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EFFECT OF DIATOMACEOUS EARTH (DE) (PROTECT-IT) AS A NEW GRAIN PROTECTANT AGAINST RICE WEEVIL, *SITOPHILUS ORYZAE* (L.), AND SEED PARAMETERS

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ABSTRACT

Laboratory experiments were carried out to assess the insecticidal effect of the DE formulation "Protect" evaluated at 0.025, 0.05, 0.1, 0.15, 0.2, 0.25 and 0.3% against adults of rice weevil in stored jowar seeds. Cent per cent mortality was noticed in DE @ 0.3%, 0.25%, 0.2% and 0.15%. However, no mortality was recorded in control during the storage period of two months. It is evident from the results that 0.0 per cent seed damage was recorded in 0.3 per cent and 0.25 per cent and it is on par with DE @ 0.2 per cent. DE @ 0.3 and 0.25 per cent recorded higher seed germination (95.63 %) during two months of storage. Least germination (61.84%) was recorded in untreated control.

Key words: Diatomaceous Earth (Protect-It), *S. oryzae,* mortality, seed germination.

INTRODUCTION

Sorghum is the most important crop after wheat, rice and maize grown widely in tropics and subtropics. Rice weevil, *Sitophilus oryzae* L. is the major pest of stored cereals all over the world. It causes enormous losses upto cent per cent in stored cereals in India and other countries (Champ and Dyte, 1976). The indiscriminate use of insecticides has posed several problems like residual toxicity, resistance development and environmental hazards. There is a need to find alternatives to the chemicals that can effectively prevent the storage losses, be safer to the human beings and least detrimental to environment. This strategy could be achieved by exploiting formulated Diatomaceous Earth (DE) – Diatomaceous Earth is the fossil remains of diatom skeletons. Diatoms are a type of green or brown algae that grow in fresh water lakes and marine estuaries. 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.

In order to know the effect of diatomaceous earth an experiment was conducted in the Department of Agricultural Entomology, UAS Dharwad, Karnataka state, India.

MATERIALS AND METHODS

A formulated product of diatomaceous earth, was procured from Hedley Technologies Ins., USA. It is a mixture of fresh water DE with 10 per cent silica aerogel to enhance insecticidal activity (Korunic and Fields, 1995). It is a beige-coloured DE containing approximately 83.70 per cent amorphous silicon dioxide, 5.6 per cent Al_2O_3, 2.3 per cent Fe_2O_3, 0.9 per cent CaO, 0.3 per cent MgO and 0.9per cent other oxides (e.g., TiO_3, P_2O_3) and 3 to 5 per cent moisture content. The median particle size is 5 mm. It contains significantly less than one per cent (usually less than 0.3%) crystalline silica content. This product was evaluated at 0.025, 0.05, 0.1, 0.15, 0.20, 0.25 and 0.3% under room conditions of more than 80 per cent RH and temperature of 23^{o}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 adults of *Sitophilus oryzae* per beaker separately. The beetles were confined to container by covering its mouth with muslin cloth fastened with rubber band.

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

At 15 days after treatments, 100 per cent adult mortality was observed in seeds treated with DE @ 0.1, 0.15, 0.2, 0.25 and 0.3 per cent, whereas DE @ 0.05 per cent

Table 1: Effect of diatomaceous earth on the damage and mortality of rice weevil adults

