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RESEARCH ARTICLE

STUDY OF PULSE BEETLE *Callosobruchus analish & chinensis* IN STORED *Cicer aritenium* USING CHEPLY PRODUCTS

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ABSTRACT

Fly ash, cow-dung ash, acacia bark ash, red soil powder and turpentine oil as post harvest grain protectants were tested for their insecticidal potency against pulse beetle (PB), attacking stored chickpea. The results revealed that fly ash at its application rate of 1.0 g per 50 g of grains showed the minimum days (5.06) to 100% mortality of released adults, minimum fecundity (0.86 eggs per grain), minimum holes (0.41 per grain), lowest number (3.14) of F_1 adults emerged, maximum inhibition (78.62%) of F_1 adults, minimum weight loss (9.63%) and the minimum of 2.86 days to 100% mortality of F_1 adults. Fly ash and turpentine oil were the most effective at all application rates compared to other materials and the control. However, fly ash proved to be the best in managing PB infestation to lower levels followed by turpentine oil and cow-dung ash while red soil powder and Kikar (*Acacia nilotica*) ash were less effective and were similar to the control at their lower application rates.

INTRODUCTION

The cultivation of pulses also helps to maintain and restore soil fertility. It is a matter of pride that India tops the list among the pulse producing countries of the world with about 15.04 million tonnes of pulses being produced in 2004-05 (India, 2006) inspite of the average quite low productivity.It is attacked by several insect pests including pulse beetle (PB), *Callosobruchus chinensis* L., as its destructive and major pest in storage (Ahmed *et al*. 2003). Gujar and Yadav (1978) reported 55-60% loss in seed weight and 45.50-66.30% loss in protein content due to its damage and pulse seeds became unfit for human consumption as well as for planting. At present, pest control measures in storage rely on the use of synthetic insecticides and fumigants, which is the quickest and surest method of pest control but it is also not advised to mix the insecticides with food grains. Their indiscriminate use in the storage, however, has led to a number of problems including insect resistance, toxic residues in food grains (Fishwick, 1988), environmental pollution (WMO, 1995) and increasing costs of application. In view of these problems together with the upcoming WTO regulations, there is a need to restrict their use globally and implement safe alternatives of conventional insecticides and fumigants to protect stored grains from insect infestations (Yusof and Ho, 1992; Subramanyam and Hagstrum, 1995).

The use of fly ash has been reported for post-harvest preservation/protection of five commonly used pulses including chickpea from infestations of PB for 18 months. No adult PB was found in pulses treated with fly ash even after 12 months of treatment. After 18 months of storage, chickpea was the most infested both in terms of number of insects observed in gunny bags and percent damaged grains. Percentage insect damaged grains were directly proportional to the number of insects observed in gunny bags. There was no effect of fly ash on the nutritional quality and percent germination of pulses (Mendki *et al.* 2001). Misra, 2000 compared ten different types of plant powders with local treatments of red soil powder, cow-dung ash powder and mustard oil coating for their effect against PB. Among local treatments, only cow-dung ash and mustard oil completely inhibited oviposition. In studies by Singal and Chauhan (1997), coal ash and soft stone were ineffective against PB when mixed in stored grains while according to Sharvale and Borikar (1998), the application of castor oil in grains was more effective than ash and neem leaves. Dhakshinamoorthy and Selvanarayanan (2002) tested the effect of dried leaf powders of neem, nochi, pungam, citrus and thulasi against PB attacking stored grains whereas fly ash, kitchen ash, castor oil, red earth and malathion (as standard control) were also used. The present studies were undertaken to evaluate the insecticidal potency of fly ash, cow-dung ash, acacia bark ash, red soil powder and turpentine oil against PB in stored grains of chickpea cultivar CM-2000.

