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Promising New Grain Protectant—(Protect-It) against Rice Weevil *Sitophylus oryzae* (L.)

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Abstract

Cent per cent mortality was noticed in DE (diatomaceous earth at 0.3, 0.25, 0.2 and 0.15%. However, no mortality was recorded in control during the storage period of two months. Thus 0.0% seed damage was recorded in 0.3 and 0.25% and it is at par with DE at 0.2% as it recorded 2.07% seed damage. DE at 0.3 and 0.25% recorded higher seed germination (95.63%) during two months of storage. However, 0.1% was found to be at par with 0.05% (89.5%) and 0.025% (87.99%). Least germination (61.84%) was recorded in untreated control.

Key words : Diatomaceous earth (Protect-It), *S. oryzae*, Mortality, Seed germination.

Sorghum is the most important crop after wheat, rice and maize grown widely in tropics and sub-tropics. Nearly 75% of the world sorghum is used for grain purpose meant for human consumption. Rice weevil, *Sitophilus oryzae* L. is the major pest of stored cereals all over the world (1). *S. oryzae* causes enormous loss upto cent per cent in stored cereals in India and other countries (2, 3). This evidently indicated importance of *S. oryzae* in storage of jowar. Prevention of loss in stored products due to insects is of utmost importance. Insecticides when properly used will continue to play an important role in reducing the storage losses due to insect pests, but the indiscriminate use of insecticides has posed several problems like residual toxicity, resistance development and environmental hazards. There is a need to find the alternatives to the chemicals that can effectively prevent the storage losses, safer to the human beings and least detrimental to environment. This strategy could be achieved by exploiting formulated diatomaceous earth (DE)—a fossil remains of diatom skeletons. Diatoms are green or brown algae that grow in fresh water lakes and marine estuaries. Deposits are spread over the planet in areas ranging from an acre or less to some covering thousands of acres. It is said many of these deposits are at least 20 million years old. It disrupts the epicuticle by absorption of lipids and insects are more vulnerable to desiccation once they lose the protection of the water proof layers. The insecticidal efficacy of DE varies among products and can be affected by physical properties of the DE like the temperature and relative humidity (RH) at which insects are exposed and the target insect species (4, 5). This strategy could be achieved by exploiting formulated diatomaceous earth (DE)—which is the fossil remains of diatom skeletons. Diatoms are green or brown algae that grow in fresh water lakes and marine estuaries. Deposits are spread over the planet in areas ranging from an acre to some thousands of acres. It disrupts the epicuticle by absorption of lipids and insects are more vulnerable to desiccation once they lose the protection of the water proof layers. To assess the effect of prevailing environmen-tal conditions, an experiment was conducted in the Department of Agricultural Entomology, UAS Dharwad, Karnataka, India.

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Methods

A formulated product of diatomaceous earth,

Table 1. Effect of diatomaceous earth (DE) on mortality of rice weevil adults at room temperature. DAT—Days after treatment. Figures in parentheses are arc sine transformed values. Means in the columns followed by the same alphabet do not differ significantly by DMRT (P = 0.01%).

Treatments	Dosage (%) (wt/wt)	On DAT 15	30	45	60	Mean
T_1 DE	0.025	85.00c (67.19)	96.67b (79.59)	88.33b (69.99)	98.33b (82.95)	92.08c (73.71)
T_2 DE	0.050	91.67b (73.37)	100.00a (89.96)	95.00b (77.33)	100.00a (89.96)	96.67b (79.55)
T_3 DE	0.10	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)
T_4 DE	0.15	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)
T_5 DE	0.20	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)
T_6 DE	0.25	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)
T_7 DE	0.30	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)
T_8 Control	–	0.00d (0.00)	0.00c (0.00)	0.00d (0.00)	0.00c (0.00)	0.00d (0.00)
CV (%)		1.52	1.01	1.61	1.34	1.24
CD at 1%		2.72	1.89	2.92	2.53	2.27
SE ±		0.64	0.45	0.69	0.61	0.53

Protect—It was procured from USA Co., Heldey Technologies Ins. Protect—It is a mixture of fresh water DE with 10% silica aerogel to enhance insecticidal activity (6). It is a beige-colored DE containing approximately 83.70% amorphous silicon dioxide, 5.6% Al_2O_3, 2.3% Fe_2O_3, 0.9% CaO, 0.3% MgO and 0.9%

Table 2. Effect of diatomaceous earth (DE) on seed damage due to rice weevil under laboratory condition. DAT—Days after treatment. Figures in parentheses are arc sine transformed values. Means in the columns followed by the same alphabet do not differ significantly by DMRT (P = 0.01%).

