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EFFICACY OF *PIPER NIGRUM* AND *CUMINUM CYMINUM* SEED POWDERS AGAINST *CALLOSOBRUCHUS CHINENSIS* L.

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ABSTRACT

Evaluation of efficacy of black pepper (*Piper nigrum* L.) and cumin (*Cuminum cyminum* L.) seed powder against *Callosobruchus chinensis* L. infesting green gram revealed a dose-dependent adult mortality and a positive correlation with period of exposure. A complete adult mortality was observed with *P. nigrum* seed powder @ 1 g/ 100 g seed as against 60% adult mortality with *C. cyminum* at 72 hr after treatment (HAT). The LC_{50} values of *P. nigrum* and *C. cyminum* seed powders were observed as 0.16 and 1.47 g/ 100 g of seed at 48 HAT. Both *P. nigrum* and *C. cyminum* seed powders showed strong ovicidal properties, and affecting the adult emergence to an extent of 0 and 6% when used @ 10 g/ 100 g seed as against 90-91% in untreated control.

Key words: *Callosobruchus chinensis,* green gram, *Piper nigrum, Cuminum cyminum,* seed powders, efficacy, oviposition deterrent, ovicidal, adult mortality, bioactive compounds, LC_{50}

Stored products of agricultural and animal origin are globally attacked by several biotic stresses, out of which insect pests account 2.0 - 4.2% (Kumar and Kalita, 2017). About 14 mt of food grains is lost during storage annually in India (Banga et al., 2020), where insect pests alone cause a loss of nearly 20-25% (Rajashekar et al., 2012). Over 600 species of beetles and 70 species of moths cause quantitative and qualitative losses in stored products (Rajendran, 2002), to a tune of 20-30% in the tropical and 5-10% in the temperate countries (Talukder, 2006; Tadesse and Ali, 2021). Deteriorations of grain chemical composition due to insect infestations aggravate the situation (Grish et al., 1975; Pushpamma and Reddy, 1979). Serious damage to the stored pulses including cowpea, pigeonpea, chickpea, soya bean, black-eyed beans and others, is caused by the pulse beetle, *Callosobruchus chinensis* L. (Coleoptera: Bruchidae) (Srivastava and Dhaliwal, 2010; Ghosh et al., 2007; Appleby and Credland, 2004). Minimizing post-harvest loss could be a viable and sustainable option to assure food security. Protection of stored pulses from insect-pest attack has been a major challenge in recent past as use of insecticides lead to many hazards (Pavela, 2008; Metcalf, 1975). This has increased thrust on use of natural plant products for storage insect pest management (Pirali- Kheirabadi and da Silva 2010), which led to identification of plant products (Akinneye et al., 2006; Emeasor et al., 2005; Nadra, 2006). This study evaluates seed powders of some spices against *C. chinensis* attacking stored green gram.

MATERIALS AND METHODS

The experiment was conducted at the Post Graduate Research Laboratory, Department of Entomology, Assam Agricultural University, Jorhat (94°22′E, 26°75′N, 91 masl) during 2018-19. Based on previous research and available information, spices like black pepper *Piper nigrum* L. (Family: Piperaceae) and cumin, *Cuminum cyminum* L. (Family: Apiaceae) were selected. Seeds were collected from local market, dried under shade and ground to finer particles by sieving with 150 μm mesh size, and stored in airtight glass containers under refrigeration until their use in subsequent experiments. Mass culturing of *C. chinensis* was carried out on green gram seeds, *Vigna radiata*, with 1 kg seeds taken in 5 l plastic container; 10 pairs of adults (1: 1 sex ratio) were released for egg-laying in these. Insects were removed after 48 hr of release and containers were put into the BOD incubator at 30ºC and 80-85% RH for the emergence of adults (Kalita and Hazarika, 2020). The efficacy test was conducted with 100 g of uninfested green gram seeds in 200 ml plastic containers with open tops covered with muslin cloth. Plant products were admixed with the green gram seeds on a weight by weight (w/w) basis as per standard procedures to attain the dosage of 1.0, 2.0, 3.0, 4.0, 5.0, 7.5, and 10.0 g/ 100 g of seed. Later, 20 neonate adults (1: 1 sex ratio)

Table 1. Effect of *Piper nigrum* and *Cuminum cyminum* seed powders on adult mortality of *C. chinensis*

