The Journal of Plant Protection Sciences, **7**(1-2) : 14-18, 2015

Assessment of different approaches of management of stored grain pest of black gram under homestead condition of purulia district of West Bengal

P.P. Ghosh*, A. Chakraborty, S.K. Bhattacharya, C. Ghosh, B. Mahato and M.K. Bhattacharjya
Krishi Vigyan Kendra, Kalyan, V. Nagar, Purulia-723147, West Bengal, India.

**Corresponding author: ppghosh_santiniketan@rediffmail.com*
Received: 05 October 2015; Accepted: 30 November 2015; Availabale Online: 28 December 2015
DOI: http://dx.doi.org/10.17582/journal.jpps/2015/7.1-2.14.18

A B S T R A C T

Black gram (*Vigna mungo* L.) is widely cultivated during May to September under the rainfed unbunded uplands of Purulia, West Bengal and the produces are stored by farmers under homestead condition for the purpose of consumption and seed for the next year sowing. *Callosobruchus* sp. (Coleoptera: Chrysomelidae) is the major stored grain pest of blackgram under homestead condition resulting 15 – 30% grain damage during storage. An attempt was made to identify a practical and low cost solution of such damage with the active participation of village women responsible for the storage. Proven biological, chemical and botanical (vegetable oil) approaches of management were tested against traditional practice and replicated among 10 different household at 10 villages. Results showed that grain dressing with both neem and mustard oil under botanical approaches performed significantly superior over other approaches and traditional practice in terms reduction in percent infestation (92%), increase in germination percentage (36.04%), 88% increase in the quantity of viable seed after storage and benefit-cost ratio. Therefore, seed dressing with neem or mustard oil at 2ml/kg seed can be finally recommended from the present findings for safe storage of black gram for the purpose of food and seed under homestead conditions of Purulia district of West Bengal.

Keywords: *Callosobruchus* sp., plant oil, participatory research, *Vigna mungo*, West Bengal

Introduction

Black gram (*Vigna mungo* L.) is widely cultivated during May to September under the rainfed unbunded uplands (locally known as "*Tanr*") of Purulia (area of 2976 ha and productivity 444 kg/ha). The produces are stored for more or less eight months (October to May) and used for food and/or seed purpose. During storage it's affected by various stored grain pests including lesser grain borer, red flour beetle, grainary weevil and pulse beetle *Callosobruchus* sp. (Coleoptera: Chrysomelidae) under the homestead conditions. *Callosobruchus* sp. is the major stored grain pest of black gram, which leads to 15 – 30% grain damage, considerable weight loss during storage, reduces germination to a great extent. Infestation is caused by grubs as well as adults by means of boring grains, making holes and starts feeding until full damage (Ahmed et al. 2003, Michalaki et al. 2006). Damage of stored food grains is very serious problem throughout the globe both in static storage as well as transits due to lack of proper facilities and shortfall in grain protection strategies (Uppadhyay and Ahmad 2011). However, in the micro-level situation, farmers or farm women have gained knowledge to exploit natural resources, or to implement accessible methods, that would lead to a degree of population suppression of pests.

