buffalo dung ash @ 80 g, cow dung powder @ 100 g, buffalo dung powder @ 100 g, goat pellet powder @ 100 g/kg grain, gunny soaked in cow urine, gunny soaked in buffalo urine were evaluated as grain protectants against pulse beetle Callosobruchus maculatus (F.) in stored black gram at the Post Harvest Technology Centre, Bapatla. There was no adult emergence and grain damage in the treatments of dung powders besides camphor and ash even after six months. Further, the germination of stored seed kept with camphor, dung ashes and powders were good which ranged between 84.33% and 92.33%. A total of 3622.67 adults emerged from the untreated grain in 180 days of storage and caused 57.67% grain damage which resulted in 4.67% germination only. Besides filling up of inter-grain space, keeping a surface layer of 2.5 cm of powdered materials like ash and cattle dung could prevent pulse beetles successfully.

Key words: Indigenous techniques, pulse beetle, black gram, grain protection, adult emergence, grain damage, germination, cattle urine, dung powder, ash.

Although chemical methods of management of storage insect pests are highly effective, the rise of insecticide resistance in pest populations and the overall growing interest, in environmentally safe pest control methods have spurred the exploration of natural farming and organic methods for alternatives to hazardous pesticides in crop protection as well as stored grain protection. Traditional methods of storage are more sustainable, ecofriendly and based on the utilization of natural resources. They have been used successfully through generations, yet majority of the users were not aware of the scientific principles involved in the indigenous methods or qualities of the materials (Karthikeyan et al., 2006). On the other hand, Zero Based Natural Farming which is native cow centric has attained wide scale in India as a farmer-led social movement (Khadse and Rosset, 2019). Generally, cow dung and urine are used in preparations of natural farming that are being used as biofertilizers and against insect pests of field crops as alternatives to synthetic pesticides. Due to the action of several bioactive constituents exerted on insect development and survival, cow urine is considered as potential biopesticide (Gahukar, 2013).

Several researchers documented the traditional methods or materials commonly adopted by the farmers like use of neem, camphor, ash, table salt, turmeric powder (Anju and Kanchan, 2013); cow dung slurry, cow urine, powders of various plant materials, leaf extracts (Rakesh et al., 2013; Amrit et al., 2019) etc for grain protection from insects. A number of authors also described the scientific rationale behind different practices like keeping match boxes, sand, camphor, mixing of salt, lime, ash and use of neem seed kernel extract dipped jute bags, neem leaves, karanj leaves and dung (Dhaliwal and Singh, 2010; Kartikeyan et al., 2009; Reddy, 2006; Prakash et al., 2016). Black gram is the important pulses crop grown in coastal districts of Andhra Pradesh with total cultivated area of 4.03 Lakh ha. Pulse bruchids, Callosobruchus spp. (Coleoptera: Chrysomelidae) cause greater damage to stored pulses both quantitatively and qualitatively. Sand layer of 2.5 to 4.0 cm thick above the stored pulses was found effective in preventing bruchid infestation (Jagjeet et al., 2005; Sunita et al., 2013; Swamy et al., 2015). However, indigenous practices should be verified for their efficiency if they can be used as economical ways for short term storage of food grains and seeds at domestic level. With this in view, an experiment was designed to evaluate some indigenous practices against pulse bruchid in black gram.
MATERIALS AND METHODS