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MATERIALS AND METHODS

The infested samples of stored chickpea by PB were collected from different villages, institutes, stores, godowns and research stations. The PB culture was maintained in the incubator, at constant temperature of 30±2 ^{o}C and 70±5% relative humidity, in the Department of Entomology, IBAS, Sikar (Raj.).The effect of certain ashes i.e. fly ash (one of the major industrial wastes, generated as a result of coal burning in thermal power stations), Kikar ash (*Acacia nilotica*) as plant source, cow-dung ash (animal source), red soil powder and turpentine oil were evaluated by treating 50 g of CM-2000 grains in each plastic jar with their application rates of 1.0 g, 0.5 g and 0.25 g; however, for turpentine oil, the same rates were in ml. The grains of chickpea cultivar (CSJ-104) were obtained from National Coordinated Program (Pulses) of National Agriculture Research Station, Sikar and were subjected to fumigation using Agtoxin following Riaz *et al*. (2000) for two weeks, to kill any insect pest already existing in the grains. Ten pairs of adult PB were released in each jar following Halstead (1963). The mouth of jars was covered with muslin cloth and secured by rim of lid to disallow the entry or exit of any insect and were then placed in the incubator at a temperature of 30 ± 2 °C and 70±5% relative humidity. The effectiveness of these materials as post harvest grain protectants was determined and compared with the un-treated grains in terms of parameters given below:

1. Days to 100 % mortality of released PB

Days to 100 % mortality of released (old) PB were counted to determine the effect of treatments on the life span of its adults.

2. Number of eggs

Average number of eggs per grain laid by PB was calculated to check the effect of treatments on its oviposition/fecundity. Ten grains were randomly selected from each replication and eggs laid on those grains were counted. At the end, their average was calculated to determine number of eggs per grain in each jar.

3. Number of holes

Average number of holes per grain was calculated by counting the number of holes made by PB. For this, ten grains were randomly selected in each jar and number of holes on those grains was counted. Then average was taken to determine number of holes per grain in each replication.

4. Number of F_1 adults emerged

Number of F_1 (fresh emerged) adults in each jar was calculated to see the inhibition of PB emergence by different treatments
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5. Percent inhibition rate (% IR)

Percentage reduction in emergence of F_1 adults or inhibition rate was calculated by using the following formula:

$$\% \text{ IR} = (C_n - T_n) / C_n \times 100$$

Where

C_n = Number of newly emerged adults in untreated jar (control)

T_n = Number of newly emerged adults in treated jar

6. Days to 100 % mortality of F_1 emerged PB

Days to 100 % mortality of F_1 PB were also counted to determine the effect of treatments on fresh emerged generation.

7. Weight loss (%)

The percent weight loss was calculated at the end of experiment by using the following formula:

$$\text{Weight loss (\%)} = \frac{(A - B)}{A} \times 100$$

Where A = initial weight
B = weight of sound & damaged grains)
Data were recorded on weekly basis up to 100% mortality of F_1 generation.
The data recorded were subjected to statistical analysis as Two Factor Completely Randomized Design (CRD) using MSTAT-C and SPSS 12.0 for Windows programs. Duncan's Multiple Range Test (DMRT) was applied to all the means. Moreover, the graphical work was done using Microsoft Excel program.

RESULTS

1. Days to 100 % mortality of released PB

It could be seen in Table 1 that fly ash showed the minimum days of 5.06, 5.63 and 6.64 to 100% mortality at its application rates of 1.0, 0.5 and 0.25 g, respectively, which were significantly better compared to cow-dung ash, acacia bark ash, red soil powder and turpentine oil at their all application rates. Turpentine oil at 1.0 ml was statistically alike with fly ash, whereas, its applications at 0.5 and 0.25 ml were also statistically better than all the other treatments. Fly ash provided strong effectiveness at its all application rates followed by turpentine oil, cow-dung ash, acacia bark ash and red soil powder. All the materials were significantly better than control except red soil powder at 0.25 g, which depicted the maximum days (21.91) to mortality even higher than the control.