Traditional methods usually provide cheap and feasible ways to post-harvest handling of crops, but they have many limitations. Cleanliness and dryness in the storage facilities as well as stored products is the key feature for safe storage under homestead conditions. During storage traditional materials like inert dust or burnt cowdung ash, for example, in variable amount is added to the stored product that imposes frictional resistance of the particle against insect's cuticle leads to desiccation and hampers the development of pests (Golob 1997). Prophylactic treatment of *Vigna radiate* seeds with inert clay resulted in 100% adult mortality of *Callosobruchus chinensis* within 24 h. It provides effective protection up to 12 months of storage under ambient conditions (Babu et al. 1989). Similarly, Shaheen and Khaliq (2005) showed fly ash, turpentine oil and cow-dung ash as the best seed protectant materials against pulse beetle. Singal & Singh (1990) reported that the oils of groundnut, coconut, mustard, sesame, soybean and rapeseed used as surface protectants. Ali *et al.* (1983) studied efficacy of different oils viz., neem, rapeseed, coconut, mustard, mahua and palm against the eggs, grub, adults and on the egg laying. Khalequzzaman *et al.* (2007) recommended groundnut and palm oils against pulse beetle on red gram on the basis of complete prevention of adult emergence, minimum grain weight loss after storage and high acceptability to the consumers. Similarly, Bhardwaj and Verma (2012) and Sahoo and Chandrakar (2013) worked with various edible and/or non-edible vegetable oils against pulse beetle on chickpea and concluded that the neem and karanj oil performed significantly well over sunflower and coconut oil in terms of lower fecundity, shorter adult longevity, lower seed damage and lower seed weight loss. Various biological control agents against stored grain pests has been reported with various degree of efficacy, *viz*., *Metarrhizium anaisopliae* and *Beauveria bassiana* deserve mention as the commercial formulations of such bioagents are more or less available in the market (Radha 2012; Javed et al. 2012). *B. bassiana* is effective against various stored grain pests including pulse beetle causing white muscardine disease of their hosts (Campbell et al. 1985, Vanmathi et al. 2011, Junior et al. 2012). Most of the studies conducted under the *in vitro* condition, and obviously there was a need to refine these technologies by the actual stakeholders under homestead conditions. Therefore, the present demand driven participatory action research study was laid with the hypothesis that all the management approaches would perform significantly superior to traditional practices. The objectives of the study include (i) identification of the most ecofriendly and easily accessible technology based on farmers' acceptance, (ii) identification of such technology that can be used as seed protectant, (iii) identification of the technology resulted in the highest benefit:cost ratio (BCR).

Materials and Methods

The present investigation was conducted in the command area of Krishi Vigyan Kendra, Kalyan, Purulia, West Bengal (India). Among fifty adopted villages, ten villages (*viz.* Rahamda, Arjunjora, Sirkabad, Lakrakhonda, Simuduri, Jaspur, Madhubanpur, Padlara, Bandhgarh and Dumdumi) were randomly selected for the study and the selected village Farm Science Clubs were requested to select a household to conduct the experiment. The investigation was carried out during 2013 to 2015 in *rabi* and *summer* combined season under homestead and natural infestation condition in a completely randomised design with ten replication and five treatments including traditional practice. The treatment comprises, T1: Traditional Practice [clean storage in the earthen pitcher with an earthen cap to the open mouth of the pitcher, intermittent sun drying at 2-3 month interval]. T2: Application of commercial formulation of *Beauveria bassiana* @ 4 gKg^{-1} seeds, T3: Application of neem oil @ 2 $mlKg^{-1}$ seeds, T4: Application of mustard oil @ 2 $mlKg^{-1}$ seeds; T5: Application of commercial formulation of malathion 50EC @ 10 mlL^{-1} water on the both inner and outer wall surface of earthen storage pitcher but not on grain directly. Chemical insecticide treated pitcher was air dried before pouring the grains. The treated grains of black gram were poured into their respective pitchers with tagging of treatment details, dates etc. followed by covering the open mouth of pitcher with earthen plates. In all the cases clean grains were sundried for consecutive three days following the harvest and before treatment. The critical inputs like *B. bassiana* commercial formulation, Insecticide (malathion) was procured to the selected farm family while other inputs like black gram seed (10 kg for each treatment), earthen pitcher for storage, vegetable oils were supplied by the selected farm families. Vocational trainings were imparted to each selected farm family along with other members of village regarding the particulars of the technologies to be refined including procedure of treatments, etc. All the replications were periodically monitored and final data on grain damage percentage, germination percentage, grain weight loss etc. were taken after eight months of storage. The per cent weight loss was estimated in respect of initial weight of grain in each replication of all the treatments. Samples of 100g grain from each replication of all treatments was randomly drawn and divided in to six subsamples of 100 seed each, three subsamples were used for germination test and rest were used for enumeration of damage percentage. The germination percentage was determined using moist paper towel method (ISTA 2003), data were recorded after seven days of incubation in the room temperature and for the purpose of discretion a black gram seed was assumed to be germinated when cotyledon become separated. The percent seed damage was estimated by counting and weighting visibly damaged (grains with characteristic holes) grains (FAO 1985). The gross cost and gross return each treatments was determined on the basis of the then market price and quantity of the input used in the experiment and market price of black gram after eight month of storage, respectively. The BCR was enumerated through the ratio of gross return to gross cost.

