

Relative Efficacy of Plant Products as Grain Protectant against *Sitophilus oryzae* (Linn.) in Stored Maize Grains

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Abstract: The efficacy of four plant products viz., black pepper powder, neem leaf powder, garlic clove powder and onion bulb powder @ 1, 3 and 5 g/100 g grains of maize was tested as grain protectant against *Sitophilus oryzae* (Linn.) in laboratory during 2007-08 at Department of Entomology, Rajasthan College of Agriculture, Udaipur. Black pepper powder @ 5% was found most effective causing highest adult mortality (63.33%) when released in freshly treated maize grains, lowest grain damage (10.10%), weight loss (5.00%) and adult emergence (60.00 adults). High adult mortality and low grain damage, weight loss and adult emergence was observed at the beginning, but mortality gradually declined and grain damage, weight loss and adult emergence increased as the duration of treatment increased from fresh to 21 days. Onion bulb powder 1% was found least effective by giving minimum adult mortality (11.67%), maximum grain damage (28.54%), weight loss (13.27%) and adult emergence (315.00 adults). The germination of maize grains was not significantly affected due to the treatments of different plant products up to 120 days of treatment.

Key words: *Sitophilus oryzae*, plant products, efficacy, maize, grain protectant.

Maize is attacked by number of insect pests during storage. *Sitophilus oryzae* has been reported as an important insect pest of storage causing 65.6 to 98.5% infestation (Pathak and Jha, 2003). Both adults and larvae feed on whole grains of cereals. *S. oryzae* alone causes about 50% loss in weight in storage (Koura and El-Halfway, 1967). The use of plant products as grain protectant has many advantages over insecticides as they do not have mammalian toxicity and health hazards, are less expensive, eco-friendly, easily available, easy in handling and have no adverse effect on seed viability. Therefore, the present study was conducted to evaluate the efficacy of four plant products for safe storage of maize grains against *S. oryzae* under laboratory conditions.

Materials and Methods

The experiment was conducted in the laboratory at the Department of Entomology, Rajasthan College of Agriculture, Udaipur, during 2007-08. The four test plant products namely black pepper, neem leaf, garlic clove and onion bulb were dried in shade, powdered in a grinder and passed through 60 mesh size sieves. The powder was thoroughly mixed

with the grains @ 1.0, 3.0 and 5.0 g powder per 100 g of maize grains (w/w) to study their efficacy against *S. oryzae* at 0, 7, 14 and 21 days after treatment. Two kg of maize grains treated with different plant products at different concentrations were stored in tightly closed screw capped glass jars for further experimentation. Fresh treated grains, 7, 14 and 21 days after treatment (100 g each in three replications) were taken out separately for release of 20 pairs of newly emerged adults of *S. oryzae*. The mouth of each container was covered with muslin cloth and tightened with rubber bands. These containers were kept in B.O.D. incubator at a temperature of 30±1°C and 75±5% relative humidity. Adult mortality was recorded 4 days after release, while grain damage, weight loss and adult emergence were observed after 4 months of release. The mortality recorded was corrected as suggested by Abbott's (1925):

The effect of plant products on germination of maize grains was also tested at 60 and 120 days of treatment. Hundred grains were randomly taken from the above mentioned glass jars of each treatment and were placed in sterilized petridish of 15 cm diameter lined with blotting paper and moistened daily with

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distilled water. Three petridishes were prepared for each treatment including untreated check and kept at room temperature (28-32°C) for seven days that provide the grains sufficient time to germinate. The number of germinated grains was counted.

Results and Discussion

Adult mortality

The data on adult mortality after 4 days of release on freshly treated, 7, 14 and 21-day-old treated maize grains with different plant products revealed that significantly higher adult mortality was recorded in all test doses of each plant product as compared to control (Table 1). The mortality increased with the increase in the dose level of each plant product.

Data recorded for adult mortality after 4 days of release in freshly treated maize grains showed the highest mortality (63.3%) with black pepper powder (5%) followed by 51.6% and 50.0% in neem leaf powder (5%) and black pepper powder (3%), respectively, but were statistically at par. The mortality recorded in the remaining concentrations of tested plant products varied from 11.6 to 45.8%.