Table 1. Mean days (mean ± SEM) to 100% mortality of released PB attacking stored chickpea, treated with miscellaneous materials at different application rates

Miscellaneous materials	Application rates			Mean
	1 .0	0.5	.25	
Acacia bark ash	11.68±1.002 H	13.74±1.179 FG	16.48±1.415 DE	13.97 D
Fly ash	12.79±0.765 GH	15.05±0.900 EF	18.20±1.088 CD	15.35 C
Red soil powder	5.06±0.380 K	5.63±0.423 K	6.64±0.499 JK	5.78 F
Turpentine oil	15.75±0.724 E	18.97±0.872 BC	21.91±1.102 A	18.87 B
Control				8.03 E
Mean	12.09 C	13.58 B	20.28 A	15.46 A

2. Number of eggs

Table 2 showed that fly ash and turpentine oil at all their application rates were the most effective in reducing fecundity of PB. The minimum eggs (0.86 per grain) were observed in grains treated with fly ash at 1.0 g followed by its application at 0.5 g. The order of effectiveness in reducing fecundity was fly ash > turpentine oil > red soil powder > cow-dung ash and acacia bark ash. All the materials provided significantly less number of eggs compared to the control except cow- dung ash and acacia bark ash at their application rate of 0.25 g. The maximum number of eggs (4.05 per grain) was recorded in the un-treated grains.

Table 2: Mean number of eggs (mean ± SEM) laid by PB attacking stored chickpea, treated with miscellaneous materials at different application rates

Miscellaneous materials	Application rates			Mean
	1 .0	0.5	.25	
Acacia bark ash	2.41±0.106 E	3.07±0.186 D	3.80±0.221 ABC	3.09 C
Fly ash	2.94±0.077 D	3.57±0.163 BC	3.92±0.255 AB	3.48 B
Red soil powder	2.30±0.138 E	1.07±0.059 HI	1.27±0.012 GH	1.07 F
Turpentine oil	1.26±0.013 GH	1.55±0.075 FG	1.79±0.073 F	2.88 D
Control				1.53 E
Mean	2.30 C	2.69 B	3.05 A	A

3. Number of holes

Fly ash and turpentine oil showed the minimum holes per grain at all their application rates compared to all other treatments including the control (Table 3). The maximum holes (1.91 per grain) were seen in un-treated grains, which were statistically different from all the materials except acacia bark ash at 0.25 g and red soil power at its application of 0.5 and 0.25 g. The minimum holes (0.41per grain) were recorded in grains treated with fly ash at 1.0 g followed by its application at 0.5 g and the turpentine oil at 1.0 ml. Fly ash and turpentine oil once again were the most effective at all their application rates compared to other materials including the un-treated grains.

Table 3: Mean number of holes (mean ± SEM) made by PB attacking stored chickpea, treated with miscellaneous materials at different application rates.

Miscellaneous materials	Application rates			Mean
	1 .0	0.5	.25	
Acacia bark ash	1.03±0.009 E	1.28±0.080 CD	1.55±0.075 B	1.29 D
Fly ash	1.18±0.065 DE	1.47±0.065 B	1.79±0.111 A	1.48 C
Red soil powder	1.38±0.060 BC	0.53±0.022 HI	0.60±0.042 GH	0.51 F
Turpentine oil	0.60±0.046 GH	0.73±0.040 FG	0.84±0.020 F	1.67 B
Control				0.72 E
Mean	1.08 C	1.28 B	1.43 A	

4. Number of F_1 adults emerged

As per Table 4, the minimum F_1 adults (3.14) were recorded in jars treated with fly ash at 1.0 g, which was statistically similar with its applications at 0.5 and 0.25 g and also with turpentine oil at 1.0 ml. The maximum F_1 adults (14.66) were observed in the control, which were non-significant with those recorded in jars treated with acacia bark ash at 0.25 and 0.5 g and with red soil powder at its application of 0.25 g. Fly ash was the most effective followed by turpentine oil, cow-dung ash, red soil powder and acacia bark ash. All the other treatments were significantly better as compared to the control.

