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Evaluation of Certain inert materials against pulse beetle, *Callosobruchus chinensis* (L.) infesting stored Chickpea [*Cicer arietinum* (L.)]

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ABSTRACT

A laboratory experiment was conducted with five main treatments, *viz.*; wheat husk, saw dust, sand and dung cake ash with 6 cm covering of each treatment. On the basis of adult emergence, among all the treatments, dung cake ash was most effective and wheat husk and saw dust was least effective when compared with control after 160 days of storage. All the seed protectants treatments resulted in significantly lesser number of eggs/500 seeds as compared to untreated control after 1, 50, 110 and 160 days of storage. On the basis of number of adult emerged/1000 seeds and per cent seed damage, all the seed protectants *viz.*, saw dust, sand and dung cake ash were highly effective as compare to untreated control except wheat husk. There were no adult emergence and per cent seed damage recorded up to 160 days of storage except wheat husk. After 160 days of storage, maximum abnormal seedlings were observed in sand i.e. 8.21 per cent and minimum (5.23 %) abnormal seedlings were recorded in wheat husk. Minimum seed viability (88.21 %) was recorded in saw dust while maximum seed viability (94.10 %) was recorded in wheat husk treatment. The vigour index was maximum (984.67) in seeds treated with sand and minimum (811.36) in seeds treated with wheat husk followed by dung cake ash i.e. 856.39. The root length and shoot length were not affected by any seed protectants, significantly.

Key words: *Callosobruchus chinensis*, Chickpea, Inert material

INTRODUCTION

Chickpea [*Cicer arietinum* (L.)] is a highly nutritious pulse cultivated throughout the world and is placed third in the importance list of the food legumes. India is one of the major pulse growing countries in the world with a total area of 23.28 million hectares and a total production of 14.566 million tonnes (Anonymous, 2011). It contains 38-59 per cent carbohydrates and 25.3-28.9 per cent proteins, which is the maximum provided by any pulse (Hulse, 1991) and does not contain any specific major anti-nutritional factor.

Insect pests have been a threat to food and seed since man has started growing crops. Among the insect-pests, bruchids are well known to inflict post-harvest loss to stored legumes; primarily through consumption of the resource, and secondarily through the qualitative deterioration of the commodity or reduced seed stock viability (Salunkhe *et al.*, 1985). The insect invasion causes reduction in weight, market value and germination of chickpea seeds (IITA, 1989). The problem of residues resulting from mixing of synthetic organic pesticides with pulses beyond the permissible tolerance levels for control of beetle infestation has forced the researchers to look for some non-toxic pulse protectants. Although chemical insecticides, like fumigants and dusts are effective for the control of Bruchids, but it is not applicable at farm level because farmer's storage structures are not air tight. It is also not safe to mix insecticides with food grains for protection against insects (Bekele *et al.*, 1995). Through the pesticides have positive effect on the pests, they continued to remain hazardous to man and the environment. With the objective of providing quality food for general public the interest of researches have been directed towards finding alternative to pesticides that are environmentally friendly and does not pose dangers

to man. Therefore, this study was carried out to evaluate the efficacy of locally available some inert materials for the management of pulse beetle, *Callosobruchus chinensis* L. in stored chickpea.

MATERIALS AND METHODS

A laboratory experiment was conducted in completely randomized block design with five main treatments under Institute of Basic and Applied Science, Shillong. The seed material was examined and defective, unhealthy and undeveloped seed were removed. Wheat husk, Saw dust, Sand and Dung cake ash with 6 cm covering of each treatment, were mixed with Chickpea seeds (var. HC-3) in jar (2 kg capacity) and untreated seeds were taken as control. There were a total of five treatments replicated thrice. For the first experiment, the 500 treated seeds were kept in plastic jar under normal storage conditions. Five pairs of freshly emerged pulse beetle (0-24hrs old) were released in each plastic jar. Adult mortality and number of eggs laid by the pulse beetles was recorded at 1, 50, 110 and 160 days after exposure of storage. Ten pairs of freshly emerged pulse beetle (0-24hrs old) were released in each jar for Table 2 experiment. Number of adults emerged and per cent seed damaged were recorded at 50, 110 and 160 days after storage by drawing a sample of about 1000 seeds randomly from each replication. After 160 days of storage, 100 seeds of each treatment were kept 'Between the paper' (BP) at 25±1°C temperature (ISTA, 1985). All the treatments were replicated thrice. On the 7th day after start of the test, the paper towels were opened to record the standard germination (%), abnormal seedling (%), dead seed (%), hard seed (%), seed viability and vigour index. Five normal seedlings were selected randomly from each replication at the end of germination test. Shoot length and root length of each of the five seedlings was measured and recorded in cm and average seedling length was calculated. The statistical analysis was done as per procedure suggested by Singh (2003).

