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Effect of Smoke on Mortality against Pulse Beetle, *Callosobruchus chinensis* (linnaeus) in Smoke Treated Stored Pulses

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ABSTRACT: The studies on the effect of smoke on mortality of stored pulses against pulse beetle, *Callosobruchus chinensis* (L.) were carried out to know the impact of different smokes on percent mortality of the pest of treated pulse seeds. The pulses used in this experiment was green gram, black gram and red gram. The experiments conducted on the effect of smoke generated by burning plant and animal origin by-products on mortality of adults of *C. chinensis* at 1, 12, 24, 48, 72, 96 and 120 h exposure to smoke under airtight conditions resulted in 50.98 percent after 120h of exposure to mustard seed cake followed by karanj seed cake (50.59), cow dung cake (37.15), neem seed cake (33.26) and wheat husk smoke (28.43). Therefore, present laboratory studies clearly showed that plant and animal origin by-products smoke were found quite effective against pulse beetle, *C. chinensis* without causing any deleterious effect on quality parameters of pulse seeds. These botanical products which were used as smoke for insect mortality are quite cost effective and are easily available at all places. Smokes generated from botanical byproducts can be effectively used as fumigant alternatives for grain storage, with thorough scientific research. Using of smoke in pulses on a large scale can be somewhat difficult which should be the concern of the experiment.

Keywords: Stored pulses, Smoke, Pulse beetle, *Callosobruchus*, Insect mortality.

INTRODUCTION

Pulses belong to the legume family Fabaceae or Leguminosae (plants that grow in pods), under the sub-family Papilionaceae. The FAO list includes eleven primary pulses, including peas, and excludes the oilseed legumes and those consumed in immature form as vegetables. Pulses are an important source of nutrition for billions of people around the world (Dahl *et al*., 2012). They contain 20 to 30% of protein which is almost three folds higher than cereal crops (Ahmed *et al.*, 2016). Pulses include those species that are consumed by human beings and domestic animals, commonly in the form of dry grains and doesn't include groundnut (*Arachis hypogaea*) and soyabean (*Glycine max)* which are grown mainly for edible oil (Mohapatra *et al.*, 2018). Pulses contain approximately 21-25% protein; however have limiting amount of essential amino acids such as methionine, tryptophan and cystine (Tiwari and Singh, 2012). Nearly 31% of total pulse acreage and over 21% of total pulse production in India is contributed by Urd, Mung and Cowpea (Sachan *et al.*, 1994). High values of Lysine make Urd bean an excellent complement to rice in terms of balanced human nutrition (Sakila and Pandiyan, 2018). Nutritive value of urd bean hold protein 26-27%, calcium- 154 mg/100g, fat- 1.4%, phosphorus- 385 mg/100g, minerals- 3.2%, iron- 9.1/100g, fibre- 0.9% calorific value- 347 K cal/100g, carbohydrate- 60%, moisture-10.9% and vitamins(mg/100g) B1, B2 and Niacine 0.42, 0.37 and 2.0, respectively (Kumar *et al.*, 2020).The pulse seeds suffer a greater damage during storage due to insect attack. Among the insect pests attacking stored products, pulse beetle (*Callosobruchus chinensis* Linnaeus) (Coleoptera: Bruchidae) is a serious one. (Aslam *et al.*, 2002). These losses are highly locality specific and high temperature and relative humidity often favour the growth of loss. Among these, the pulse beetle, *Callosobruchus* spp. are considered as the major storage pests of pulses (Jaiswal *et al.*, 2019). The pulse seeds suffer a great damage during storage due to insect attack (Khalequzzaman *et al.*, 2007). Bruchids belong to the family Bruchidae that comprises more than 1700 species of 62 genera worldwide. These include the major species of pulse beetles *i.e. Callosobruchus chinensis* (Ahmed *et al.*, 2003). It was reported as the serious insect pest of stored products in the temperate regions with annual loss of about 0.21 million tonnes of Rs. 315 million (Varma and Anandi, 2010). The initial infestation of this beetle starts in the field itself, where female insects lays eggs on the green pods, grubs feed on the pod cover and remain concealed inside the developing seeds (Mishra *et al.*, 2013). In India 117 species of bruchids belonging to 11 genera have been reported on infesting different pulses (Arora, 1970). The genus *Callosobruchus* sps. attacks legumes grain during both field and storage stage all over the world, but in India, *C. chinensis* (L.), *C. analis* (Fab.) and *C. maculates* (Fab.) are the major pest species of the genera (Dias, 1986). Using botanicals in the form of smokes has a great potential, since the research area has not been explored extensively for grain storage pest management. Biomass or by product from agro-waste is a major fuel for most of the rural agricultural population in India and 70% of energy consumption is met from bio fuel, which include fuel wood, dung cakes, agricultural residues and charcoal (Tyagi *et al.*, 2019). This easily accessible technology is a good substitute for hazardous chemicals and can easily to adopt by the users without having any adverse effects on stored wheat grains and human health (Yadav and Tiwari, 2018). Keeping all these facts in mind the present study was made to quantify the possible effect of smoke generated by the burning of cow dung cake on mortality of pulse beetle (Kishor *et al.,* 2021).