Data obtained were statistically analysed by means of ANOVA using SPSS v.10 Statistical software. The estimate of discrimination among treatment effect size was determined using critical difference (CD) and Tukey's Honestly Significant Difference (HSD) Test at or above 95% level of significance.

Results and Discussion

Results of three years pooled data (Table 1) indicated that grain damage was its highest level (21.1%) in Traditional practice (T1) followed by chemical treatment of the storage pitcher surface, (T5) (13.43%) on the other hand performance of T2 (*B. bassiana*); T3 (neem oil) and T4 (mustard oil) were statistically at par and was the lowest ranging from 4.20 – 6.75%. In the cases of seed germination test, it was observed that treatment with *B. bassiana* may have some negative effect on seed germination (Table 1).

The treatment with neem oil resolute the highest germination percentage (84.57%) followed by mustard oil (83.02%) and was statistically at par. The present investigation has also demonstrated that weight loss during the storage directly proportional to grain damage (%) thereby indicate higher infestation results to higher grain weight loss during storage (Fig. 1).

Table 1.
Effect of various management approaches of pulse beetle on black gram in the storage under homestead and natural infestation condition

Treatments	**Grain Damage (%)**				**Germination Percentage after 8 month storage**				**Benefit Cost Ratio**
	2013-14	2014-15	2015-16	Pooled	2013-14	2014-15	2015-16	Pooled	
T1: Traditional Practice	22.49 (28.31)^{a}	12.5 (20.7)^{a}	28.31 (32.14)^{a}	21.1^{a}	58.26 (49.76)^{d}	55.6 (48.2)^{d}	49.76 (44.86)^{c}	54.54^{d}	1.71
T2: Commercial formulation of *Beauveria bassiana* @ 4 gKg^{-1} seeds.	1.58 (7.24)^{d}	3.8 (11.20)^{d}	7.24 (15.60)^{d}	4.20^{c}	82.19 (65.04)^{b}	81.2 (64.3)^{b}	65.04 (53.75)^{ab}	76.14^{b}	1.85
T3: Neem oil @ 2 $mlKg^{-1}$ seeds.	2.50 (9.10)^{cd}	2.00 (8.10)^{cd}	9.10 (17.55)^{cd}	4.53^{c}	91.09 (72.63)^{a}	90.0 (71.6)^{a}	72.63 (58.45)^{a}	84.57^{a}	1.86
T4: Mustard Oil @ 2 $mlKg^{-1}$ seeds.	4.37 (12.06)^{c}	3.63 (10.98)^{cd}	12.26 (20.50)^{c}	6.75^{c}	89.74 (71.32)	88.72 (70.38)	70.60 (57.17)^{a}	83.02^{ab}	1.90
T5: Malathion 50EC @ $10mlL^{-1}$ on the wall of storage facility but not on grain directly.	10.97 (19.34)^{b}	10.0 (18.4)^{b}	19.34 (26.08)	13.43^{b}	72.78c (58.55)^{a}	75.1 (60.1)^{a}	58.55 (49.92)^{b}	68.81^{c}	1.71
CD at 5% Level	2.96	2.88	2.95	2.93	6.92	6.65	6.84	6.80	-

N.B. All the figure depicted are the average of ten replications. Data in the parentheses are angular transformed data. Data bearing same alphabets are not significantly different at $p \leq 0.05$ level on the basis of Tukey's HSD Test.

