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Full Length Research Paper

Non destructive method to manage the most dreaded pest *Callosobruchus maculatus* (Fab.) in Black gram *Vigna mungo L.*

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Under storage conditions, pulses suffer maximum grain loss due to the dreaded stored grain bruchid pests. Effect of different grain protectants on oviposition of pulse beetle, *Callosobruchus maculatus* showed that untreated check (13.31) registered the maximum number of eggs followed by seed treated with coarse river sand (11.62). Minimum number of eggs was recorded in activated clay (5.76) followed by talc powder (6.58) and fly ash (7.12). Different grain protectants on adult emergence of pulse beetle, found that activated clay (62.27) and talc powder (96.27) were found to be equally effective. Untreated check showed more number of adult emergence. Grain protectants on percent grain damage by pulse beetle, indicated that activated clay (25.94) and talc powder (31.82) were equally effective followed by fly ash (34.49).

Key words: Black gram, Bruchids, grain protectants, oviposition, percent damage.

INTRODUCTION

Pulses, also called grain legumes, are extensively grown in tropical regions of the world for centuries as a major protein rich crop bringing considerable improvement in human diet (Das et al., 2010). India is one of the major pulse growing countries in the world with a total area of 23.31 million hectares and a total production of 14.50 million tonnes (FAO, 2011). Among the different pulses, black gram is a rich source of protein which is one of the essential nutrients of human diet. Black gram (*Vigna mungo* L.) contributes 10% to the national pulse production from an area of 13%. This crop is grown in 3 million hectares area producing 1.37 million tonnes of grains. It is grown in part of Asia and South Africa. In India it is mostly cultivated in Madhya Pradesh, Maharashtra, Andhra Pradesh, Uttar Pradesh, Karnataka, Tamil Nadu and West Bengal. Pulses are rich sources of protein as they contain about 20 to 30% protein, which is almost three times higher than that found in cereals but these are more difficult to store than cereals as they suffer great damage during storage due to insect-pests and micro-organisms (Anonymous, 1978). Insect pests have been a threat to food and seed since man has started growing crops. Almost all stored food stuffs and seeds are liable to insect injury (Saxena, 1995). 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).

To manage this storage pest, different strategies are tried by the scientists. But still it continued to be a threatening pest in storage. The use of pesticides has been employed by the farmers. Though this 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 researchers have been directed towards finding alternative to pesticide that are environmentally friendly and does not pose dangers to man.

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Table 1. Grain protectants used for the study.

Treatment	Grain protectants	Dose/kg
T_1	Mixing with ragi seeds	10 g
T_2	Rice husk	10 g
T_3	Rice bran oil	5 ml
T_4	Fly ash	10 g
T_5	Rice husk ash	10 g
T_6	Neem leaf powder	10 g
T_7	Coarse river sand	10 g
T_8	Talc powder	10 g
T_9	Activated clay	10 g
T_{10}	Control	-

MATERIALS AND METHODS

The undamaged seeds of ADT 3 black gram (100 g) were kept in plastic containers (500 ml) admixed with different grain protectants and it was shaken manually until the seeds were uniformly coated. Three replications were maintained for each treatment. Five pairs of newly emerged adults were released in each of the replications in all the treatments. The plastic containers were covered with kada cloth and secured tightly with rubber band. The number of eggs, adults and percent grain damage were recorded every month and the observations were recorded up to six months. The various treatments (T1 to T10) were given in Table 1.

RESULTS AND DISCUSSION

Effect of different grain protectants on oviposition

The black gram seeds (ADT 3) treated with different grain protectants reduced the rate of oviposition by pulse beetle in comparison to untreated check is rendered in Table 2. After one month of treatment the average number of eggs ranged from 0.04 to 0.14 in different treatments and 0.17 in untreated check. The seeds treated with talc powder (0.04) proved to be significantly superior over all the treatments, which was at par with neem leaf powder (0.08), fly ash (0.08), activated clay and mixing with ragi seeds (0.09).