RESULTS AND DISCUSSION

Adult mortality: The data presented in Table 1 showed that after one day of storage dung cake ash gave 92.33 per cent adult mortality of beetles followed by wheat husk (12.23%). After 50 days of storage, maximum adult mortality (64.06 %) was

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observed in dung cake ash treatment followed by wheat husk (10.00%). After 110 days of storage, effectiveness of all the treatments reduced sharply except dung cake ash. Maximum (40 %) adult mortality was recorded in dung cake ash and minimum i.e. zero per cent in saw dust, which was similar to untreated (control). After 160 days of storage, maximum (94.66 %) adult mortality was observed in dung cake ash followed by Sand i.e. 16.66 per cent. The results of present studies indicated that, on the basis of adult mortality up to 160 days of storage dung cake ash was the most effective treatment, while wheat husk and saw dust were the least effective treatment, when compared with the control, this could be due to the fact that these treatments had less air suffocation as compared to ash. Similar results were observed by Mathur *et al.* (1985) who reported 79.54 per cent adult mortality of *C. chinensis* (L.) in black gram seeds treated with ash @ 1.65 per cent (w/w) after 5 days of treatment. The results obtained in treatment of seeds with 6 cm covering of saw dust, sand and dung cake ash also corroborate the earlier findings of Subhash *et al.* (2007). Kittur (1990) found cow dung ash and sand to be good in controlling *C. chinensis* activities in redgram seeds. Jagjeet *et al.* (2005) reported that 4 cm covering with each of sand, dung cake ash, saw dust and wheat husk, when mixed with half kg of seed recorded significant adult mortality of *C. maculates* in pigeon pea seeds. Tabu *et al.* (2012) reported that sand and wood ash at the dosage of 90g kg $^{-1}$ caused 66.67 and 70 per cent adult mortality, respectively. This difference could be due to the environmental conditions and other factors under which the experiment was conducted.

Number of eggs: Chickpea seeds treated with all the seed protectants resulted in significantly lesser number of eggs laid by *C. chinensis* as compared to control, when observed at 1, 50, 110 and 160 days after storage (Table 1). After one day of storage, the number of eggs laid by 5 females ranged from 0 to 53.00 eggs/500 seeds in different treatments as compared to 161.02 eggs in untreated (control) seeds. After 50 days of storage, the same trend was observed as after one day of treatment. Among all seed protectants, maximum (64.66 eggs/500 seeds) eggs were observed in wheat husk and minimum (0 egg/500 seeds) eggs were recorded in saw dust, sand and dung cake ash. After 110 days of storage, among the seed protectants the number of eggs laids ranged from 0 to 77.00/500 seeds. After 160 days of storage, among the seed protectants, minimum (0 egg/500 seeds) eggs were observed on chickpea seeds covered with saw dust, sand and dung cake ash and maximum numbers of eggs were recorded in wheat husk i.e. 87.00 eggs/500 seeds. The result of present study indicate that on the basis of number of eggs laid/5 females, seed treatment with saw dust, sand and dung cake ash were equally effective throughout the storage period of 160 days. While wheat husk treatment was least effective. The results are in harmony with those of Misra (2000), who showed that there was no egg lying by *C. chinensis* on stored black gram seeds treated with 3 per cent cow dung ash powder. The present results in respect of dung cake ash are also similar with those of Chiranjeevi and Sudhakar (1996) and Chaudhary and Pathak (1989) who reported no egg laying by *C. chinensis* in checkpea seeds with 2 cm and 3 cm thick layer. Tabu *et al.* (2012) reported that sand and wood ash induced significant reduction in oviposition by *C. chinensis* when compared to the untreated check. Regarding the tested inert material (wood ash and sand), as it was mentioned above they are significantly better than that of the untreated check in reducing oviposition. It has been suggested by Adane and Abraham (1996) free movements of the adults for oviposition in prevented by the ash filling in the inter-granular space as a result of this, egg lying and larval development of the beetles could be hampered and they also forced to deposit their entire stock of eggs on relatively few grain kernels or beans. Adugna *et al.* (2003) also reported that the ash dust that reduces the relative humidity of the storage condition could also dry the grain surface as a result of this, egg lying and larval development of the beetles could be hampered.