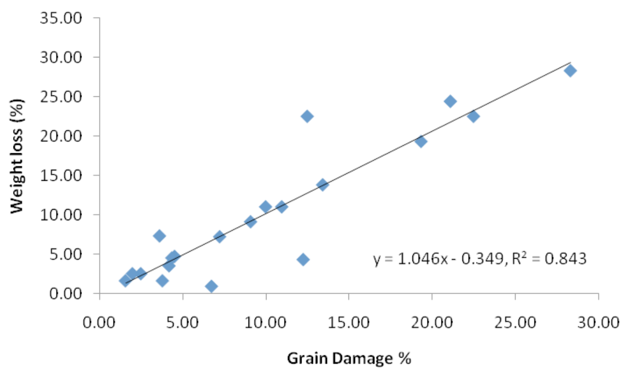

Fig 1. Relationship between grain damage (%) caused by *calobruchus* sp. and weight loss (%) during storage.

In terms of BCR analysis and readiness of the availability of technology product to village household treatment with mustard out yielded other treatments. Plant oils are well known seed protectants due to their anti-respirant, suffocating properties (Obeng-Ofori 1995) and reported to exert ovicidal action against insect pests of storage products (Don-Pedro 1989). It was also demonstrated that plant oil have the oviposition deterrence and repellent principle (Udo 2011). The results of the present investigation invariably corroborate the earlier findings carried out in the *in vitro* condition with an identical satisfactory level to the farmers. The lower grain damage was achieved due to less infestation, high adult mortality, less grub emergence (ovicidal/oviposition deterrence) and similar results also observed by Bhardwaj and Verma (2012); Sahoo and Chandrakar (2013) under *in vitro* condition.

The less germination percentage in other treatments including traditional practices was supported by the higher grain damage due to higher infestation. Therefore, the present investigation has unequivocally demonstrated that plant oils have no effect on germination percentage of the seeds which confirms non-adverse effect on grain chemistry and corroborated the findings of Udo (2011) under *in vitro* condition.

In conclusion, under the present micro-level situation, it can finally be recommended from the present assessment that seed dressing with neem or mustard oil each at 2ml/kg seed can be used for safe storage of blackgram for both food and seed purpose under homestead condition. Both this plant-oils are readily available to the village households and are practically feasible and economically viable option to prevent the pulse beetle damage in the homestead storage in terms of the lowest infestation of pulse beetle, germination percentage, and BCR. The *B. bassiana* treatment, although performed well during the course of investigation but not recommended due to commercial unavailability in the vicinity of village households, besides, as indicated in the present study, some short of germination hindrance with this treatments. Further, investigation regarding the germination hindrance with bio-control agents treatment of storage product and its viable management may be of research worth for future study. The common feedback from the farmers of study village indicated the acceptability of plant oil based protection of storage product under homestead condition and wide horizontal spread of the technology is expected in the due course of time.

Literature Cited

Ahmed KS Itino T Ichikawa T 2003. Duration of developmental stages of *Callosobruchus chinensis* L. (Coleoptera:Bruchidae) on azukibean and the effects of neem and sesame oils at different stages of their development. *Pakistan Journal of Biological Science* **6**: 932-35.

Ali SI Singh OP Mishra US 1983. Effectiveness of plant oils against pulse beetle, *Callosobruchus chinensis* Linn. *Indian Journal of Entomology* **45**(1): 6-9.

Babu TR Reddy VS Hussaini SH 1989. Effect of edible and non-edible oils on the development of the pulse beetle (*Callosobruchus chinensis* L.) and on viability and yield of mungbean (*Vigna radiata* [L.] Wilcezek). *Tropical Science* **29**: 215-20.

Bhardwaj A Verma SC 2012. Evaluation of vegetable oils against pulse beetle, *Callosobruchus chinensis* (Coleoptera: Bruchidae) infesting pea seed (*Pisum sativum* L.). *Pest Management in Horticultural Ecosystem* **18**(1): 46-53.