After four months of treatment the average number of eggs laid per seed ranged from 9.85 to 17.44 in different treatments and 19.52 in untreated check. Minimum number of eggs was observed in seeds treated with activated clay (9.85) which was at par with talc powder (11.06). The seeds treated with coarse river sand (17.44), rice bran oil (17.05), mixed with ragi seeds (17.03), rice husk ash (16.46) and neem leaf powder (16.31) were proved to be ineffective.

In fifth and sixth months similar trend was observed in all the treatments. Minimum number of eggs was recorded in activated clay followed by talc powder and fly ash. The seed treatments with coarse river sand, rice bran oil and mixed with ragi seeds were ineffective. By observing the overall mean, untreated check (13.31) registered the maximum number of eggs followed by seed treated with coarse river sand (11.62). Minimum number of eggs was recorded with activated clay (5.76) which was followed by talc powder (6.58) and fly ash (7.12). Inert dusts have been traditionally used as stored grain protectants. Inert dusts particularly based upon silica content are gaining importance as storage protectants. The main reason behind this is that they induced egg mortality by desiccation (Golob,*website).*

It is evident from the present study that the use of grain protectants showed significant reduction in oviposition of pulse beetle *C. maculatus* in black gram seeds treated with activated clay and talc effectively protected the seeds against bruchid *C. maculatus*. These findings are being supported by the observations of Swamiappan et al. (1976). The next best treatment was the fly ash and it was reported to have less number of eggs. This is in conformity with the findings of Shaheen and Farid (2006) who reported that among miscellaneous materials as post-harvest grain protectants, fly ash proved to be the best in managing pulse beetle in cowpea seeds. Govindan et al. (2010) reported that *C. maculatus* laid less number of eggs on the seeds of black gram treated with 1% activated clay (41.33) and 4.00% fly ash (103.00).

Effect of different grain protectants on adult emergence

The results pertaining to the efficacy of grain protectants against pulse beetle in adult emergence are presented in Table 3.

After one month of treatment the average number of adult emergence from 100 g ranged from 2.00 to 35.33 in different treatments and 59.66 in untreated check. Very few number of adults (2.00) were recorded in rice bran oil treated seeds which was at par with activated clay (2.33) followed by talc powder (5.00). More number of adult emergence was recorded in untreated check (59.66) followed by seeds treated with rice husk (35.33).After five months of treatment the number of adult emergence in different treatments ranged from 103.33 to 461.66. During this month seeds treated with activated clay (103.33) were found to be most effective, which was followed by seeds treated with talc powder (170.33). When considering all the treatments the seeds treated with coarse river sand (461.66) were found to be least effective which was at par with untreated check (475.00). After six months of treatment a similar trend was observed in all the treatments as in case of fifth month. By considering the overall mean, number of adults emerged from seeds treated with different treatments was ranged between 62.27 and 291.66. Activated clay (62.27) and talc powder (96.27) were found to be effective in controlling the emergence of adult pulse beetle. During sixth month of observation, the number of

Table 2. Effect of different grain protectants on oviposition of pulse beetle, *C. maculatus* (Fab.).

