Fly ash - Excellent filler for black pepper, *Piper nigrum* dust formulation against *Callosobruchus maculatus* (F.)

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ABSTRACT

Piper nigrum L. seed is well known for its insecticidal properties against storage pests. *P. nigrum* dust formulation (Pn10D) was prepared by mixing pulverized seed powder of *P. nigrum* (10%) and fly ash (90%). Pn10D was tested against pulse beetle *Callosobruchus maculatus* (F.) Pn10D at 4.00 percent caused cent percent mortality of *C. maculatus* after 72 hr after the treatment. Pn10D 4.00 percent was most effective in reducing the oviposition. Egg hatchability of *C. maculatus* ranged between 57.12 (Pn10D 2.00 %) and 73.73% (Pn10D1.00 %). Only 7.00 beetles emerged from the seeds treated with Pn10D 4.00 per cent. Seed weight loss was 0.35 percent in Pn10D 4.00 and 3.50 percent. Germination ranged between 57.33 (Pn10D 0.50 %) and 93.33 percent (Pn10D 4.00 %).

Key words: *Piper nigrum*, Fly ash, *Callosobruchus maculatus*

INTRODUCTION

Flyash, one of the major industrial wastes, generated as a result of coal burning in thermal power stations. Its annual production all over the world is 300–350 million tonnes through combustion of 3000 million tonnes of coal (Raman *et al.,* 1996). Fly ash generation in India was 40 million tonne in the year 1993-1994. The expected generation by 2012 would be 170 million tonne. Many modes have been identified to use the fly ash for productive purposes. One of the modes is use of fly ash as pesticide (Vijayakumar and Narayanasamy, 1995a) or carrier of insecticide (Vijayakumar and Narayanasamy, 1995b). Though limited quantity could be utilized for this purpose, the dust formulation prepared using this fly ash is cost effective. Bearing in mind the deleterious effects of synthetic insecticides, botanicals have been tested against insects. Among the botanicals, *Piper nigrum* L. seed powder is also suggested for controlling stored product insects (Pandey *et al.,* 1976; Shivanna *et al.,* 1994). Since the ready made formulation based on *P. nigrum* is not available, a simple low cost dust formulation was made using fly ash as filler and tested against rice bug (Jeyarajan Nelson *et al.,* 2003). Considering the need for safe and cheap insecticide to manage the stored product insects, the present study was under taken to test the effect of Pn10D with fly ash as filler against the serious storage pest of pulses, pulse beetle *Callosobruchus maculatus* (Gupta and Bhaduri, 1984).

The cowpea weevil, *Callosobruchus maculatus*, can reproduce both in the field and in storage. In order to protect legumes in warehouses especially in third world countries we often have recourse to synthetic pesticides with their attendant dangers of user safety, high cost, development of resistant strains and toxic residues. To avoid such undesirable consequences, scientists have focused their attention on the use of less hazardous practices or substances to protect stored products.

MATERIALS AND METHODS

Callosobruchus maculatus was reared on black gram seeds in glass jars covered with muslin cloth by following the method developed by Credland and Wright (1989). Powder of *P. nigrum* seed (10 %) and fly ash (90 %) were mixed thoroughly and the resultant mixture was tested. Twenty grams of black gram seeds was taken in petridishes. Pn10D at different doses was added to black gram seeds and shaken thoroughly. Thirty newly emerged adults were released in to each petridish and kept in laboratory. Mortality (lack of locomotion and/ or response to repeated probing) was recorded at 24 hr intervals for seven days. Three replications were maintained for each treatment.

Twenty grams of black gram seeds was taken in glass bottles. Pn10D at different dose was added to black gram seeds and shaken thoroughly. Activated clay (1:100) was used as a check. Then the glass bottles were covered firmly using muslin cloth. Five pairs of newly emerged adults of *C. maculatus* were released to each glass bottle,