Campbell RR Anderson TE Semel M Roberts DW 1985. Management of the Colorado potato beetle using *Beauveria bassiana*. *American Journal of Potato Research* **61**: 29-37.

Don-Pedro KN. 1989 Effect of fixed vegetable oils on oviposition and adult mortality of *Callosobruchus maculatus* (F.) on cowpea. *International Pest Con-*

trol **31**(2): 34-37.

FAO. 1985 *Prevention of post harvest food losses.* Training series No. 10 (122). Food and Agriculture Organization of the United Nations, Rome, Italy. 120 pp.

Golob P. 1997 Current status and future perspectives for inert dusts for control of stored product insects. *Journal of Stored Products Research* **33**: 69-79.

ISTA. 2003 *International rules for seed testing*, 2003 (Ed Draper SR) Zurich, Switzerland, ISTA, pp 121.

Javed S Srijan A Viswamitra V. 2012 Management strategies of pulse beetle through eco-friendly methods in various legume genotypes – A Review. *International Journal of Pure & Applied Bioscience* **2**(4):196-02.

Junior FBDP Guarana CFR Paz ESL Queiroz CFDe João L. 2012 Laboratory evaluation of *Beauveria bassiana* (Bals.) Vuill. isolates to control the *Callosobruchus maculatus* L. (Coleoptera: Bruchidae) in cowpea grains. *African Journal of Microbiological Research* **6**(47): 7365-69.

Khalequzzaman M Mahdi SHA Osman Goni SHM. 2007 Efficacy of edible oils in the control of pulse beetle, *Callosobruchus chinenesis* L. in stored pigeonpea. *University Journal of Zoology, Rajshahi University* **26**: 89-92.

Michalaki MP Athanassiou CG Kavallieratos NG Kavallieratos YA Balotis GN. 2006 Effectiveness of *Metarrhizium anisopliae* applied alone or in combination with diatomaceous earth against *Tribolium confusum* Du Val larvae: Influence of temperature, relative humidity and type of commodity. *Crop Protection* **25**: 418-25.

Obeng-Ofori D. 1995 Plant oils as grain protectants against infestations of *Cryptolestes pusillus* and *Rhyzopertha dominica* in stored grain. *Entomologia Experimentalis et Applicata* **77**: 133-39.

Radha R. 2012 Insecticidal efficacy of entomopathogenic fungi in stored cowpea against cowpea bruchid, *Callosobruchus maculatus* L. (Coleoptera: Bruchidae). *Asian Academic Research Journal of Multidisciplinary* **1**(3): 201-02.

Sahoo AK Chandrakar HK. 2013 Efficacy of edible and nonedible oils against pulse beetle *Callosobruchus chinensis* L. in stored chickpea. *International Journal of Plant Protection* **6**(2) : 299-03.

Shaheen FA Khali q A. 2005 Management of Pulse Beetle, Callosobruchus chinensis L. (Coleoptera: Bruchidae) in stored chickpea using ashes, red soil powder and turpentine oil. *Pakistan Journal of Entomology* **27**(2):19-24.

Singal SK Singh Z. 1990 Studies of plant oils as surface protectants against pulse beetle, *Callosobruchus chinensis* L. in chickpea, *Cicer arietinum* (L.) in India. *Tropical Pest Management* **36**(3): 314-16.

Udo IO. 2011 Protectant effects of plant oils against cowpea weevil (*Callosobruchus maculatus*) on stored cowpea (*Vigna unguiculata*). *Asian Research Publishing Network Journal of Agricultural & Biological Science* **6**(12): 58-61.

Uppadhyay RK Ahmad S. 2011 Management Strategies for control of stored grain insect pests in farmer stores and public ware house. *World Journal of Agricultural Sciences* **7**(5): 527-49.

Vanmathi JS Latha CP Singh AJAR. 2011 Impact of entomopathogenic fungus, *Beauveria bassiana* on stored grains pest, *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae). *Journal of Biopesticide* **4**(2): 194-97.