Treatments	Dosage (%) (wt/wt)	On DAT 15	30	45	60	Mean
T_1 DE	0.025	13.20b (21.28)	10.68b (19.07)	12.00b (20.26)	10.00b (18.43)	11.47b (19.73)
T_2 DE	0.050	7.00c (15.34)	6.80c (15.11)	7.07c (15.40)	6.33c (14.57)	10.37c (18.78)
T_3 DE	0.10	6.65c (14.93)	5.00d (12.92)	6.00d (14.17)	5.33d (13.34)	5.75d (11.76)
T_4 DE	0.15	4.31d (11.98)	3.50e (10.78)	4.17e (11.77)	3.00e (9.97)	3.75r (9.97)
T_5 DE	0.20	2.65e (9.36)	2.00f (8.13)	2.30f (8.72)	1.33f (6.60)	2.07f (8.31)
T_6 DE	0.25	0.00f (0.00)	0.00f (0.00)	0.00f (0.00)	0.00f (0.00)	0.00f (0.00)
T_7	0.30	0.00f (0.00)	0.00f (0.00)	0.00f (0.00)	0.00f (0.00)	0.00f (0.00)
T_8—Control	–	42.30a (40.55)	49.33a (44.60)	54.00a (47.28)	60.00a (50.75)	51.41a (95.78)
CV (%)		1.56	1.77	1.89	2.24	1.42
CD at 1%		0.53	0.59	0.67	0.77	0.68
SE ±		0.13	0.14	0.16	0.18	0.16

Table 3. Effect of diatomaceous earth (DE) on jowar seed weight loss under laboratory condition. DAT—Days after treatment. Figures in parentheses are arc transformed values. Means in the columns followed by the same alphabet do not differ significantly by DMRT (P = 0.01%).

Treatments	Dosage (%) (wt/wt)	On DAT 15	30	45	60	Mean
T_1 DE	0.025	3.50b (10.79)	3.30b (10.46)	3.41b (10.63)	3.27b (10.42)	3.37b (10.55)
T_2 DE	0.050	2.42c (8.95)	2.30c (8.72)	2.47C (9.03)	2.33c (8.78)	2.38c (8.89)
T_3 DE	0.10	1.86d (7.84)	1.80b (7.71)	1.87d (7.85)	1.77d (7.63)	1.82d (7.75)
T_4 DE	0.15	1.41e (6.81)	1.30e (6.54)	1.37e (6.71)	12.33e (6.37)	1.33e (6.62)
T_5 DE	0.20	0.90f (5.44)	0.80f (5.13)	0.87f (5.34)	0.73f (4.91)	0.82f (5.12)
T_6 DE	0.25	0.00g (0.00)	0.00g (0.00)	0.00g (0.00)	0.00g (0.00)	0.00g (0.00)
T_7 DE	0.30	0.00g (0.00)	0.00g (0.00)	0.00g (0.00)	0.00g (0.00)	0.00g (0.00)
T_8 —Control	–	17.85a (24.98)	18.27a (25.29)	18.67a (25.59)	19.33a (26.07)	18.53a (25.48)
CV (%)		1.10	1.15	1.53	1.66	1.46
CD at 1%		0.21	0.68	0.30	0.32	0.34
SE ±		0.51	0.16	0.07	0.07	0.08

other oxides (e.g. TiO_3, P_2O_3) and 3 to 5% moisture content. The median particle size is 5µm. It contains significantly less than 1% (usually less than 0.3%) crystalline silica content. This product was evaluated at different dosages (0.025, 0.05, 0.1, 0.15, 0.20, 0.25 and 0.3%) under room conditions of more than 80% RH and temperature of 23 C.

The moisture content of grains at the start of the experiment was determined. Formulated DE at the desired dosage was thoroughly mixed with 100 grams of uninfested jowar seeds in 100 ml beaker. Freshly emerged 5 to 7 day old rice weevils were drawn from stock culture and released at the rate of 20 ad-ults *Sitophilus oryzae* of per beaker separately. Similarly releases were made 30 days after first rele-ase for rice weevil. Thus two releases were made during two months of storage period.