covered firmly and kept in laboratory at ambient conditions. Three replications were maintained for each treatment. Numbers of eggs laid on the seeds were counted on third day after the release of beetles. On 5th day after the release of beetles counts on translucent unhatched eggs and opaque hatched eggs were taken and hatchability percentage was worked out. On 15th day after the release of beetles all the dead insects were removed from the bottles to prevent them from the mixing with first generation (F1) offspring. The number of newly emerged adults were counted and removed from the bottle once in three days till the complete emergence of F1 offspring (up to 60 days after treatment). Observations on number of damaged and undamaged seeds were taken on 60th day after the treatment and seed damage percentage was worked out. The weight of the seed was taken on 60th day after the treatment and seed weight loss percentage was worked out. Germination of black gram seeds was assessed on 90th day after the treatment using roll towel method. The methods of Gomez and Gomez (1984) were followed in scrutinizing the data from various experiments. Square root and angular transformations were adopted for the data in numbers and percentage respectively (Abbott, 1925). Means in simple CRD analysis were separated by Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Insecticidal action of Pn10D on *C. maculatus*

Pn10D was tested for its insecticidal action at different concentrations *viz.*, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50 and 4.00 percent in comparison with activated clay 1.00 percent and fly ash 4.00 percent. Data on mortality (Table 1) of *C. maculatus* after 12, 24, 36, 48, 60, 72, 84 and 96 hr of the treatment were recorded. Pn10D 4.00 and 3.50 3.00 percent surpassed other treatments except activated clay with 45.55, 33.33 and 28.88 per cent mortality at 12 hours after the treatment respectively and these treatments were significantly different from each other. Aslam *et al.* (2002) reported that the black pepper *Piper nigrum* caused 100 percent mortality of *C. chinensis* after 3.75 days after treatment. At 24 hours after the treatment, cent percent mortality was seen in activated clay 1.00 percent which was followed by Pn10D 4.00 percent, Pn10D 3.50, Pn10D 3.00, 2.50 and 2.00 percent, while untreated check 3.33 percent mortality was recorded. Pn10D 4.00, 3.50, 3.00 and 2.50 per cent recorded 66.66, 61.11, 56.66 and 57.77 percent mortality, respectively 36 hours after treatment. At 48 hours after the treatment, the highest mortality was observed in Pn10D 4.00 percent (94.44%) which was followed by Pn10D 3.50, Pn10D 3.00 and Pn10D 3.00. Lale (1992) also reported that *P. quieneense* at 1.5 g / 20 g

Table 1. Insecticidal action of *Piper nigrum* 10D on *Callosobruchus maculatus*

Treatments	% Adult mortality								Mean
	12 hr	24 hr	36 hr	48 hr	60 hr	72 hr	84 hr	96 hr	
Pn 10 D 0.50 %	12.22(20.42)	26.66(30.90)	36.66(37.25)	53.33(46.91)	68.88(56.10)	78.88(62.66)	92.22(73.87)	100.00(89.47)	58.60
Pn 10 D 1.00%	14.43(22.29)	33.32(35.15)	42.22(40.52)	62.22(52.07)	72.20(58.24)	82.22(65.08)	96.66(81.32)	100.00(89.47)	62.90
Pn 10 D 1.50%	17.77(24.91)	37.77(37.89)	48.33(44.04)	62.22(52.09)	76.66(61.15)	86.66(69.01)	100.00(89.47)	100.00(89.47)	66.17
Pn 10 D 2.00%	18.88(25.74)	43.33(41.15)	47.77(43.72)	68.88(56.10)	79.99(63.48)	86.64(68.56)	100.00(89.47)	100.00(89.47)	68.47
Pn 10 D 2.50%	19.99(26.51)	49.99(44.99)	57.77(49.47)	69.99(56.85)	83.33(65.97)	88.88(70.57)	100.00(89.47)	100.00(89.47)	71.24
Pn 10 D 3.00 %	28.88(32.47)	52.22(46.28)	56.66(48.83)	72.21(58.25)	84.44(66.86)	88.88(70.57)	100.00(89.47)	100.00(89.47)	72.91
Pn 10 D 3.50 %	33.33(35.24)	53.33(46.94)	61.11(51.42)	79.99(63.48)	85.55(67.68)	88.88(70.57)	100.00(89.47)	100.00(89.47)	74.99
Pn 10 D 4.00%	45.55(42.43)	59.99(50.80)	66.66(54.75)	94.44(79.17)	96.66(83.50)	100.00(89.47)	100.00(89.47)	100.00(89.47)	82.91
Activated clay 1.00%	95.55(77.99)	100.00(89.47)	100.00(89.47)	100.00(89.47)	100.00(89.47)	100.00(89.47)	100.00(89.47)	100.00(89.47)	99.44
Fly ash 4.00%	4.44(11.99)	11.11(19.42)	21.10(27.28)	38.88(38.56)	47.77(43.72)	61.10(51.44)	67.77(55.41)	75.55(60.37)	40.96
Control	0.00(0.52)	3.33(10.51)	6.66(14.63)	13.33(21.41)	15.55(23.19)	21.11(27.33)	28.88(32.50)	31.11(33.89)	14.99