MATERIALS AND METHODS

The experiments on the Effect of Smoke on Management of Stored pulses against Pulse beetle, *Callosobruchus chinensis* (Linnaeus) were conduc ted during 2020 in the department of Entomology, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Dist. Naini, Uttar Pradesh. This experiment was conducted under competely Randomized block Design (CRD) with three replications. Plastic containers of 1.00 kg capacity were used for the rearing of test insects (Pulse beetle). Opening of the container will be covered with muslin cloth in order to facilitate the aeration. Healthy grains (disinfected) of Green gram were used for the purpose of rearing test insects. **Treatments:** $\mathbf{T_0}$ Untreated Control (No Smoke), $\mathbf{T_1}$ Mustard Seed Cake Smoke (MSCS), $\mathbf{T_2}$ Karanj Seed Cake Smoke (KSCS), $\mathbf{T_3}$ Cow Dung cake Smoke (CDCS), $\mathbf{T_4}$ Neem Seed Cake Smoke (NSCS), $\mathbf{T_5}$ Wheat Husk Smoke (WHS).

METHODOLOGY

The experiments were conducted on the effect of smoke generated by burning Neem seed cake, Mustard seed cake, Cow dung cake, Karanj seed cake, Wheat husk smoke on the mortality of Pulse beetle, *Callosobruchus chinensis* under laboratory conditions. Smokes from five different products were produced in the smoker. The experiment was conducted by taking freshly emerged adult of pulse beetle, *Callosobruchus chinensis* by releasing 100 insects each, separately in conical flasks in three replications containing 10 g of different pulse grains. After releasing insects, Smoke was filled in conical flasks by burning cow dung cake, neem seed cake, mustard seed cake, karanj seed cake, wheat husk, separately with the help of smoker and opening of the conical flasks were tightly closed with cotton plugs and then covered with aluminium foil. The experiments were setup separately for different intervals of time i.e., 1, 12, 24, 48, 72, 96 and 120 hours, respectively to find out the effect of smoke on the treated pulse beetles under smoke exposure for different time periods (Mann and Srivastava, 2013).

Experimental setup for smoke treatment against pulse beetle for different time exposure

RESULTS AND DISCUSSIONS

The data obtained on the effect of smoke on insect mortality in green gram is presented in **table 1** showed that smoke from karanj seed cake (51.33) was found to be the most effective treatment followed by mustard seed cake (50.00) after 120 h of smoke exposure. It was observed that smoke from any by product was not found lethal to pulse beetle after 1 hour of exposure as no insect mortality was observed in exposure to various smokes. The insect mortality was increased with the increase in the exposure period of various smoke under airtight conditions. The smoke was most effective after 96 and 120 h of exposure to smoke. The data presented

Table 2 depicted the effect of smoke on mortality of pulse beetle, *C. chinensis* on black gram under different exposure periods. The percent mortality of pulse beetle was drastically increased after 72 hours exposure, followed by after 96 hour exposure to mustard seed cake, karanj seed cake, cow dung cake, neem seed cake and wheat husk smoke. The highest mortality of pulse beetle was observed in black gram at 120 hours exposure to mustard seed cake, karanj seed cake, cow dung cake, neem seed cake and wheat husk smoke was 52.27, 51.39, 38.00, 32.00, 26.77 percent. Table 3 depicted the observations taken on the effect of smoke on insect mortality of *C. chinensis* on red gram. The smoke from mustard seed cake, karanj seed cake, cow dung cake, neem seed cake and wheat husk proved to be lethal after 96 and 120 hours of exposure with significant highest mortality of 50.67, 49.05, 36.12, 33.45, 29.89 percent after 120 hours exposure to various smokes. The data presented in Table 4 depicted the effect of various smoke on overall mean mortality of pulse beetle, *C. chinensis* in different pulses under different exposure periods. After 1 hour of exposure to smoke, there was no mortality occurred in adult pulse beetle, whereas 50.98, 50.59, 37.15, 33.26 and 28.43 percent mortality was observed after 120 hours of exposure to various smoke which was found to be most effective. The data clearly showed that the overall mean adult mortality of pulse beetle, *C. chinensis* on different stored pulses was increased to four times with smoke treatments at different interval of exposure periods.