Dosage (g / 100 g seeds)	Adult mortality (%) at different time interval													
	Piper nigrum							*Cuminum cyminum*						
	6HAT	12HAT	24HAT	48HAT	72HAT	96HAT	120HAT	6HAT	12HAT	24HAT	48HAT	72HAT	96HAT	120HAT
10.0	50.00 (50.60)	71.67 (63.17)	98.33 (98.25)	100 (90.99)	100 (90.99)	100 (90.99)	100 (90.99)	45.00 (47.79)	51.67 (51.69)	78.33 (67.23)	85.00 (71.69)	91.67 (78.74)	100 (90.99)	100 (90.99)
7.5	35.00 (40.05)	66.67 (58.03)	93.33 (92.98)	100 (90.99)	100 (90.99)	100 (90.99)	100 (90.99)	41.67 (44.98)	45.00 (47.56)	66.67 (57.42)	81.67 (70.58)	88.33 (74.89)	95.00 (83.25)	100 (90.99)
5.0	46.67 (47.93)	63.33 (44.43)	95.00 (94.74)	100 (90.99)	100 (90.99)	100 (90.99)	100 (90.99)	30.00 (38.09)	33.33 (39.48)	60.00 (54.06)	71.67 (61.93)	80.00 (67.83)	95.00 (83.25)	100 (90.99)
4.0	30.00 (36.83)	55.00 (50.10)	96.67 (96.49)	100 (90.99)	100 (90.99)	100 (90.99)	100 (90.99)	30.00 (38.09)	33.33 (39.42)	50.00 (50.60)	65.00 (56.86)	78.33 (67.23)	91.67 (78.74)	100 (90.99)
3.0	30.00 (36.83)	41.67 (45.12)	96.67 (96.49)	100 (90.99)	100 (90.99)	100 (90.99)	100 (90.99)	23.33 (32.43)	26.67 (34.00)	46.67 (47.95)	65.00 (56.86)	76.67 (65.05)	90.00 (77.38)	100 (90.99)
2.0	25.00 (33.43)	40.00 (43.16)	90.00 (89.47)	98.33 (89.66)	100 (90.99)	100 (90.99)	100 (90.99)	21.67 (31.69)	23.33 (32.43)	43.33 (45.57)	60.00 (54.06)	70.00 (59.19)	88.33 (74.99)	88.33 (74.99)
1.0	20.00 (29.68)	38.33 (42.65)	81.67 (80.70)	96.67 (86.81)	100 (90.99)	100 (90.99)	100 (90.99)	13.33 (24.10)	16.67 (26.31)	40.00 (43.16)	46.67 (47.95)	60.00 (54.06)	61.67 (54.43)	88.33 (74.99)
Control	3.33 (0.33)	3.33 (0.33)	5.00 (0.33)	5.00 (0.33)	5.00 (0.33)	5.00 (0.33)	5.00 (0.33)	1.67 (0.33)	3.33 (0.33)	5.00 (0.33)	5.00 (0.33)	5.00 (0.33)	5.00 (0.33)	6.67 (0.33)
S.Ed. (±)	1.02**	2.01**	1.78**	0.76**	NS	NS	NS	1.42**	1.44**	1.07**	1.31**	1.07**	0.93**	0.89**
CD (p=0.05)	2.16	4.25	3.78	1.61	-	-	-	3.01	3.06	2.28	2.79	2.28	1.97	1.88
CD (p=0.01)	2.98	5.86	5.20	2.22	-	-	-	4.15	4.21	3.14	3.84	3.14	2.72	2.59
LC_{50} values	-	-	-	0.16	-	-	-	-	-	-	1.47	0.77	0.65	-
df	-	-	-	19	-	-	-	-	-	-	19	19	19	-
Reg. equation (y=a+bx)	-	-	-	3.943+ 2.199x	-	-	-	-	-	-	0.925+ 1.112x	1.242+ 1.084x	2.181+ 1.837x	-
Chi square (X^2)	-	-	-	32.810	-	-	-	-	-	-	12.114	10.075	28.624	-
Slope ± S Em	-	-	-	2.199± 0.492	-	-	-	-	-	-	1.112±0.092	1.084±0.098	1.837±0.128	-