These were altogether eight treatments including untreated check and each treatment was replicated thrice. Observations on adult mortality, seed damage and germination were recorded at every 15 days after treatment. Seeds were randomly taken from each treatment for observations on seed damage and germination. Data was subjected to statistical analysis. Simple CRD design was followed.

Results and Discussion

The results show that cent per cent mortality was noticed in DE at 0.3, 0.25, 0.2, 0.15 and 0.10% on 15, 30, 45 and 60 DAT. Whereas, DE at 0.05% recorded 100% mortality at 30 and 60 DAT. However, no mortality was recorded in control (Table 1).

The present findings are in line with efficacy and persistence of two products of diatomaceous earth, dryacide and protect–It against four storage pests, *Prostephanus truncatus* (Horn), *Sitophilus zeamais* Motschulsky, *Callosobruchus maculatus* (F.) and *Acanthoscelides obtectus* (Say) at 0.1 and 0.02%, respectively. Both, DEs usually increased mortality and reduced progeny of all four insects compared to untreated control (7). Efficacy of DE increased with decreased RH and increased temperature. The temperature and RH interaction revealed 100% mortality of *C. chinensis* even at highest RH (90%) at both higher temperatures (30 and 35 C) tested, while at combinations of 20 C and 25 C with only lower RHs (30 and 35%). There was slight decrease in the mortality in both 20 C and 25 C with 70% RH compared to lower RH combinations during storage period of two months. Mortality less than 10%

Table 4. Effect of diatomaceous earth (DE) on jowar seed germination under laboratory condition. DAT—Days after treatment. Figures in parentheses are arc sine transformed values. Means in the columns followed by the same alphabet do not differ significantly by DMRT (P = 0.01%).

Treatments	Dosage (%) (wt/wt)	On DAT 15	30	45	60	Mean
T_1 DE	0.025	90.67d	89.33d	87.33d	84.66d	87.99e
		(72.18)	(70.93)	(69.21)	(66.93)	(69.72)
T_2 DE	0.050	92.00cd	90.67cd	88.67de	86.67cd	89.50de
		(73.54)	(72.20)	(70.32)	(68.57)	(71.08)
T_3 DE	0.10	93.33bcd	91.33cd	90.67cd	88.00cd	90.83cd
		(75.04)	(72.87)	(72.26)	(69.75)	(72.33)
T_4 DE	0.15	94.00bc	92.67bc	92.00bc	90.00bc	92.17bcd
		(75.92)	(74.37)	(73.54)	(71.54)	(73.76)
T_5 DE	0.20	95.00b	93.33bc	93.67ab	91.33ab	93.33bc
		(77.05)	(75.04)	(75.40)	(72.87)	(75.01)
T_6 DE	0.25	96.67ab	94.67ab	94.00ab	92.00ab	94.33ab
		(78.43)	(76.67)	(75.79)	(73.62)	(76.19)
T_7 DE	0.30	97.33a	96.00a	95.21a	94.00a	95.63a
		(80.70)	(78.43)	(77.39)	(75.79)	(77.91)
T_8 Control	–	70.00e	62.00e	58.67f	54.67e	61.84f
		(60.12)	(51.92)	(49.97)	(47.66)	(51.61)
CV (%)		1.82	1.84	1.28	1.74	1.50
CD at 1%		3.24	3.19	2.19	2.88	2.58
SE ±		0.77	0.76	0.52	0.69	10.61

was found in untreated control (8).

About 96 to 97% adult mortality of *T. castaneum* (Herbst), *O. surinamensis* (L.) and Indian meal moth, *Plodia interpunctella* (Hubner) were noticed in 0.5 g and 1.0 g per kg of insecto (9), whereas, 99 to 100% mortality was recorded in first instars of Indian meal moth. In adults of *S. oryzae* and *T. castaneum* on wheat treated with silicosec at four dose rates of 0.25, 0.5, 1 and 1.5 g per kg, mortality was highest in 1.0 and 1.5 g per kg, 96 to 97 per cent mortality of red flour beetles in DE formulation, insecto at 0.5 and 1.0 g per kg and less seed damage in treated grains (10).

Lowest (0.00%) seed damage was noticed in 0.3 and 0.25% during one month of storage period. Treatment of 0.2% was the next best treatment and was found significantly superior over other treatments by recording 2.07%. Whereas, 0.1% (5.75%) and 0.05% (10.37%) were found to be at par with each other, which were significantly superior over control (51.41%) (Table 2).