Table 1: Effect of smoke on mortality of Pulse beetle, *C. chinensis* in Green gram.

Sr. No.	Treatment	Percent adult mortality of pulse beetle in green gram						
		At different time intervals of smoke exposure(hour)						
		1h	12h	24h	48h	72h	96h	120h
T_1	Mustard seed cake smoke(MSCS)	0.00	10.67	18.67	33.33	36.00	39.33	50.00
T_2	Karanj seed cake smoke (KSCS)	0.00	11.33	20.00	24.67	34.67	40.67	51.33
T_3	Cow dung cake smoke (CDCS)	0.00	6.67	13.33	17.33	21.33	27.33	37.33
T_4	Neem seed cake smoke(NSCS)	0.00	5.60	8.00	14.97	26.00	31.33	34.33
T_5	Wheat husk smoke (WHS)	0.00	2.93	6.87	8.57	16.67	18.00	28.63
T_0	Untreated control(UC)	0.00	0.00	0.00	0.00	2.67	4.50	7.12
SEm(±)		0.00	0.73	0.31	0.76	0.95	0.75	1.42
CD(P = 1.00)		-	3.14	1.34	3.28	4.11	3.26	6.14
(CV percent)		0.00	20.29	4.80	7.97	7.21	4.86	7.72

Table 2: Effect of smoke on mortality of Pulse beetle, *C. chinensis* in Black gram.

Sr. No.	Treatment	Percent adult mortality of pulse beetle in black gram						
		At different time intervals of smoke exposure (hour)						
		1h	12h	24h	48h	72h	96h	120h
T_1	Mustard seed cake smoke (MSCS)	0.00	10.00	22.00	30.81	32.81	37.82	52.27
T_2	Karanj seed cake smoke (KSCS)	0.00	6.00	8.00	14.71	24.67	32.82	51.39
T_3	Cow dung cake smoke (CDCS)	0.00	4.67	6.78	16.49	25.33	30.00	38.00
T_4	Neem seed cake smoke (NSCS)	0.00	5.67	6.67	14.67	23.41	27.89	32.00
T_5	Wheat husk smoke (WHS)	0.00	1.33	4.43	10.00	15.13	24.00	26.77
T_0	Untreated control(UC)	0.00	0.00	0.00	3.53	6.63	6.91	9.60
SEm(±)		0.00	0.33	0.65	0.34	0.53	0.65	0.98
CD(P = 1.00)		-	1.44	2.68	2.20	2.00	2.72	3.34
CV (percent)		0.00	12.52	13.45	5.85	3.75	4.11	3.82

Table 3: Effect of smoke on mortality of Pulse beetle, *C. chinensis* in Red gram.

Sr. No.	Treatment	Percent adult mortality of pulse beetle in Red gram						
		At different time intervals of smoke exposure (hour)						
		1h	12h	24h	48h	72h	96h	120h
T_1	Mustard seed cake smoke (MSCS)	0.00	10.70	23.46	28.03	35.47	37.86	50.67
T_2	Karanj seed cake smoke (KSCS)	0.00	8.00	14.78	16.00	21.21	31.51	49.05
T_3	Cow dung cake smoke (CDCS)	0.00	6.67	8.22	9.75	18.75	29.55	36.12
T_4	Neem seed cake smoke (NSCS)	0.00	6.00	6.00	11.31	19.47	26.67	33.45
T_5	Wheat husk smoke (WHS)	0.00	9.51	13.33	16.00	14.70	23.41	29.89
T_0	Untreated control(UC)	0.00	0.00	0.00	0.00	4.05	7.36	7.47
SEm(±)		0.00	0.39	0.65	0.34	0.53	0.65	0.98
CD (P = 1.00)		-	1.69	2.80	1.47	2.30	2.82	4.25
CV (percent)		0.00	10.11	10.23	4.37	4.86	4.34	4.94

Table 4: Overall mean adult mortality of pulse beetle, *C. chinensis* with or without smoke under airtight conditions in pulse commodities.