Some traditional methods and materials were evaluated against pulse beetle, *Callosobruchus maculatus* (F.) in black gram at the Post Harvest Technology Centre, Bapatla during 2017-18 and 2018-19. The black gram (var: LBG 752) grain was obtained from the fresh produce, cleaned by removing the debris and soil particles and then fumigated with phosphine (9 g/tonne) for seven days to remove the latent field infestation. After two days of aeration, the grains were used for the experiments. Pulse beetle, *C. maculatus* insects required for the insect bioassays were cultured on black gram and was maintained at ambient room temperature and relative humidity. There were twelve treatments viz; (T1) match boxes @ 10 no, (T2) lime powder @ 15 g, (T3) camphor @ 1 g, (T4) common salt @ 200 g, (T5) cow dung ash @ 80 g, (T6) buffalo dung ash @ 80 g, (T7) cow dung powder @ 100 g, (T8) buffalo dung powder @ 100 g, (T9) goat pellet powder @ 100 g/kg grain, (T10) gunny soaked in cow urine, (T11) gunny soaked in buffalo urine and (T12) an untreated control. Match boxes, lime powder, camphor and common salt were purchased in the local market. Cattle urine, dung and ashes were obtained from a progressive farmer who maintained a ‘gir’ cow and ‘desi’ healthy buffaloes. Similarly, goat pellets were also collected from a herd, dried and made into powder. Dung and urine materials required for the treatments were obtained from the same cattle during the two years.

Gunny bags treated with cattle urine were shade dried and those grain filled bags were placed in the plastic jars. Match boxes and camphor were placed in the grain at the surface while lime powder and common salt were mixed with grain. Ash and dung powders were placed over the grain and tapered so as to fill the inter grain space and also maintained some portion as a surface layer. Black gram (500 g) was taken in a plastic jar of one kg capacity and ten pairs of freshly emerged pulse beetles were released into each treatment and secured with a lid which had a small hole (1 cm diameter) but covered with nylon net to prevent insect escape, heat build-up and condensation due to insect activity. Data on oviposition was recorded at 10 days after release of insects (DAR) while the numbers of adults emerged were recorded at 60, 120 and 180 DAR. Grain damage (%) and germination (%) were recorded at 180 days after storage. The experiments were conducted by adopting completely randomized block design with three replications at ambient conditions. The data obtained were suitably transformed and subjected to ANOVA and the means were tested for significance.

RESULTS AND DISCUSSION

Significant differences were observed among the treatments in terms of bruchid population build up, grain damage and germination of black gram stored for six months during 2017-18 (Table 1). More adults emerged from the grain stored in the gunny bags soaked in cow urine (321.0) and buffalo urine (325.67) while the untreated grain recorded the emergence of 252.33 adults at 60 DAR. Buffalo dung powder and goat pellet powder treatments recorded 148.67 and 162.33 nos of adults, respectively. Common salt, match boxes and lime powder treatments recorded the emergence of 240.67, 262.33 and 149.67 adults, respectively at 60 DAR. There was no adult emergence in the treatments of camphor, cow dung ash and buffalo dung ash and cow dung powder during six months of storage whereas from the untreated control a total of 3261.33 insects were emerged. More or less similar pattern was followed in the population emergence of pulse bruchids at 120 and 180 DAR, and also with the total number of adults during six months of storage. When observed for the grain damage due to bruchid infestation, as there was no adult emergence in camphor, cow dung ash, buffalo dung ash and cow dung powder treatments, grain damage was also nil in those treatments. Further, the germination (%) of the black gram stored along with camphor, cow dung ash, buffalo dung ash and cow dung powder treatments, grain damage was also nil in those treatments. However, from the untreated control showed only 3.67% germination due to 61.67 % grain damage.

In contrast to the results of the previous year, adult emergence was not observed in the treatments of different dung powders besides camphor and ash treatments even after six months of storage during 2018-19, whereas a total of 3622.67 insects were emerged from the untreated control (Table 1). However, from the grain stored in the gunny bags soaked in cow urine and buffalo urine the numbers of insects emerged were higher (2751.0 and 3579.0 respectively). Similarly, the treatments; common salt, match boxes and lime powder also recorded the adult population at higher numbers (2473.33, 3500.67 and 3944.0, respectively) during 180 days of storage. As the consequence, a positive correlation between bruchid population and grain damage with respective treatments was also observed.
Table 1. Effect of indigenous practices on bruchid buildup, grain damage and germination of stored black gram (2017-18, 2018-19)