Number of adult emerged: Chickpea seeds treated with saw dust, sand and dung cake ash had no adult emergence after 50, 110 and 160 days of storage and these treatments proved significantly superior than remaining treatments (Table 2). After 50 days of storage, maximum numbers of adult emergence were recorded in wheat husk i.e. 31.00 adults/1000 seeds, while in untreated seeds were 56.00 adults/1000 seeds. After 110 days of storage, amongst the different seed protectants, the number of adult emerged ranged from 0 to 82.00. After 160 days of storage, wheat husk treated seeds recorded (2187 adults/1000 seeds) adults emerged as compared to untreated seeds (5967 adults /1000 seeds). The results of the present studies revealed that treatments with different seed protectants except wheat husk imposed complete check on adult emergence of *C. chinensis* (L.). The results of the present study in respect of sandy soil are similar with those of Ramangoudar *et al.* (2000) who reported that no adults of *C. chinensis* emerged when horse gram (*Macrotyloma uniflorum* Lam. verde) seeds were treated with sandy soil as 2.5 cm thick layer over seeds after 4 months of treatments. Number of adults emerged from chickpea seeds treated with sand (6 cm covering) are similar to those of Choudhary and Pathak (1989) who reported no adult emergence with sand top layer of 2 cm and 3 cm thickness against *C. chinensis*. Kittur (1990) reported that zero per cent adult emergence of *C. chinensis* was observed when red gram seeds treated with cow dung ash @ 30 per cent. Tabu *et al.* (2012) reported that the treatments of ash and sand caused more than 90 per cent reduction in F1 progeny and less production of *C. chinensis*. The reduction in adult emergence could either be due to the larval mortality or reduction in the hatching of the eggs. It has been reported by Jilani *et al.* (1988) that the larvae which hatch from the eggs of *Callosobruchus* species must penetrate the seeds to survive. However, the larvae are unable to do so unless the eggs are firmly attached to the seed surface. Giga *et al.* (1992) reported the efficacy of inert dusts in reducing adult emergence in the parts of Uganda and Tanzania and confirmed that farmers who were admixing fine sand, clay dust or wood ashes with their common beans hindered the activities of newly hatched adults.

Seed damage: The data given in Table 2 showed that all the seed protectants were effective and resulted in significantly lesser seed damage at all the storage interval of 50, 110 and 160 days after treatments, when compared with untreated control. Treatments with saw dust, sand and dung cake ash recorded no seed damage after 50, 110 and 160 days of storage. After 50 days of storage,