It is also apparent from the Table 1 that increase in the duration after treatments from fresh to 21 days reduced the efficacy of plant products resulting in low adult mortality. Data recorded for adult mortality after 4 days of release on 21-day-old treated maize grains showed highest adult mortality (45.0%) in black pepper powder (5%) followed by 38.3

Table 1. Effect of different plant products on adult mortality and weevil emergence of *Sitophilus oryzae* in maize grains

Powdered plant products	Dose % (w/w)	Adult mortality (%) after 4 days of release*				Number of weevils emerged after 4 months of release**			
		0- DAT	7- DAT	14- DAT	21- DAT	0- DAT	7- DAT	14- DAT	21- DAT
Black pepper	1.0	18.33	16.67	14.17	11.67	213.67	229.67	255.67	306.00
		(25.34)	(24.08)	(22.09)	(19.95)	(14.63)	(15.17)	(16.00)	(17.51)
	3.0	50.00	45.83	40.00	36.67	110.67	125.00	140.33	180.33
		(45.00)	(42.61)	(39.23)	(37.26)	(10.51)	(11.19)	(11.86)	(13.44)
Neem leaf	1.0	63.33	58.33	52.50	45.00	60.00	72.67	95.67	129.00
		(52.74)	(49.80)	(46.43)	(42.13)	(7.76)	(8.55)	(9.80)	(11.38)
	3.0	15.83	14.17	11.67	9.17	233.00	242.00	268.33	320.67
		(23.35)	(22.09)	(19.95)	(17.59)	(15.27)	(15.56)	(16.39)	(17.92)
Garlic clove	1.0	40.83	37.50	30.83	24.17	140.00	158.33	175.67	229.00
		(39.72)	(37.76)	(33.73)	(29.44)	(11.84)	(12.59)	(13.26)	(15.14)
	3.0	51.67	46.67	41.67	38.33	80.33	93.00	115.00	150.33
		(45.96)	(43.09)	(40.20)	(38.25)	(8.98)	(9.66)	(10.74)	(12.27)
Onion bulb	1.0	14.17	12.50	10.00	8.33	275.33	288.67	325.00	398.00
		(22.05)	(20.70)	(18.43)	(16.74)	(16.61)	(17.00)	(18.04)	(19.96)
	3.0	35.00	30.83	26.67	21.67	180.67	192.33	221.00	272.67
		(36.26)	(33.73)	(31.09)	(27.73)	(13.46)	(13.88)	(14.88)	(16.53)
Control	1.0	45.83	40.00	34.17	30.00	125.33	139.00	165.67	208.00
		(42.61)	(39.23)	(35.77)	(33.21)	(11.20)	(11.81)	(12.88)	(14.43)
	3.0	11.67	10.83	8.33	7.50	315.00	329.33	368.33	415.33
		(19.95)	(19.04)	(16.74)	(15.75)	(17.75)	(18.16)	(19.20)	(20.39)
S. Em. $\pm$	1.0	29.17	25.00	20.83	15.83	185.67	201.67	231.00	280.33
		(32.66)	(29.98)	(27.15)	(23.43)	(13.64)	(14.22)	(15.21)	(16.76)
	3.0	39.17	32.50	27.50	22.50	148.67	161.00	178.33	252.00
		(38.74)	(34.75)	(31.61)	(28.32)	(12.20)	(12.70)	(13.36)	(15.89)
C.D. at 5%	-	0.00	0.00	0.00	0.00	535.33	521.00	500.33	515.67
		(0.00)	(0.00)	(0.00)	(0.00)	(23.14)	(22.83)	(22.38)	(22.72)
	-	0.86	0.80	0.65	0.69	0.30	0.30	0.25	0.24
		2.50	2.33	1.88	1.99	0.87	0.87	0.73	0.71
C.V. (%)	-	4.56	4.54	4.01	4.68	3.81	3.69	2.90	2.57

*Data in parentheses are angular transformed values; **Data in parentheses are square root ($x + 0.5$) transformed values DAT= Days after treatment

and 36.6% in neem leaf powder (5%) and black pepper powder (3%), respectively, but were statistically at par. The mortality recorded in the remaining concentrations of tested plant products varied from 7.5 to 30.0%.

Grain damage

It is evident from the Table 2 that all treatments reduced grain damage and were significantly superior to control (48.6 to 53.5%). Grain damage decreased with increase in the dose level of each plant product.

Data recorded on grain damage after 4 months of infestation in freshly treated maize grains showed that maximum protection with

significant lowest grain damage (10.1%) was recorded in black pepper powder (5%) followed by 12.0% and 12.6% in neem leaf powder (5%) and black pepper powder (3%), respectively, being statistically at par. Minimum protection with maximum grain damage (28.5%) was observed in onion bulb powder 1%. The grain damage recorded in the remaining concentrations of tested plant products varied from 14.1 to 25.0%.