Treatments	Dosage	Damage					Mortality				
	(%) (w/w)	15 DAT	30 DAT	45 DAT	60 DAT	Mean	15 DAT	30 DAT	45 DAT	60 DAT	Mean
Diatomaceous Earth	0.025	13.20b (21.28)	10.68b (19.07)	12.00b (20.26)	10.00b (18.43)	11.47b (19.73)	85.00c (67.19)	96.67b (79.59)	88.33c (69.99)	98.33b (82.95)	92.08c (73.71)
Diatomaceous Earth	0.05	7.00c (15.34)	6.80c (15.11)	7.07c (15.40)	6.33c (14.57)	10.37c (18.78)	91.67b (73.37)	100.00a (89.96)	95.00b (77.33)	100.00a (89.96)	96.67b (79.55)
Diatomaceous Earth	0.10	6.65c (14.93)	5.00d (12.92)	6.00d (14.17)	5.33d (13.34)	5.75d (11.76)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)
Diatomaceous Earth	0.15	4.31d (11.98)	3.50e (10.78)	4.17e (11.77)	3.00e (9.97)	3.75r (9.97)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)
Diatomaceous Earth	0.20	2.65e (9.36)	2.00f (8.13)	2.30f (8.72)	1.33f (6.60)	2.07f (8.31)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)
Diatomaceous Earth	0.25	0.00f (0.00)	0.00f (0.00)	0.00f (0.00)	0.00f (0.00)	0.00f (0.00)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)
Diatomaceous Earth	0.30	0.00f (0.00)	0.00f (0.00)	0.00f (0.00)	0.00f (0.00)	0.00f (0.00)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)	100.00a (89.96)
Control	–	42.30a (40.55)	49.33a (44.60)	54.00a (47.28)	60.00a (50.75)	51.41a (95.78)	0.00d (0.00)	0.00c (0.00)	0.00d (0.00)	0.00c (0.00)	0.00d (0.00)
CV (%)		1.56	1.77	1.89	2.24	1.42	1.52	1.01	1.61	1.34	1.24
CD at 1%		0.53	0.59	0.67	0.77	0.68	2.72	1.89	2.92	2.53	2.27
SEm ±		0.13	0.14	0.16	0.18	0.16	0.64	0.45	0.69	0.61	0.53

DAT - Days after treatment
Figures in parentheses are arc sine transformed values

Table 2: Effect of diatomaceous earth on jowar seed weight loss and seed germination under laboratory condition

Treatments	Dosage (%) (w/w)	Weight loss					Germination				
		15 DAT	30 DAT	45 DAT	60 DAT	Mean	15 DAT	30 DAT	45 DAT	60 DAT	Mean
Diatomaceous Earth	0.025	3.50b (10.79)	3.30b (10.46)	3.41b (10.63)	3.27b (10.42)	3.37b (10.55)	90.67d (72.18)	89.33d (70.93)	87.33d (69.21)	84.66d (66.93)	87.99e (69.72)
Diatomaceous Earth	0.05	2.42c (8.95)	2.30c (8.72)	2.47c (9.03)	2.33c (8.78)	2.38c (8.89)	92.00cd (73.54)	90.67cd (72.20)	88.67de (70.32)	86.67cd (68.57)	89.50de (71.08)
Diatomaceous Earth	0.10	1.86d (7.84)	1.80b (7.71)	1.87d (7.85)	1.77d (7.63)	1.82d (7.75)	93.33bcd (75.04)	91.33cd (72.87)	90.67cd (72.26)	88.00cd (69.75)	90.83cd (72.33)
Diatomaceous Earth	0.15	1.41e (6.81)	1.30e (6.54)	1.37e (6.71)	12.33e (6.37)	1.33e (6.62)	94.00bc (75.92)	92.67bc (74.37)	92.00bc (73.54)	90.00bc (71.54)	92.17bcd (73.76)
Diatomaceous Earth	0.20	0.90f (5.44)	0.80f (5.13)	0.87f (5.34)	0.73f (4.91)	0.82f (5.12)	95.00b (77.05)	93.33bc (75.04)	93.67ab (75.40)	91.33ab (72.87)	93.33bc (75.01)
Diatomaceous Earth	0.25	0.00g (0.00)	0.00g (0.00)	0.00g (0.00)	0.00g (0.00)	0.00g (0.00)	96.67ab (78.43)	94.67ab (76.67)	94.00ab (75.79)	92.00ab (73.62)	94.33ab (76.19)
Diatomaceous Earth	0.30	0.00g (0.00)	0.00g (0.00)	0.00g (0.00)	0.00g (0.00)	0.00g (0.00)	97.33a (80.70)	96.00a (78.43)	95.21a (77.39)	94.00a (75.79)	95.63a (77.91)
Control	–	17.85a (24.98)	18.27a (25.29)	18.67a (25.59)	19.33a (26.07)	18.53a (25.48)	70.00e (60.12)	62.00e (51.92)	58.67f (49.97)	54.67e (47.66)	61.84f (51.61)
CV (%)		1.10	1.15	1.53	1.66	1.46	1.82	1.84	1.28	1.74	1.50
CD at 1%		0.21	0.68	0.30	0.32	0.34	3.24	3.19	2.19	2.88	2.58
SEm ±		0.51	0.16	0.07	0.07	0.0	0.77	0.76	0.52	0.69	10.61