Figures in parentheses are transformed Arcsine values

	SED	CD (0.05)
Treatment	0.81	1.61 **
Period	0.69	1.37**
Treatment x period	2.30	4.55 **

Table 2. Effect of *Piper nigrum* 10 D on oviposition, egg hatching and adult emergence of *Callosobruchus maculatus*

Treatments	No. of eggs laid *	Hatchability ** %	No. of adults emerged *	% Seed weight loss after 45 days**	Seed germination after 90 days** %
Pn10D 0.50 %	61. 33(1.78)e	73.73(59.21)c	28.00(1.44)ef	12.03(20.27)e	57.33(49.22)c
Pn10D 1.00 %	50.66(1.70)d	72.67(58.51)c	25.33(1.40)de	11.11(19.47)e	65.33(53.93)cd
Pn10D1.50 %	50.33(1.70)d	69.64(56.19)c	22.33(1.34)cd	6.11(14.25)d	72.00(58.09)c
Pn10D 2.00 %	42.00(1.62)c	64.49(53.43)ab	17.66(1.24)c	4.78(12.59)bc	77.33(61.59)b
Pn10D 2.50 %	31.66(1.50)b	57.12(49.09)b	13.33(1.12)b	2.50(8.98)b	80.00 (63.51)b
Pn10D 3.00 %	30.00(1.47)b	63.15(52.62)ab	11.66(1.06)b	2.80(9.59)b	81.33(64.43)b
Pn10D 3.50 %	28.00(1.44)b	59.29(50.36)a	7.66(0.87)a	0.35(3.33)a	85.33(67.52)b
Pn10D 4.00 %	22.66(1.35)a	59.29(50.36)a	7.00(0.84)a	0.35(3.33)a	93.33(75.20)a
Activated clay 1.00 %	41.33(1.61)c	72.62(58.47)c	20.33(1.30)cd	6.43(14.67)d	48.00(43.85)e
Control	172.00(2.23)g	93.22(69.73)d	143.66(2.15)f	19.31(26.07)g	24.00(29.28)f
Fly ash 4.00%	103.00(2.01)f	84.80(67.07)d	68.33(1.48)g	16.18(23.70)f	10.66(18.98)g

*Figures in parentheses are transformed logarithmic values; ** Figures in parentheses are transformed arcsine values;
In a column means followed by same letter(s) are not significantly different (p=0.05) by DMRT

admixed with cowpea seed caused 96 per cent mortality of adults of *C. maculatus*. Lowest mortality 13.33 per cent was recorded by untreated check.

Maximum mortality was noticed in Pn10D 4.00 per cent followed by Pn10D 3.50 per cent, Pn10D 3.00 percent and Pn10D 2.50 per cent at 60 hours after the treatment. Miyakado *et al*. (1979) observed that dust of *P. nigrum* was toxic to bruchids. At 72 hours after the treatment complete mortality (100.00%) was noted in Pn10D 4.00 per cent, 88.88 percent mortality recorded by three doses *viz.*, Pn10D 3.50, 3.00 and 2.50 percent. Among the different doses of Pn10D lowest mortality were recorded by 0.50 percent whereas untreated check. Hundred per cent mortality recorded by Pn10D 3.50, 3.00, 2.50, 2.00 and 1.50 per cent, Pn10D 1.00 percent, 0.50 percent, while fly ash alone 4.00 per cent, lowest mortality (28.88%) was seen in untreated check at 84 hours after treatments. Ivbijaro and Agbage (1986) stated that 0.1g *P nigrum* /20g cowpea seed caused 100 per cent mortality of *C. maculatus* adults. All the beetles were dead in all the doses of Pn10D treatment, where as fly ash alone 4.00 per cent and untreated check was recorded 75.55 and 31.11 percent mortality at 96 hours after the treatments. Senthil Kumar *et al*. (1998) have successfully utilized flyash, in the form of dust, to control pre-harvest pests of soybean. Pn10D 4.00 percent was significantly superior to all other Pn10D treatments but significantly lower than activated clay.