Sr. No.	Treatment	Overall mean adult mortality of pulse beetle in pulse commodities						
		At different time intervals of smoke exposure (hour)						
		1h	12h	24h	48h	72h	96h	120h
T_1	Mustard seed cake smoke(MSCS)	0.00	10.45	21.37	30.72	34.70	38.33	50.98
T_2	Karanj seed cake smoke (KSCS)	0.00	8.44	14.26	18.46	26.85	35	50.59
T_3	Cow dung cake smoke (CDCS)	0.00	6.03	9.44	14.52	21.80	28.96	37.15
T_4	Neem seed cake smoke (NSCS)	0.00	5.75	6.89	13.65	22.96	28.63	33.26
T_5	Wheat husk smoke (WHS)	0.00	4.59	8.21	11.52	15.50	21.80	28.43
T_0	Untreated control(UC)	0.00	0.00	0.00	1.17	4.45	6.25	8.06

Smoke is the cheapest and easily available source of carbon dioxide (CO_2). CO_2 has been used used for killing insects in stored products (White *et al*., 1990). Sinha *et al.*, 2001 evaluated percent mortality of 31.5, 32.0, 37.8, 57.8 and80 percent of adult pulse beetle, *C. maculates* after 24,48,72, 96 and 120 hours exposure to smoke of cow dung containing 4 percent CO_2, respectively. Prasantha *et al.*, 2002 used smoke of plants materials against rice weevil, was very much effective and materials used for smoke can be easily available from nearby house area. Srivastava *et al.*, 2006 concluded the effect of cowdung smoke on stages of storage insects and resulted almost 80percent mortality of pulse beetles, *C. maculates* (Fab.) after 24 hours exposure to cow dung cake smoke. Michaelraj and Sharma, 2006 studied fumigant toxicity of two neem formulations against two pests, Rice weevil and lesser grain borer and evaluated the insect mortality and observed 93.33 percent mortality of *Rhyzopertha dominica* after 72 hours of exposure periods. 100 percent mortality was observed in rice weevil, *Sitophilus oryzae* due to fumigation of neem formulations. Yadav and Tiwari, 2018 evaluated the effect of cowdung smoke and neem leaves smoke on mortality of various storage insects and also studied the effect of smoke on quality parameters of wheat seeds post- germination. It was observed that 50 percent of the insects were died after 72 hours of neem leaves smoke exposure and 96 hours of cowdung smoke exposure. Tyagi *et al.*, 2019 studied the effect of botanical smokes against pulse beetle under storage condition and result indicated adult mortality of 0.4 to 98.4 percent was observed when smokes of different byproducts were tested. Among these the smoke from mustard seed cake was found to be most effective followed by karanj and neem seed cake. Kishor *et al.*, 2021 studied the effect of cow dung smoke on mortality of pulse beetle, *C. chinensis* and on quality parameters on different pulse commodities viz., green gram, black gram and red gram and result showed more than 50 percent insect mortality was observed after 96 hours to 120 hours exposure to cow dung smoke.

SUMMARY

After 1 hour of exposure to smoke, there were no mortality occurred in adult pulse beetles, whereas, the highest overall mean adult mortality was observed when pulses were exposed to mustard seed cake smoke after 120 hours of exposure with more than 50% of mortality of pulse beetle was observed when exposed to mustard seed cake and neem seed cake i.e., 50.98 and 50.59 percent respectively followed by cow dung cake (37.15%), Neem seed cake (33.26%) and wheat husk (28.43%). No any insects were found dead under air tight conditions without smoke after 1h, 12h and 24h interval of time, whereas overall mean adult mortality of pulse beetles were calculated 1.17 and 4.45 percent after 48 and 72 hours of exposure. The overall mean adult mortality of pulse beetle was calculated 6.25 and 8.06 percent after 96 and 120h of insect confinement under airtight conditions on different pulses. The data clearly showed that the overall mean adult mortality of pulse beetle, *C. chinensis* on different stored pulses was increased to four times with smoke treatment at different interval of exposure periods.

CONCLUSIONS

The results obtained during this course of investigation showed that smoke generated from burnt mustard seed cake has potential to protect pulse commodities viz., green gram, black gram and red gram grains against pulse beetle *C. chinensis* at 120h exposure to smokes. It was followed by neem seed cake and Karanj seed cake smokes. Further, it has also been concluded that smokes were more effective during the initial stages of insect growth. It has also been concluded that among all the plant and animal origin by-products, smoke from mustard seed cake was found to be the most effective on adult mortality of pulse beetle. As being natural, easily available, eco- friendly, cost effective and easy to adopt by small scale farmers, these plant and animal origin by-products can therefore be used as safe alternatives to synthetic insecticides and conventional harmful fumigants under storage conditions. In future course of time, using smoke derived from various plant and animal origin products can be most effective for storage. Before storing the products in large containers pulses can be treated with these smokes which will help in keeping pulse beetle as well as other storage pests away from the seeds and even prevents its damage.

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