Treatment No.	Treatments	Dosage	Number of eggs (Mean of three replications)						
			1st Month	2nd Month	3rd Month	4th Month	5th Month	6th Month	Over all mean
T_1	Mixing with ragi seeds	10 g/kg	0.09(0.37)^{abc}	0.88(0.92)^{bc}	4.80(2.16)^{ab}	17.03(4.13)^{d}	18.37(4.29)^{de}	18.57(4.31)^{cd}	9.78
T_2	Rice husk	10 g/kg	0.13(0.42)^{bcd}	0.80(0.86)^{abc}	12.43(3.52)^{c}	13.18(3.63)^{c}	17.59(4.20)^{cde}	17.90(4.23)^{c}	10.33
T_3	Rice bran oil	5 ml/kg	0.14(0.43)^{cd}	0.80(0.86)^{abc}	8.24(2.87)^{bc}	17.05(4.13)^{d}	18.41(4.29)^{de}	18.58(4.31)^{cd}	10.53
T_4	Fly ash	10 g/kg	0.08(0.36)^{abc}	0.37(0.55)^{ab}	5.44(2.29)^{ab}	11.51(3.39)^{b}	12.51(3.54)^{b}	12.85(3.58)^{b}	7.12
T_5	Rice husk ash	10 g/kg	0.12(0.41)^{bcd}	0.47(0.61)^{ab}	8.92(2.97)^{bc}	16.46(4.06)^{d}	17.13(4.14)^{cd}	17.62(4.20)^{c}	10.12
T_6	Neem leaf powder	10 g/kg	0.08(0.35)^{ab}	0.78(0.89)^{abc}	7.68(2.67)^{abc}	16.31(4.04)^{d}	16.59(4.07)^{c}	17.46(4.18)^{c}	9.81
T_7	Coarse river sand	10 g/kg	0.11(0.39)^{bcd}	2.10(1.44)^{cd}	10.90(3.26)^{c}	17.44(4.18)^{d}	19.00(4.36)^{e}	20.20(4.49)^{d}	11.62
T_8	Talc powder	10 g/kg	0.04(0.30)^{a}	0.04(0.29)^{a}	4.03(1.99)^{ab}	11.06(3.33)^{ab}	11.63(3.41)^{b}	11.96(3.46)^{b}	6.58
T_9	Activated clay	10 g/kg	0.09(0.37)^{abc}	0.07(0.35)^{ab}	3.79(1.89)^{a}	9.85(3.14)^{a}	10.19(3.19)^{a}	10.33(3.21)^{a}	5.76
T_{10}	Control		0.17(0.46)^{d}	2.46(1.56)^{d}	13.10(3.62)^{c}	19.52(4.42)^{e}	22.33(4.73)^{f}	22.33(4.73)^{e}	13.31
Over all mean			0.10	0.87	7.93	14.94	16.37	16.78	
CD			0.06**	0.54**	0.87**	0.19**	0.19**	0.18**	
CV (%)			4.06	9.20	4.32	2.79	2.32	2.27	

Values in parentheses are square root transformed value; **Significant at 1% level; in a column mean followed by a common letter are not significantly different by DMRT (P=0.05).

Table 3. Effect of different grain protectants on adult emergence of pulse beetle, *maculatus* (Fab.).

Treatment no.	Treatments	Dosage	Number of adults/100 g seed (Mean of three replications)						
			1st Month	2nd Month	3rd Month	4th Month	5th Month	6th Month	Over all mean
T_1	Mixing with ragi seeds	10 g/kg	17.33(4.16)^{d}	34.00(5.50)^{abc}	151.66(12.26)^{cd}	231.33(15.17)^{c}	373.33(19.32)^{ef}	390.00(19.74)^{ef}	199.60
T_2	Rice husk	10 g/kg	35.33(5.93)^{f}	58.00(7.59)^{c}	152.00(12.28)^{cd}	226.33(15.00)^{c}	343.33(18.52)^{de}	363.33(19.05)^{de}	196.38
T_3	Rice bran oil	5 ml/kg	2.00(1.40)^{a}	18.00(4.19)^{ab}	112.33(10.59)^{bc}	228.66(15.11)^{c}	323.33(17.97)^{d}	340.00(18.43)^{d}	170.72
T_4	Fly ash	10 g/kg	10.66(3.26)^{c}	23.66(4.38)^{ab}	88.00(9.33)^{b}	165.33(12.84)^{b}	240.66(15.50)^{c}	253.33(15.90)^{c}	130.27
T_5	Rice husk ash	10 g/kg	20.33(4.50)^{d}	44.66(6.45)^{bc}	188.66(13.72)^{de}	262.33(16.18)^{c}	410.00(20.24)^{f}	416.66(20.41)^{f}	223.77
T_6	Neem leaf powder	10 g/kg	9.33(3.06)^{c}	23.33(4.54)^{abc}	92.00(9.58)^{b}	222.00(14.88)^{c}	325.00(18.02)^{d}	336.66(18.34)^{d}	168.05
T_7	Coarse river sand	10 g/kg	26.33(5.13)^{e}	53.33(7.23)^{bc}	236.66(15.37)^{e}	336.66(18.34)^{d}	461.66(21.48)^{g}	471.66(21.71)^{g}	264.38
T_8	Talc powder	10 g/kg	5.00(2.23)^{b}	19.00(4.34)^{ab}	81.66(9.03)^{ab}	127.00(11.25)^{a}	170.33(13.04)^{b}	175.00(13.22)^{b}	96.27
T_9	Activated clay	10 g/kg	2.33(1.53)^{a}	6.33(2.45)^{a}	53.33(6.74)^{a}	98.33(9.88)^{a}	103.33(10.14)^{a}	110.00(10.48)^{a}	62.27
T_{10}	Control		59.66(7.72)^{g}	116.00(10.71)^{d}	247.66(15.72)^{e}	356.66(18.87)^{d}	475.00(21.79)^{g}	495.00(22.24)^{g}	291.66
Over all mean			18.83	39.63	140.40	225.46	322.60	335.16	
CD			0.48**	2.78**	2.32**	1.55**	1.00**	0.81**	
CV (%)			9.53	7.95	4.82	3.63	3.54	3.50	