<table>
<thead>
<tr>
<th>Tr. No.</th>
<th>Treatment</th>
<th>Adult emergence (No.)</th>
<th>Grain damage (%)</th>
<th>Germination (%)</th>
<th>Adult emergence (No.)</th>
<th>Grain damage (%)</th>
<th>Germination (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>At 60 DAR Dose/kg grain</td>
<td>At 120 DAR</td>
<td>At 180 DAR Total</td>
<td>At 180 DAR</td>
<td>At 120 DAR</td>
<td>At 180 DAR Total</td>
</tr>
<tr>
<td>T_1</td>
<td>Match boxes @ 10 no</td>
<td>262.33</td>
<td>1765.67</td>
<td>791.0</td>
<td>2819.0</td>
<td>53.67</td>
<td>12.33</td>
</tr>
<tr>
<td>T_2</td>
<td>Lime powder @ 15 g</td>
<td>149.67</td>
<td>1867.33</td>
<td>1257.0</td>
<td>3274.0</td>
<td>42.33</td>
<td>23.67</td>
</tr>
<tr>
<td>T_3</td>
<td>Camphor @ 1 g</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>T_4</td>
<td>Common salt @ 200 g</td>
<td>240.67</td>
<td>2174.33</td>
<td>464.67</td>
<td>2879.67</td>
<td>39.0</td>
<td>29.33</td>
</tr>
<tr>
<td>T_5</td>
<td>Cow dung ash @ 80 g</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>T_6</td>
<td>Buffalo dung ash @ 80 g</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>T_7</td>
<td>Cow dung powder @ 100 g</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>T_8</td>
<td>Buffalo dung powder @ 100 g</td>
<td>148.67</td>
<td>1681.00</td>
<td>626.33</td>
<td>2456.0</td>
<td>49.0</td>
<td>17.0</td>
</tr>
<tr>
<td>T_9</td>
<td>Goat pellet powder @ 100 g</td>
<td>162.33</td>
<td>315.33</td>
<td>349.0</td>
<td>826.67</td>
<td>29.0</td>
<td>49.33</td>
</tr>
<tr>
<td>T_10</td>
<td>Gunny soaked in cow urine</td>
<td>321.00</td>
<td>2179.33</td>
<td>769.0</td>
<td>3269.33</td>
<td>57.33</td>
<td>7.33</td>
</tr>
<tr>
<td>T_11</td>
<td>Gunny soaked in buffalo urine</td>
<td>325.67</td>
<td>2297.67</td>
<td>1126.0</td>
<td>3749.33</td>
<td>58.0</td>
<td>6.33</td>
</tr>
<tr>
<td>T_12</td>
<td>Untreated control @ 100 g</td>
<td>252.33</td>
<td>2497.67</td>
<td>511.33</td>
<td>3201.33</td>
<td>61.67</td>
<td>3.67</td>
</tr>
</tbody>
</table>

Values in parentheses transformed values; DAR: Days after release of insects; In each column values with similar alphabet do not vary significantly.
In the same way, negative relation was observed with grain damage (%) and germination (%). Thus, a total of 3622.67 bruchid insects emerged from the untreated grain during 180 days of storage caused 57.67% grain damage which resulted in 4.67% germination only. Germination tests also showed that for the black gram seed stored along with camphor, dung powders and ashes, the viability of seeds was well maintained with the germination (%) varied between 84.33 and 92.33.