maximum (1.62 %) seed damaged was recorded in seed treated with wheat husk as compared to seed damaged (3.08 %) in untreated control. After 110 days of storage, amongst the seed protectants treatments, maximum (5.07 %) seed damage was recorded in seed covered with wheat husk as compare to untreated seeds (6.80 %). Remaining treatments showed zero per cent seed damage. After 160 days of storage, the seed damage percentage of wheat husk treatments and untreated seeds increased drastically. However, among the treatments, maximum seed damage percentage was observed in wheat husk i.e. 78.11 per cent whereas; in untreated seeds it was 92.32 per cent. The results of present study indicate that after 160 days of storage all the treatments with different seed protectants resulted in reduced seed damage caused by *C. chinensis* (L.) effectively as compared to untreated control. The present finding in respect of sand, are in confirmity with Chaudhary and Pathak (1989) and Ramangoudar *et al.* (2000). Chiranjeevi (1991) reported that cow dung ash @ 1-2 parts per 100 parts of green gram seed (w/w) was most effective in reducing percentage of damage by *C. chinensis*. Misra (2000) reported cow dung ash @ 3 per cent recorded 0.00 per cent damage and weight loss up to 5 months of storage period. Subhash *et al.* (2007) reported that there were no adult emergence and seed damage due to *C. chinensis* (L.) after 105 days of storage when green gram seeds treated with 7 cm covering with dung cake ash. Tabu *et al.* (2012) reported that the minimum seed damage of 0.66 per cent in wood ash, at 90g kg^{-1} whereas in the untreated check, the maximum seed damage recorded was 17.5 per cent. Adugna (2006) observed that untreated check (control) had significantly higher grain damage, weight loss and lower grain germination. On the other hand ash treated grains of chickpea had significantly lower insect population with lower grain damage and germination loss than the other treatment. Khaire (1992) reported that mixing ash with grain makes the entry of insects in grain a difficult task and causes physical and physiological injuries to the insects. Besides, ash is a fine powder chemically inactive but with insecticidal power. The ash dust that reduces the relative humidity of the storage condition could also dry the grain surface. Egg laying and larval development of the beetles could be hampered because ash dust covers the grain seeds.

Germination: The results of present studies (Table 3) on germination showed that after 160 days of storage, chickpea seeds covered with different inert materials had no harmful effects on germination as compared to untreated control. Amongst the different seed protectants treatments, the germination ranged from 86.26 to 92.04 per cent. Maximum (92.04 %) germination in chickpea seeds was found in treatment of wheat husk and it was at par with dung cake ash with 90.76 per cent, sand (89.86%) and the control (92.04 %). The minimum (86.26 %) germination was observed in chickpea seeds treated with saw dust. The present results in respect of cow dung ash are in confirmity with Chiranjeevi (1991); Misra (2000) and Hampanna *et al.* (2006) reported that cow dung ash when treated to chickpea seeds recorded maximum germination percentage against *C. chinensis* for the period of six months. Adugna (2006) reported that the germination of control, sand and ash treatment were very high in the first month count ranging from 86 to over 96 per cent. Ash had significantly high germination as compare to sand treated chickpea seeds. Gurdannavar and Desphande (2006) reported ash (30%) reduced the population of *C. chinensis* without adversely affecting the seed quality parameters *viz.*, germination per cent and vigour index. Tabu *et al.* (2012) reported that the chickpea seed cover with inert material (ash and sand) did not show any adverse effect on germination of seeds 90 days after treatment.

Abnormal seedling: The data presented in Table 3 on abnormal seedling showed that amongst different seed protectants sand and dung cake ash had significantly higher abnormal seedlings i.e. 8.21 and 8.02 per cent, respectively, as compared to other treatments and untreated seeds (5.23 %). The minimum (5.23 %) percentages of abnormal seedlings were observed in wheat husk, which is similar to untreated seeds germination. The results of present studies were similar to the findings of Subhash *et al.* (2007) who reported that all indigenous products did not have any significant effect on abnormal seedling (%) after 105 days of storage. Minimum (0.33%) abnormal seedlings were in saw dust and wheat husk with each 7 cm covering of green gram seeds.

Dead seed: The different seed protectants had no significant effect on per cent dead seeds as compared to control except those treated with saw dust at 160 days after storage (Table 3). Minimum dead seeds (0 %) were observed in dung cake ash and it was at par with wheat husk (0.54 %) and sand (1.00 %). Maximum (4.25 %) dead seeds were recorded in saw dust which was significantly higher than untreated seeds had 2.02 per cent dead seeds. Results are confirmity with Subhash *et al.* (2007) also reported that the seed treatment with different grain protectants did not significantly affect the per cent dead seed of green gram after 105 days of storage.