Values in parentheses are square root transformed values; In a column mean followed by a common letter are not significantly different by DMRT (P=0.05). **Significant at 1% level .

Table 4. Effect of different grain protectants on percent grain damage by pulse beetle, *C. maculatus* (Fab.).

Treatment no.	Treatments	Dosage	Per cent grain damage (Mean of three replications)						
			1st Month	2nd Month	3rd Month	4th Month	5th Month	6th Month	Over all mean
T_1	Mixing with ragi seeds	10 g/kg	8.66(17.04)^{cde}	10.66(19.05)^{bc}	33.00(35.05)^{ab}	81.33(64.40)^{e}	90.33(71.89)^{e}	91.00(72.55)^{de}	52.49
T_2	Rice husk	10 g/kg	11.66(19.94)^{f}	23.00(28.63)^{e}	51.66(45.95)^{e}	56.66(48.83)^{c}	88.00(69.80)^{e}	88.66(70.44)^{de}	53.27
T_3	Rice bran oil	5 ml/kg	12.66(20.84)^{fg}	14.66(22.49)^{d}	44.66(41.92)^{cd}	83.33(65.95)^{e}	92.00(73.65)^{e}	92.33(74.01)^{e}	56.60
T_4	Fly ash	10 g/kg	5.66(13.75)^{b}	9.00(17.34)^{b}	33.66(35.45)^{b}	47.33(43.47)^{b}	55.00(47.87)^{b}	56.33(48.65)^{b}	34.49
T_5	Rice husk ash	10 g/kg	11.00(19.35)^{ef}	14.00(21.96)^{cd}	43.33(41.16)^{cd}	72.00(58.06)^{d}	82.33(65.18)^{d}	85.66(67.78)^{d}	51.38
T_6	Neem leaf powder	10 g/kg	6.66(14.95)^{bc}	11.66(19.96)^{bcd}	39.33(38.82)^{c}	67.66(55.35)^{d}	71.33(57.64)^{c}	73.66(59.13)^{c}	45.05
T_7	Coarse river sand	10 g/kg	10.33(18.74)^{def}	20.33(26.80)^{e}	46.66(43.08)^{de}	88.00(69.80)^{f}	92.33(74.01)^{e}	93.33(75.28)^{ef}	58.49
T_8	Talc powder	10 g/kg	8.33(16.73)^{cd}	8.66(17.04)^{b}	31.66(34.23)^{ab}	45.66(42.50)^{b}	48.00(43.85)^{b}	48.66(44.23)^{ab}	31.82
T_9	Activated clay	10 g/kg	3.66(10.86)^{a}	5.33(13.34)^{a}	27.66(31.71)^{a}	38.33(38.19)^{a}	40.00(39.15)^{a}	40.66(39.54)^{a}	25.94
T_{10}	Control		15.00(22.77)^{g}	30.00(33.16)^{f}	58.33(49.80)^{f}	92.00(73.65)^{g}	96.00(78.52)^{f}	96.33(79.13)^{f}	64.61
Over all mean			9.36	14.73	41.00	67.23	75.53	76.66	
CD			2.27**	2.83**	3.22**	3.82**	4.17**	4.80**	
CV (%)			5.68	5.14	4.96	5.86	6.74	9.69	

Values in parentheses are arc sine transformed values; **Significant at 1% level; in a column mean followed by a common letter are not significantly different by DMRT (P=0.05).

check was at par with each other.