Table 4: Mean number of fresh adults of PB (mean ± SEM) emerged in stored chickpea, treated with miscellaneous materials at different application rates

Miscellaneous materials	Application rates			Mean
Cow-dung ash	1 .0	0.5	.25	
Acacia bark ash	7.98±0.584 FG	9.81±0.356 DEF	11.90±0.633 BC	1.29 D
Fly ash	10.65±0.556 CDE	13.48±0.792 AB	15.33±1.186 A	1.48 C
Red soil powder	9.14±0.708 EF	11.33±1.008 CD	13.83±1.297 AB	0.51 F
Turpentine oil	4.56±0.254 HIJ	5.64±0.468 HI	6.46±0.345 GH	1.67 B
Control			14.66 A	0.72 E
Mean	8.36 C	9.80 B	11.13 A	

5. Percent inhibition rate (% IR)

Figure 1 showed that fly ash at its application rates of 1.0, 0.5 and 0.25 g while turpentine oil at 1.0, 0.5 and 0.25 ml were more effective giving more than 50% inhibition in emergence of F_1 PB. The maximum inhibition (78.62%) was calculated in jars treated with fly ash at 1.0 g, which was statistically similar to its application at 0.5 g. The ash from acacia bark provided the minimum inhibition of -4.31%, which was statistically lower than all other treatments. The ashes of cow-dung, acacia bark and red soil powder showed less than 50% inhibition at their all application rates.

Table 5: Mean days to 100% mortality of fresh emerged PB (mean ± SEM) attacking stored chickpea, treated with miscellaneous materials at different application rates

Miscellaneous materials	Application rates			Mean
Cow-dung ash	1 .0	0.5	.25	
Acacia bark ash	8.47±1.343 F	11.14±1.284 E F	13.59±0.857 CD	1.29 D
Fly ash	10.23±0.005 E	13.46±1.124 D	16.55±1.168 AB	1.48 C
Red soil powder	11.18±1.156 E	4.19±1.353 IJ	5.03±1.399 HI	0.51 F
Turpentine oil	4.56±0.700 I	5.64±0.468 HI	16.73±0.762 A	1.67 B
Control				
Mean	9.03 C	9.80 B	11.19 B	16.88 A

DISCUSSION

The maximum weight loss (45.28%) was recorded in the control. However, acacia ash and turpentine oil at all their application rates and cow-dung ash at 1.0 g provided less than 25.00% weight loss. Generally in above studies, fly ash and turpentine oil at all their application rates were statistically better than all other materials whereas cow-dung ash was also promising in managing PB. However, red soil powder and acacia bark were the least effective against PB. According to Mendki *et al.* (2001), fly ash was evaluated for the post-harvest preservation of five commonly used pulses viz., soybean, chickpea, green gram, black gram and red gram. All the pulses were deliberately infested with PB and treated with 1g fly ash per 5 kg of pulses under ambient storage conditions for 18 months. No adult PB was found in pulses treated with fly ash even after 12 months of treatment. After 18 months of storage, chickpea was the most infested both in terms of number of insects observed in gunny bags and percent damaged grains; whereas, soybean and black gram were the least infested. Percentage insect-damaged grains were directly proportional to the number of insects observed in gunny bags. There was no effect of fly ash on the nutritional quality and percent germination of pulses.

In some other studies by Dhakshinamoorthy and Selvana-rayanan (2002), the effect of some natural plant products against PB was evaluated. The treatments comprised leaves (as dried powder) of various plants i.e. neem, nochi, pungam, citrus and thulasi; fly ash, kitchen ash, castor oil, red earth, malathion (as standard control) and the untreated control. Treated seeds were kept in plastic containers and 20 adult beetles were introduced into each container and kept covered with muslin cloth. The results revealed that the mortality of the beetle at 7 days after treatment was the highest (100%) in castor oil followed by neem leaf powder (91.66%). Singal and Chauhan (1997) tested the effect of some plant products and other materials on the development of PB attacking stored grains. Neem seed oil and neem seed kernel powder individually prevented egg-laying for up to 8 months of storage and a negligible adult population developed after this period. Coal ash and soft stone were ineffective in this respect. Sharvale and Borikar (1998) tested the effect of some plant products and grain protectants for prevention of damage by PB in stored chickpea. Neem leaves, castor oil, ash, malathion 50 EC and BHC 10 D [HCH] were tested. Malathion and HCH were the most effective resulting in the highest mortality of PB. Among the plant products tested, castor oil was more effective than ash and neem leaves. Misra, 2000 compared ten different types of plant powders with local treatments of red soil powder, cow-dung ash powder and mustard oil coating for their effect against PB. Among local treatments, only cow-dung ash and mustard oil completely inhibited oviposition.

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