Hard seed: Chickpea seeds covered with different inert materials had no significant effect on percentage of hard seeds except wheat husk as compared to untreated seeds (Table 3). Maximum (1.22 %) hard seeds were recorded in wheat husk followed by 0.66 per cent hard seeds in saw dust. Remaining all other treatments along with untreated seeds had minimum (0.0 %) percentage of hard seeds. Subhash *et al.* (2007) reported that saw dust and wheat husk (7 cm covering) each had 0.33 per cent hard seeds in green gram which was at par with the untreated control.

Seed viability: After 160 days of storage, chickpea seeds treated with different seed protectants, except saw dust had no significant effects on per cent seed viability as compared to untreated seeds (Table 4). The maximum (94.10 %) seed viability was recorded in wheat husk and minimum (88.21 %) seed viability was observed in chickpea seeds treated with saw dust which is at par with sand (89.96 %). The results of present study are in confirmity with Subhash *et al.* (2007) who reported maximum seed viability (99.67%) in saw dust and wheat husk (7 cm covering each) treatments in green gram seeds.

Seedling vigour index: The maximum (984.67) seedling vigour index was recorded in the seeds treated with sand followed by saw dust (892.21).The seedling vigour index recorded in untreated seeds was 883.12. The minimum (811.36) seedling vigour index was observed in wheat husk (Table 4). The results of present study showed that seed treated with sand and saw dust had higher seedling vigour index as compared to control. Gundannavar and Desphande (2006) reported ash (30%) reduced the population of

C.chinensis without affecting the seed quality parameters *viz.*, germination and vigour index. Subhash *et al.* (2007) also reported that the seed treated with saw dust, wheat husk and dung cake ash had higher vigour index as compare to control in green gram seeds.

Seedling root length: After 160 days of storage interval seeds treated with different seed protectants had no adverse effect on the seedling root length, however, the maximum seedling root length was recorded in chickpea seeds treated with sand (13.19 cm) followed by saw dust (12.76 cm) and the minimum seedling root length was recorded in chickpea seeds treated with wheat husk (9.92 cm) followed by dung cake ash (11.22 cm), whereas, in untreated seeds seedling root length was 11.00 cm (Table 4). The results of present studies indicate that chickpea seeds covered with different inert materials had no significant effect on seedling root length as compared to control. Subhash *et al.* (2007) also reported that green gram seeds treated with indigenous protectants had no significant effects on seedling root length as compare to control.

Seedling shoot length: The results presented in Table 4 showed that after 160 days of storage chickpea seeds treated with different seed protectants had no significant effect on seedling shoot length as compared to untreated seeds. The minimum (7.40 cm) seedling shoot length was recorded in dung cake ash followed by saw dust (7.41 cm). Maximum (8.59 cm) seedling shoot length was recorded in chickpea seeds treated with sand. The seedling shoot length of untreated seeds was 7.66 cm, which was at par with wheat husk (7.43 cm). The results of present studies revealed that chickpea seeds treated with seed protectants enhanced the seedling shoot length except in wheat husk, dung cake ash and saw dust when compared to untreated seeds. The results of present studies are in line with the findings of Subhash *et al.* (2007) who observed that green gram seeds treated with indigenous protectants enhanced seedling shoot length when compared to untreated control.

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Table 1. Efficacy of seed protectants on mortality and fecundity of pulse beetle, *Callosobruchus chinensis* (L.) on chickpea, *Cicer arietinum* (L.) seeds at different storage intervals