The results are in line with those of Farid and Abdul (2005), who proved that fly ash, turpentine oil and cow dung ash were the best grain protectants against pulse beetle in stored chickpea. Hakbijl (2002) reported the use of ash from burnt cow dung as an insecticide against Tribolium castaneum (Herbst), Sitophilus granarius (L.) and Cryptolestes ferrugineus (Stephens) larvae, where the insects were killed by desiccation or restricting insect movement and emergence due to filling up of inter-granular spaces with ash. When the adult insects move through the ash, their bodies, especially the chitin layer on abdomen are grazed which results in clogging of insect spiracles and trachea or blocking off the lateral stigmata subsequently causing mortality of the insects due to suffocation (De Groot, 2004). Haile et al. (2003) stated that the ash dust reduces the relative humidity of the storage condition and dry the grain surface which hampers oviposition and larval development of the beetles. The effectiveness of ash in reducing bruchid infestation was reported by Jane et al. (1991) that a minimum ratio of 3 parts of ash to 4 parts of cowpeas prevented population growth of C. maculatus and a 3 cm layer of ash on top of stored seeds prevented infestation by adults. As it was evident in this study, despite the use of certain methods, Naveena et al. (2016) found that insect infestation still persisted in the samples collected from the ‘Soliga’ households and maximum infestation was found in grains coated with red earth (56.41%), followed by the use of laksisoppu (56.07%) and mixing lime powder (47.83%).

The differences in the adult emergence from the dung powders can be explained with this. While making the dry dung of different cattle into powder, it was observed that there were lot of fibre material in buffalo dung due to which it became difficult to make fine powder, more so with goat pellets. Whereas dried cow dung could be made amorphous simply. It was because of the material which the cattle were fed with. Buffalo feed contained majorly roughages i.e., dry paddy straw and small portion of green grass while the cow was given special feed including concentrates, horse gram, green grass and very small portion of straw. Goats feed on a diverse variety of plants. When the buffalo dung powder or goat pellet powder was mixed with pulse grains, it could not pack the grain properly by filling intermittent spaces and thus allowed insect movement and further population build up. Since the cow dung powder filled the inter-grain space, insect movement and its perpetuation was disrupted. With this experience, during the second year all the three varieties of dung powders were finely ground in a mixer and sieved to have same particle size. There was no adult emergence from these three treatments. Besides filling up of inter-grain space, keeping a surface layer of 1 inch thickness with dry dung powder could prevent pulse bruchids successfully. As the instinct of the beetles is to seek the surface of the grain for mating and egg laying, filling up of inter-grain space with material like ash and dung powders disrupted the very behaviour of the insects and thus prevented the grain infestation. This is in accordance with Hampanna et al. (2006) who reported that cow dung ash (2%) and dry dung powder (20%) were effective in reducing the population build-up of rice weevil in sorghum and pulse beetle in chickpea. In terms of germination also, cow dung ash and dry dung powder were the most favourable.

During the two years, significantly higher numbers of adults were emerged from the black gram stored in gunny bags treated with bovine cattle urine compared to dung powder and ash treatments, although the bags gave very strong stinky odour. However, among the both species, cow urine treatment recorded significantly less adult emergence (3269.33 and 2751.0, respectively) compared to the buffalo urine treatment (3749.33 and 3579.0 respectively) during the two consecutive years. The results are concomitant with Kumari et al. (2010) who observed that cow urine alone was ineffective but the NSKE in urine resulted in no egg laying, minimum egg hatching and maximum mortality of first instar larvae (93-97%) of white grubs, Brahma coriacea Hope. In the same way, several workers reported the efficacy of plant materials in combination with cow urine for the control of insect pests of field crops (Gupta, 2005; Chand and Tiwari, 2010; Kumari and Chandra 2010; Aahirwar et al., 2010; Geetanjaly and Tiwari, 2013). In contrast, Nur et al., (2018) observed that the repellence effect of fermented cattle urine sprayed @ 15% was more than the plant extracts against mealy bugs. The LC30 values of allamanda leaves extracts were 0.66% at 24 HAT which was followed by fermented cattle urine (0.25%) at 48 HAT.
Thus, the present investigation validated the efficacy of materials like ash and dung powders for the control of pulse bruchids in stored black gram. The seed viability was also well preserved. Especially the use of ash should be considered as an integrated management option. Being eco-friendly and cheaper, subsistence farmers can be encouraged to use these techniques as they offer good protection from bruchid infestation in the small-scale storage of pulses and have great significance in ensuring household food security.

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REFERENCES