Data within parentheses mean of the Abbott's corrected angular transformed values; HAT- Hours after treatment; y= probit kill, x=log dose

were released in each of the plastic containers and the data on adult mortality (%) was recorded at 6, 12, 24, 48, 72, and 96 hr after treatment (HAT). Each treatment was replicated thrice along with a control. To test the ovicidal properties, 20 neonate adults at 1:1 sex ratio were released into plastic containers containing 100 g seed for egg laying and insects were removed after 12 hr of release. Seeds were then treated with the edible plant powders @ 1, 5, and 10 g/ 100 g of seed and numbers of marked egg hatched was recorded when more than 90.0% adults emerged in the control. The data on adult mortality was recorded at different time intervals and the mortality was considered when the beetle did not respond to gentle touch. The data on % adult mortality were subjected to Abbott's correction, and subjected to angular transformation before ANOVA, p=0.05 under a completely randomized block design. The data on adult mortality were also subjected to probit analysis to calculate LC_{50} values using SPSS computer software (Version 12.0).

RESULTS AND DISCUSSION

The results revealed that treatments with *P. nigrum* seed powder were superior in controlling *C. chinensis*, with 100% adult mortality @ 1 g/ 100 g of seed at 96 HAT onwards as compared to 20%, 38.33%, 81.67% and 96.67% mortality at 6, 12, 24, 48, and 72, respectively; while treatments with 10 g/ 100g of seed recorded 100% mortality at 48 HAT followed by 98%, 71.67% and 50% adult mortality at 24, 12 and 6 HAT. Black pepper powder gave 100% adult mortality at the lowest dosage of 3.0 g/ 100g of seed after 48 HAT; while *C. cyminum* seed powder led to 100% mortality at 10 g/ 100g seeds after 96 and 120 HAT; least mortality of 13.33% was observed with 1 g/ 100 g of *C. cyminum* powder after 6 HAT. The adult mortality ranged from 88.33- 100% at 120 HAT as against 6.67% in untreated control (Table 1). Awoyinka et al. (2006) and Scott et al. (2005) revealed the insecticidal property of seed extract of black pepper against the *C. chinensis*. The toxicity of *P. nigrum* seed powder against *C. chinensis* could be attributed to chavin, piperine, and unsaturated amides (Lale, 1992). Mortality of *C. chinensis* increased with dosage and exposure period of the *C. cyminum* seed powder; and this can be attributed to the bioactive compounds like cymene, γ-terpinene, cuminaldehyde and (−) β-pinene (Srivastava and Dhaliwal, 2010).

The LC_{50} value of *P. nigrum* seed powder was found to be 0.16 g/ 100 g of seed at 48 HAT, while the LC_{50} values for *C. cyminum* seed powder against *C. chinensis*

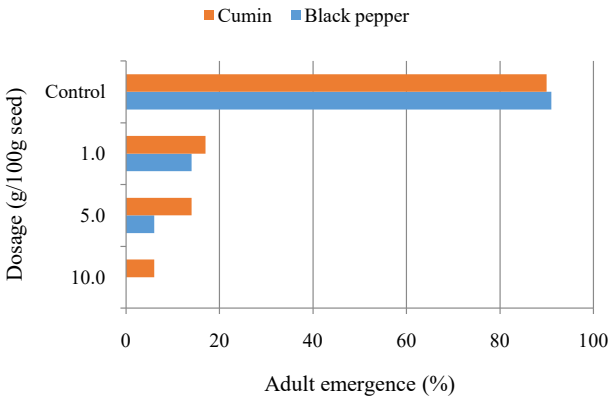

Fig. 1. Ovicidal effect of seed powders against *C. chinensis* (23 days after infestation)

was 1.47, 0.77 and 0.65 g/ 100g seeds at 48, 72 and 96 HAT, respectively (Table 1). The data on the effect of *P. nigrum* seed powder on ovicidal properties at 23 days of exposure revealed a complete inhibition of adult emergence @ 10 g/ 100g seed, while 6.00% adult emergence was observed with 5 g/ 100g seeds (Fig. 1); maximum emergence (14.00%) was observed with 1 g/ 100g seeds as compared to 91% in untreated control. With *C. cyminum* seed powder, the least emergence (6%) was observed @ 10 g/ 100g seeds followed by 14% @ 5 g/ 100g seeds; while maximum of 17% was observed with 1 g/ 100 g seeds as compared to 90% in the untreated control. The ovicidal effect of *P. nigrum* on *C. chinensis* might be attributed due to the progressive accumulation of the bioactive compounds on the treated seeds. It can be concluded that the dry seed powder of *P. nigrum* and *C. cyminum* could successfully be utilized against *C. chinensis* infesting green gram under storage.

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