The results show that 0% weight loss was noticed in DE at 0.3 and 0.25% which was superior over other treatments. Whereas, 0.2% (0.82%) was the next best treatment. Among all treatments, DE at 0.15% (1.33%), 0.1% (1.82%), 0.05% (2.38%) and 0.025% (3.37%) were found to be significantly superior over untreated control (18.53%). There is lack literature to compare the present findings. Due to less seed damage and seed infestation, there was less weight loss in treated grains (Table 3).

From the results we conclude that DE at 0.3 and 0.25% recorded cumulative mean of 95.63% higher seed germination during two months of storage period (Table 4). However, 0.1% was found to be at par with 0.05% (89.5%) and 0.025% (87.99%). Whereas, 61.84% seed germination was recorded in untreated check. Higher seed germination was noticed in treated grains due to less seed infestation. Present findings reveal that highest seed germination (91 and 92%) was recorded during storage period in 30 and 35 C at 50% RH and was found to be significantly superior over other treatments. Whereas, 83 to 85% seed germination was recorded in 20 and 25C at 50% RH were the next best treatments. However, lowest seed germination was recorded in 35 C at 90% RH (8). There was no literature pertaining to seed damage. Because it is new product, so not much work has been carried out on the effect of DE (Protect-It) on seed damage.

Conclusion

Bioefficacy of different concentrations of DE on rice weevil, *S. oryzae* under room temperature revealed that it was lowest in DE at 0.3, 0.25, 0.2 and 0.15%, which were followed by DE at 0.1 per cent. However, cent per cent mortality was recorded in DE at 0.3, 0.25, 0.2, 0.15 and 0.1% which were followed by 0.05%. Whereas, no seed damage was recorded in DE at 0.3 and 0.25%, which were at par with DE at 0.2% (2.07%) and no weight loss was noticed in DE at 0.3 and 0.25%, which was followed by DE at 0.2%. Thus DE at 0.3 0.25% recorded higher seed germination and were found to be more effective. Whereas, more seed damage, weight loss, least germination and no mortality were recorded in untreated control.

References

1. Grenier A. M., B. Pintareau and P. Nardo. 1994. Enzymatic variability in three species of *Sitophilus oryzae* (Coleoptera : Curculionidae). J. Stor. Prod. Res. 30 : 201—213.
2. Singh K., N. S. Agarwal and G. K. Girish. 1974. Studies on quantitative loss in various high yielding varieties of maize due to *Sitophilus oryzae* L. (Coleoptera : Curculionidae). J. Sci. Tech. 12 : 3—4.
3. Champ B. R. and C. E. Dyte. 1976. Global survey of pesticide susceptibility of stored grain pests. FAO Pl. Prot. Sci. No. 5, FAO, Rome.
4. Golob P. 1997. Current status and future perspective for inert dusts for control of stored product insects. J. Stor. Prod. Res. 33 : 69—79.
5. Korunic Z. 1998. Diatomaceous earth, a group of natural insecticides. J. Stor. Prod. Res. 34 : 87—97.
6. Korunic Z. and P. G. Fields. 1995. Diatomaceous earth insecticidal composition. Canadian and USA Patent Pending.
7. Stathers T. E., M. Denniff and P. Golob. 2004. The efficacy and persistence of diatomaceous earths admixed with commodity against four tropical seed product beetle pests. J. Stor. Prod. Res. 40 : 133—123.
8. Poornima M. and J. S. Awaknavar. 2007. Effect of Temperature and relative humidity on efficacy of diatomaceous earth (DE) on mortality of pulse beetle, *Callosobruchus chinensis* (L.) Proc. Nat. Symp. on towards pest-free grains and seeds in storage, pp. 76—77.
9. Subramanyam B. H., N. Madamachi and S. Norwood. 1998. Effectiveness of insecto applied to shelled maize against stored—product insecto larvae. J. Eco. Ento. 91 : 280—286.
10. Athanassiou C. G., B. J. Vayias, C. B. Dimizas, N. G. Kavallieratos, A. S. Papagregoriou and C. T. Buchelos. 2003. Insecticidal efficacy of diatomaceous earth against *S. oryzae* (Coleoptera : Curculioridae) and *T. confusum* (Duval) (Coleoptera : Tenebrionidae) on stored wheat : Influence of dose rate, temperature and exposure interval. J. Stor. Prod. Res. 41 : 47—55.