Exposure of insects to inert dusts results in loss of body weight mainly through water loss. In the present study less number of adult emergence was observed in grains treated with activated clay which is at par with talc powder. Highest number of adult emergence was observed in grains treated with coarse river sand. These findings are being supported by Pandey and Varma (1977) who reported that complete mortality of *C. maculatus* was observed in cowpea seeds treated with activated clay. Babu et al. (1989) reported that pre-treatment of *Vigna radiata* seeds with inert clay resulted in 100% adult mortality of *C. chinensis* within 24 h. It provides effective protection up to 12 months of storage under ambient conditions.

These findings are in line with Govindan et al. (2010) who observed that few adult beetles of *C. maculatus* was emerged from black gram seeds treated with 1.00% activated clay (20.33), when compared to 4.00% fly ash (68.33) and untreated check (143.66). Therefore it may be concluded from the results that the adult population in black gram seeds treated with activated clay was superior over other treatments. This may be due to absorptive and protective property against pulse beetle *C. maculatus*.

Effect of different grain protectants on percent grain damage

The data on the efficacy of different grain protectants on percent grain damage by pulse beetle is presented in Table 4. The percent grain damage at one month to six months after treatment revealed that significant difference was noticed in various treatments tested against pulse beetle infestation.

After one month of treatment the percent grain damage by pulse beetle in different treatments ranged from 3.66 to 12.66 and 15.00 in untreated check. The percent grain damage was found to be minimum in activated clay (3.66) followed by fly ash (5.66). Maximum percent grain damage is seen in seed treated with rice bran oil (12.66). The percent grain damage was found to be significantly low in all the treatments when compared to untreated check (15.00).

After fourth, fifth and sixth months of treatment trend observed was similar in which the percent grain damage was found to be minimum in activated clay throughout the counts and it was followed by talc powder except first month and maximum percent grain damage was recorded in untreated check.

Considering the overall mean, activated clay and talc powder were equally effective in controlling the grain damage by the pulse beetle followed

by fly ash and neem leaf powder treatments. The (bark extract of *Nerium indicum* were effective as insecticidal property to control pulse beetle, *C chinensis* Anil Kumar and Zambare, 2012. Untreated check uniformly showed high percent grain damage than all other treatments and the percent adults emerged in coarse river sand and in untreated grain damage inProvide untreated control was 64.61. Whereas it was only 25.94, 31.82, 34.49 in activated clay and talc powder and fly ash respectively. The highest percent of seed infestation by *C. maculatus* was recorded in seeds treated with coarse river sand. The lowest percent of seed infestation was recorded in seeds treated with activated clay which is in line with the findings of Ramazeame and Adiroubane (2009) who reported that lowest percent of seed infestation was recorded in red gram seeds treated with activated clay next to Neem Seed Kernal Extract (NSKE) against *C. chinensis.*

The next effective treatment was fly ash in reducing the percent of grain damage. This was also found to be effective during storage of black gram seeds. Mendki et al. (2001) reported that fly ash effectively suppressed the population of C*. chinensis* for as long as 16 to 18 months. Fly ash includes substantial amounts of silicon dioxide (SiO_2) (both amorphous and crystalline) and calcium oxide (CaO) (Hrishikesh et al., 2012)

Srimathi and Ramaswamy (1983) reported that cow pea seeds treated with red earth did not protect the seeds from insect attack mainly bruchids. Similar observations were reported by Adugna (2006).

Conclusion

Effect of different grain protectants on oviposition of pulse beetle, C*. maculatus* showed that untreated check (13.31) registered with the maximum number of eggs followed by seed treated with coarse river sand (11.62). Minimum number of eggs was recorded in activated clay (5.76) followed by talc powder (6.58) and fly ash (7.12). Effect of different grain protectants on adult emergence of pulse beetle, *C. maculatus* indicated that activated clay (62.27) and talc powder (96.27) are found to be effective. Effect of different grain protectants on percent grain damage by pulse beetle, *C. maculatus* indicated that activated clay (25.44) and talc powder (31.82) were effective in controlling the grain damage caused by the pulse beetle followed by fly ash (34.49) and neem leaf powder treatments.

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