DAT - Days after treatment

recorded 91.67 per cent mortality and was found to be significantly superior over untreated check. Even lowest concentration DE @ 0.025 per cent recorded 85.00 per cent mortality. At 30 DAT, 100 per cent adult mortality was observed in 0.05, 0.1, 0.15, 0.2, 0.25 and 0.3 per cent of DE and found to be superior over untreated control. Whereas, DE @ 0.025 per cent recorded 96.67 per cent mortality.

After 15 days of second release of beetles 100 per cent adult mortality was observed in 0.1, 0.15, 0.2, 0.25 and 0.3 per cent DE, whereas, 95 per cent mortality was recorded in 0.05 per cent, which was significantly superior over untreated control. However, lower concentration of DE @ 0.025 per cent recorded 88.00 per cent mortality. At 60 DAT, cent per cent adult mortality was recorded in 0.05, 0.1, 0.15, 0.2, 0.25 and 0.3 per cent, whereas, 98 per cent mortality was recorded in DE @ 0.025 per cent concentration, which was significantly superior over untreated control. (Table-1).

The present findings are in line with *Starhers et al.* (2004), who reported that efficacy and persistence of two products of diatomaceous earth, Dryacide and Protect - against four storage pests, *Prostephanus truncatus* (Horn), *Sitophilus zeamais* Motschulsky, *Callosobruchus maculatus* (F.) and *Acanthoscelides obtectus* (Say) at 0.1 and 0.02 per cent, respectively. Poornima and Awaknavar (2007) reported that efficacy of DE increased with decreased RH and increased temperature. The temperature and RH interaction revealed 100 per cent 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 per cent RH compared with lower RH combinations during storage period of two months. Mortality less than 10 per cent in untreated control.

Subramanyam *et al.* (1998), who reported that 96 to 97 per cent adult mortality of *T. castaneum* (Herbst), *O. surinamensis* (L.) and Indian meal moth, *Plodia interpunctella* (Hubner) in 0.5 g and 1.0 g per kg of Insecto, whereas, 99 to 100 per cent mortality was recorded in first instars of Indian meal moth. Athanassiou *et al.* (2003) reported that 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. Athanassiou *et al.* (2003) reported 96 to 97 per cent mortality of red flour beetles in DE formulation Insecto @ 0.5 g and 1.0 g per kg and less seed damage in treated grains

Lowest (0.00%) seed damage was noticed in 0.3 and 0.25 per cent during one month of storage period. Treatment 0.2 per cent was the next best treatment and was found significantly superior over other treatments by recording 2.07 per cent. Whereas, 0.1 per cent (5.75%) and 0.05 per cent (10.37%) were found on par with each other, which were significantly superior over control (51.41%). (Table-1).

It is evident from the results that 0 per cent weight loss was noticed in DE @ 0.3 and 0.25 per cent which was superior over other treatments. Whereas, 0.2 per cent (0.82%) was the next best treatment. Among all treatments, DE @ 0.15 per cent (1.33%), 0.1 per cent (1.82%),0.05 per cent (2.38%) and 0.025 per cent (3.37%) found significantly superior over untreated control (18.53%). (Table-2).

From the results we conclude that DE @ 0.3 and 0.25 per cent recorded cumulative mean of 95.63 per cent higher seed germination during two months of storage period (Table 2). However, 0.1 per cent was found to be on par with 0.05% (89.5%) and 0.025% (87.99%) Whereas, 61.84 per cent 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 %) recorded during storage period in 30°C and 35°C at 50 per cent RH and found to be significantly superior over other treatments. Whereas, 83 to 85per cent seed germination was recorded in 20°C and 25°C at 50% RH were the next best treatments. However, lowest seed germination was recorded in 35°C at 90% RH (Poornima and Awaknavar, 2007). 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.

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