Treatment & Doses	Per cent Adult mortality (DAS)*				Average no. of eggs laid by 5 pairs/500 seeds (DAS)*			
	1	50	110	160	1	50	110	160
Wheat husk 6 cm covering	12.23 (18.66)	10.00 (15.26)	6.66 (12.55)	10.00 (15.26)	53.00 (7.33)	64.66 (8.08)	77.00 (8.83)	87.00 (9.37)
Saw dust 6 cm covering	3.33 (6.68)	6.66 (9.39)	0.00 (1.00)	10.00 (18.42)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
Sand 6 cm covering	10.00 (15.26)	6.66 (9.39)	3.33 (6.68)	16.66 (15.53)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
Dung cake ash 6 cm covering	92.33 (74.19)	64.06 (59.12)	40.00 (39.13)	94.66 (78.38)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
Control (untreated)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	6.66 (9.39)	161.02 (12.54)	163.00 (12.70)	159.33 (12.51)	171.02 (13.04)
SE (m)	(6.98)	(5.16)	(3.26)	(6.68)	(0.29)	(0.29)	(0.20)	(0.16)
CD at 5 % level	(20.49)	(15.14)	(9.58)	(19.63)	(0.86)	(0.86)	(0.61)	(0.47)

*DAS = Days after storage

Figures in the parenthesis are √n+1 transformed values

Table 2. Efficacy of seed protectants on adult emergence and per cent seed damage by *Callosobruchus chinensis* (L.) on chickpea, *Cicer arietinum* (L.) seeds at different storage intervals.

Treatment & Doses	Average no. of adults emerged/ 1000 seeds (DAS)*			Per cent Seed damage (DAS)*		
	50	**110**	**160**	**50**	**110**	**160**
Wheat husk 6 cm covering	31.00 (5.55)	82.00 (8.83)	2187.00 (44.86)	1.62 (22.15)	5.07 (42.65)	78.11 (61.80)
Saw dust 6 cm covering	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
Sand 6 cm covering	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
Dung cake ash 6 cm covering	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
Control (untreated)	56.00 (7.74)	104.98 (11.88)	5967.00 (76.78)	3.08 (31.75)	6.80 (55.84)	92.32 (79.87)
SE (m)	(0.19)	(0.12)	(1.29)	(1.12)	(1.16)	(0.39)
CD at 5 % level	(0.57)	(0.36)	(3.78)	(3.30)	(3.42)	(1.15)

*DAS = Days after storage

Figures in the parenthesis are √n+1 transformed values

Table 3. Effect of seed protectants on Standard germination, abnormal seedlings, dead seeds and hard seeds of chickpea, *Cicer arietinum* (L.) seeds at 160 days after storage

Treatment & Doses	Standard germination (%)	Abnormal seedling (%)	Dead seed (%)	Hard seed (%)
Wheat husk 6 cm covering	92.04	5.23	0.54	1.22
	(74.00)	(12.66)	(2.65)	(5.21)
Saw dust 6 cm covering	86.26	6.78	4.25	0.66
	(68.32)	(14.69)	(11.47)	(5.24)
Sand 6 cm covering	89.86	8.21	1.00	0.00
	(71.54)	(16.20)	(4.89)	(1.00)
Dung cake ash 6 cm covering	90.76	8.02	0.00	0.00
	(72.42)	(15.83)	(1.00)	(1.00)
Control (untreated)	92.04	5.23	2.02	0.00
	(74.00)	(12.91)	(6.89)	(1.00)
SE (m)	(1.19)	(1.21)	(1.98)	(1.39)
CD at 5 % level	(3.50)	(3.57)	(5.83)	(4.10)

Figures in the parenthesis are √n+1 transformed values

Table 4. Effect of seed protectants on seed viability, vigour index, average root length and shoot length of chickpea, *Cicer arietinum* (L.) seeds at 160 days after storage

Treatment & Doses	Seed viability (%)	Seedling Vigour index	Root length (cm)	Shoot length (cm)
Wheat husk 6 cm covering	94.10 (76.46)	811.36 (28.33)	9.92	7.43
Saw dust 6 cm covering	88.21 (69.97)	892.21 (29.78)	12.76	7.41
Sand 6 cm covering	89.96 (71.62)	984.67 (31.33)	13.19	8.59
Dung cake ash 6 cm covering	90.22 (71.98)	856.39 (29.22)	11.22	7.40
Control (untreated)	92.26 (73.96)	883.12 (29.71)	11.00	7.66
SE (m)	(1.34)	(0.83)	(0.76)	(0.49)
CD at 5 % level	(3.93)	(2.44)	NS	NS

Figures in the parenthesis are √n+1 transformed values