It is also evident from the Table 2 that increase in the duration of treatments from fresh to 21 days reduced the efficacy of plant products resulting in increased grain damage. Data recorded on grain damage after

Table 2. Efficacy of different plant products against *Sitophilus oryzae* on grain damage, weight loss and germination of maize grains

Powdered plant products	Dose % (w/w)	Grain damage (%) after 4 months of infestation				Weight loss (%) after 4 months of infestation				Germination (%)	
		0-DAT	7-DAT	14-DAT	21-DAT	0- DAT	7- DAT	14- DAT	21- DAT	60 days	120 days
Black pepper	1.0	20.81 (27.13)	21.80 (27.83)	23.30 (28.86)	25.61 (30.40)	9.80 (18.24)	10.50 (18.90)	11.80 (20.09)	12.60 (20.79)	93.00 (74.82)	92.67 (74.43)
	3.0	12.61 (20.79)	14.63 (22.48)	16.08 (23.63)	17.68 (24.85)	6.03 (14.22)	6.90 (15.23)	7.80 (16.22)	8.70 (17.15)	92.67 (74.40)	92.33 (73.98)
	5.0	10.10 (18.53)	11.04 (19.41)	12.21 (20.44)	12.92 (21.06)	5.00 (12.92)	5.20 (13.17)	5.90 (14.05)	6.10 (14.29)	92.33 (74.07)	90.33 (72.02)
Neem leaf	1.0	22.04 (28.00)	23.04 (28.68)	25.90 (30.59)	27.78 (31.81)	10.00 (18.43)	11.60 (19.91)	12.30 (20.53)	13.70 (21.72)	92.00 (73.82)	91.67 (73.53)
	3.0	15.00 (22.78)	16.96 (24.31)	18.48 (25.46)	19.68 (26.33)	7.20 (15.56)	8.20 (16.63)	8.90 (17.36)	9.60 (18.05)	91.33 (73.12)	91.00 (72.56)
	5.0	12.09 (20.35)	13.00 (21.12)	14.97 (22.75)	16.47 (23.94)	5.57 (13.64)	6.10 (14.29)	7.20 (15.56)	8.00 (16.42)	91.00 (72.70)	90.67 (72.31)
Garlic clove	1.0	25.00 (30.00)	26.80 (31.18)	27.49 (31.62)	28.36 (32.18)	11.50 (19.82)	12.70 (20.88)	13.30 (21.39)	14.20 (22.14)	92.33 (74.12)	92.00 (73.64)
	3.0	17.17 (24.48)	18.47 (25.45)	19.87 (26.47)	21.50 (27.62)	8.13 (16.57)	9.00 (17.45)	9.60 (18.05)	10.40 (18.81)	91.67 (73.26)	91.00 (72.79)
	5.0	14.10 (22.05)	15.69 (23.33)	16.92 (24.29)	18.01 (25.11)	6.80 (15.11)	7.20 (15.56)	8.00 (16.42)	8.80 (17.24)	91.00 (72.61)	90.33 (72.02)
Onion bulb	1.0	28.54 (32.29)	29.82 (33.09)	30.20 (33.33)	31.61 (34.20)	13.27 (21.36)	13.80 (21.81)	14.50 (22.38)	15.60 (23.26)	93.33 (75.28)	93.00 (74.82)
	3.0	18.82 (25.71)	20.01 (26.56)	21.87 (27.88)	23.00 (28.65)	9.20 (17.65)	10.20 (18.62)	10.90 (19.28)	11.50 (19.81)	93.00 (74.93)	92.33 (74.21)
	5.0	15.51 (23.19)	17.19 (24.49)	19.01 (25.85)	20.24 (26.73)	7.43 (15.82)	8.30 (16.74)	9.00 (17.45)	9.80 (18.24)	92.00 (73.70)	90.67 (72.25)
Control	-	53.52 (47.02)	51.99 (46.14)	48.67 (44.24)	50.26 (45.15)	25.20 (30.13)	25.00 (30.00)	23.80 (29.20)	24.03 (29.36)	92.33 (74.12)	91.33 (72.95)
S. Em. $\pm$		0.37	0.37	0.36	0.41	0.19	0.24	0.27	0.31	1.76	1.61
C.D. at 5%		1.08	1.09	1.04	1.19	0.54	0.69	0.79	0.89	NS	NS
C.V. (%)		2.45	2.38	2.20	2.43	1.83	2.23	2.46	2.68	4.12	3.81

Data in parentheses are angular transformed values, DAT = Days after treatment

4 months of infestation in 21-day-old treated maize grains showed maximum protection with significant lowest grain damage (12.9%) was observed in black pepper powder (5%) followed by 16.4, 17.6 and 18.0% in neem leaf powder (5%), black pepper powder (3%) and garlic clove powder (5%), respectively, but were statistically at par. Minimum protection with maximum grain damage (31.6%) was observed in onion bulb powder 1% and was significantly different to all test concentrations. The grain damage recorded in the remaining concentrations of tested plant products varied from 19.6 to 28.3%.

Weight loss

It is evident from Table 2 that all treatments reduced weight loss and were significantly superior to control (23.8 to 25.2%). Grain weight loss decreased with increase in the dose level of each plant product.

Data recorded on weight loss after 4 months of infestation in freshly treated maize grains showed that significant minimum weight loss (5.0%) was recorded in black pepper powder (5%) followed by 5.5 and 6.0% in neem leaf powder (5%) and black pepper powder (3%), respectively. Maximum weight loss (13.2%) was observed in onion bulb powder (1%) and was significantly different to all test concentrations.