Black gram seeds were treated with different concentrations of Pn10D 10 D (Pn 10D) *viz*.,0.50, 1.00, 1.50, 2.00, 2.50,3.00,3.50 and 4.00 per cent and data (Table 2) on oviposition, hatchability and adult emergence, weight loss and germination were recorded. Regarding the oviposition, Pn10D 4.00 per cent treated seeds had less number of eggs 26.66 eggs were laid followed by Pn10D 3.50 which was on par with Pn10D 3.00, Pn10D 2.50. Among the different Pn10D doses maximum number of eggs laid by *C. maculatus* in Pn10D 0.50 per cent, Pn10D 1.00 per cent and Pn10D 1.50 per cent compare to activated clay 1.00 per cent (41.33) fly ash alone 4.00 per cent and untreated check. Khanna (1995) who reported that *P. guieneense* seed powder at low concentration reduced oviposition and adult emergence. *Piper nigrum* was moderately toxic to this pest (Rajapakse and Ratnasekera, 2008). However when we impregnated with fly-ash the impact has been increased.

The hatchability percent was maximum in untreated check which had on par with activated clay 1.00 percent and fly ash alone 4.00 percent. In case of Pn10D treatments highest egg hatchability percentage seen in Pn10D treated seeds of 0.50, 1.00, 1.50 and 2.00 percent was recorded 73.73, 72.67, 69.64 and 64.49 percent, respectively. Among the different treatments, Pn10D lowest egg hatchability Pn10D 4.00 3.50 (59.29 %) and 3.00. Few adult beetles were emerged from black gram seeds treated with Pn10D 4.00 percent which was on par with (Pn10D 3.50 per cent) followed by Pn10D 3.00 percent which had on par with (Pn10D 2.50 per cent) and Pn10D 2.00 per cent. Among the different treatments of Pn10D maximum number of emerged from Pn10D 0.50 percent, Pn10D 1.00 percent and Pn10D 1.50 percent. Standard check activated clay 1.00 percent, when compared to fly ash alone 4.00 percent and untreated check. The present finding on fly ash is in agreement with the finding of Badari Prasad *et al*. (2001). No adult emergence of *C. chinensis* in pulses treated with flyash until first 14 months of observations (Mendki *et al*., 2000)

Seed weight loss was 0.35 percent in Pn10D 4.00 percent which was on par with (Pn10D 3.50 percent) followed by Pn10D 3.00 per cent which was on par with (Pn10D 2.50 percent), Pn10D 2.00 per cent and Pn10D 1.50 percent. Among the different Pn10D concentrations highest seed weight loss was showed in Pn10D 0.50 percent and Pn10D 1.00 percent, compared to standard activated clay 1.00 percent, fly ash alone 4.00 percent and untreated check was recorded 6.43, 16.18 and 19.31percent seed weight loss, respectively at 45 days after treatment. Umoetoock *et al*. (2004) reported that dried fruit powder of *P. guineense* at 0.5g per 50g of cowpea seed registered less damage and weight loss due to *Callosobruchus maculatus*.

Germination percentage was maximum in Pn10D 4.00 percent followed by Pn10D 3.50 percent which was on par with three doses of Pn10D viz., Pn10D 3.00, 2.50 and 2.00 percent. Among the different Pn10D doses minimum germination percentage was noticed in lower dose of Pn10D 0.50 percent, Pn10D 1.00 percent and Pn10D 1.50 percent compared to standard activated clay 1.00 per cent (24.00%), untreated check (24.00%) and fly ash alone 4.00 percent. Ivbijaro and Agbaje, (1986) reported that surface treatment of cowpea with *P. nigrum* seed at 1.5 g/ 20 g did not reduce seed germination. Mendki *et al*. (2001) reported that flyash effectively suppress population of *C. chinensis* for as long as 16–18 months. Five thousand kg pulses protected by application of 1 kg flyash.

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