Increase in the duration of treatments from fresh to 21 days reduced the efficacy of plant products resulting in increased grain weight loss. Maximum protection with significant lowest weight loss, 6.1%, was recorded in black pepper powder (5%) followed by 8.0, 8.7 and 8.8% in neem leaf powder (5%), black pepper powder (3%) and garlic clove powder (5%), respectively, after 4 months of infestation in 21-day-old treated maize grains, but were statistically at par. Minimum protection with maximum weight loss (15.6%) was observed in onion bulb powder (1%) and was significantly different to all test concentrations. Weight loss in remaining concentrations of tested plant products varied from 9.6 to 14.2%.

Adult emergence

Significantly lower adult emergence was observed in all test doses of plant products as compare to control (500.33 to 535.33 adults). Adult emergence decreased with increase in the dose level of each plant product (Table 1).

Adult emergence after 4 months of release in freshly treated maize grains showed that significant lowest adult emergence, 60.0 adults, was recorded in black pepper powder (5%) followed by 80.3 adults in neem leaf powder (5%). Maximum adult emergence, 315.0 adults, was observed in onion bulb powder (1%) and was significantly different to all test concentrations. Adult emergence recorded in the remaining concentrations of tested plant products varied from 110.6 to 275.3 adults.

Increase in the duration of treatments from fresh to 21 days reduced the efficacy of plant products resulting in high adult emergence. Data recorded on adult emergence in 21-day-old treated maize grains showed that significant lowest adult emergence, 129.0 adults, was recorded in black pepper powder (5%) followed by 150.3 and 180.3 adults in neem leaf powder (5%) and black pepper powder (3%), respectively. Maximum adult emergence (415.33 adults) was recorded in onion bulb powder (1%) and was significantly different to all test concentrations. Adult emergence recorded in remaining concentrations of tested plant products varied from 208.00 to 398.00 adults.

The results of present investigation corroborate with the observations of Mishra *et al.* (1992) who reported 63.3% mortality of *S. oryzae* after 75 days of treatment, 11.8% grain damage, 5.2% weight loss after 90 days of treatment with neem leaf powder @ 5 g/100 g wheat grains and 184.0 and 56.3 adult emergence of *S. oryzae* after 90 days of release in maize grains treated with neem leaf powder at 3 and 5% concentrations, respectively. Aguiar *et al.* (1994) reported significant adult mortality of *Sitophilus* sp. on stored rice after treatment with black pepper powder 1.5 and 3.0 g/100 grains. Sharma (1995) reported no emergence of adult *R. dominica* after 9 months of storage of maize grains treated with neem leaf powder at 5 and 10% while 16.2 and 23.6 adults emerged at 2% concentration after 3 and 9 months of storage, respectively. Sharma (1999) reported that 5% neem leaf powder fully protected maize grains for 5 months against *S. oryzae*. Ansari and Srivastava (2004) observed that black pepper powder and neem leaf powder at 10 g kg⁻¹ rice grains were highly effective and caused 94.29 and 87.17% adult mortality of *S. oryzae* after 30 days of release, 2.03 and

7.04% grain damage and 1.95 and 7.64% weight loss after 4 months of infestation by *S. oryzae*, respectively. Meghwal *et al.* (2005) found 46.66 and 43.33% adult mortality of *Callosobruchus chinensis* (Linn.) after 3 days of release in the freshly treated moth bean grains with garlic clove and onion bulb powder @ 12 g/100 g grains, respectively.

Germination

The grains treated with different plant products were stored for 60 and 120 days to know the effect on germination. It is evident from the Table 2 that there was no significant difference on germination among treatments and all treatments were also at par with control. The germination of grains ranged from 91.00 to 93.33% after 60 days of storage while after 120 days it varied from 90.33 to 92.67%.

The results of present investigation corroborate with Sundria *et al.* (2001) who observed that six botanicals viz. ratanjot, garlic, neem seed kernel, neem leaf and black pepper powder @ 20 g kg⁻¹ grains, and neem seed kernel suspension (20 ml) had no adverse effect on seed viability of green gram even after four months of storage. Singh and Sharma (2002) found that leaves powder of neem, tulsi, mehandi and pudina @ 1, 2.5 and 5% did not affect the germination of green gram seed. Meghwal *et al.* (2005) found no adverse effect on the germination of moth bean grains even after long duration of storage (150 days) treated with neem seed kernel powder, neem leaf powder, garlic clove powder and onion bulb powder @ 4, 8 and 12 g/100 g grains.

It is therefore, concluded that black pepper powder and neem leaf powder at 5% concentration can be mixed with grain in storage for protection from insect pest and no adverse effect of storage up to months was observed on the germination of maize grains.

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