LABORATORY EVALUATION OF DILL SEED EXTRACT IN REDUCING INFESTATION OF RICE WEEVIL IN STORED WHEAT[1]

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ABSTRACT

Wheat was surface-treated with acetone extract of dill seed and exposed to rice weevils, *Sitophilus oryzae* (L.). At 2000 ppm, dill extract provided complete protection 1-day after treatment, and still provided 68.13% reduction of the F_1 generation after treated wheat was stored for 52 weeks. One day after treatment, dosages of 1000 and 500 ppm reduced the F_1 generation 81.86 and 21.99%, respectively, and the effect decreased rapidly.

Key Words: Dill seed, *Anethum graveolens*, rice weevil, *Sitophilus oryzae*.

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INTRODUCTION

Dill, *Anethum graveolens* L., is an herb grown all over the world. The seed or fruit, either whole or ground, is used in cooking as a condiment for flavoring salads, cakes, and sauces, and is also used in pickling.

The insecticidal and synergistic properties of the dill plants were reported by Hartzell (1944), and Lichtenstein et al. (1974). The toxicity and repellency of dill seed to stored-product insects were reported by Su (1985). Its long lasting repellency to confused flour beetles, *Tribolium confusum* Jacquelin du Val, was also demonstrated (Su 1987). The major components of the dill seed acetone extract were identified as 2-methyl-5-(1-methylethenyl)-2-cyclohexen-1-one (*d*-carvone) and 4,5-dimethoxy-6-(2-propenyl)-1,3-benzodioxole (dillapiol) (Su and Horvat 1988). A laboratory study on the effectiveness of dill seed acetone extract as surface treatment for protection of wheat in storage is reported here.

MATERIALS AND METHODS

Dill Seed Extract

Dill seed, distributed by McCormick and Co., was purchased from a local supermarket. The acetone extract of dill seed was prepared as described by Su (1985). The pulverized dill seed powder was extracted with acetone at 40-50°C. The acetone extract was concentrated under reduced pressure and then lyophilized.

[1]This paper reports the results of research only. Mention of a proprietary product does not constitute a recommendation or an endorsement by the USDA.

Test Insects

Rice weevils (< 24 h old), *Sitophilus oryzae* (L.), reared in wheat at the Stored-Product Insects Research and Development Laboratory, Savannah, GA, were used as the test insects.

Surface Treatment of Wheat

The wheat was treated at dosages of 2000, 1000, and 500 ppm in weight of extract vs. weight of wheat. Required amounts of acetone extract of dill for the indicated concentrations were dissolved in 2-3 ml of acetone and each was applied to 300 g of wheat (14.5 ± 0.2% moisture). The treated samples in 0.946-liter glass jars were mechanically shaken at a moderate rate for 15 mins. The treated wheat samples were air-dried and stored in 0.946-liter glass jars in a room maintained at 27 ± 1°C and 60 ± 5% RH. Acetone treated wheat served as a control. The tests were conducted periodically with the treated wheat samples after they were stored for 1 day, 11 wk, 24 wk, 41 wk, and 52 wk.

Test Method

A plastic ring (90 mm dia × 5 mm high) was placed in the center of a glass crystallizing dish (160 mm dia × 100 mm high). A 20-g lot of test wheat was placed inside the ring which acted as a barrier to prevent the wheat from scattering. Ten pairs of adult rice weevils, less than 24 h old, were introduced to the sample. The dish was covered with a plexiglass lid which had two 35 mm dia holes covered with 40 mesh metallic cloth, opposite to each other, 20 mm from the edge. The dishes were kept in a room at 27 ± 1°C and 60 ± 5% RH. After 7 days of exposure, the insects, inside and outside the ring, were removed, examined, and counted to determine mortality and repellency. Then each sample was kept in a 0.237-liter glass jar and stored in the exposure room. Four weeks after exposure, the samples were examined every 2 or 3 days for F_1 adult emergence. When emergence started, the insects were counted every 2 or 3 days and removed. The readings were stopped 8 wks after exposure in order to avoid including the F_2 insects.

The number of F_1 adults was used as a criteria for evaluation. The F_1 adult emergence in the treated sample compared to the F_1 adult emergence in the control is an index of effectiveness of the treated material in reducing infestation.

Data were analyzed by using analysis of variance and Duncan's multiple range test (Duncan 1955).

RESULTS AND DISCUSSION

The acetone extraction of dill seed yielded a light-brown syrupy liquid. Its topical toxicity LD_{50} to rice weevils was 43.15 μg per insect (Su 1985).

When rice weevils were exposed to surface-treated wheat at dosages of 2000, 1000, and 500 ppm for 7 days, no noticeable toxicity (total dead insects) and repellency (insects outside the ring) to the insects were observed. Periodic study of the reduction of rice weevil F_1 adults by dill seed acetone extract applied on wheat and stored for 52 weeks is summarized in Table 1. One day after treatment at 2000 and 1000 ppm, the extract gave complete and 81.86% reduction of F_1 generation, respectively, when compared to the control. After the treated wheat was stored for 52 weeks, the 2000 ppm treatment still gave 68.13% reduction of the F_1 generation but the 1000 ppm treatment resulted only 16.27% reduction. The 500 ppm dosage

Table 1. Effect of dill seed acetone extract applied to wheat and aged for indicated periods after treatment before exposure to rice weevils.*

Dose	No. of F_1 adults and % reduction of F_1 adults after treated wheat has aged as indicated†									
	1 day		11 wk		24 wk		41 wk		52 wk	
(ppm)	$F_1 \pm SE$‡	% Red	$F_1 \pm SE$‡	% Red	$F_1 \pm SE$‡	% Red	$F_1 \pm SE$‡	% Red	$F_1 \pm SE$‡	% Red
2000	0.00 ± 0.00 a	100	100.00 ± 9.71 a	53.83	63.67 ± 14.84 a	65.71	70.00 ± 9.45 a	61.89	48.33 ± 11.26 a	68.13
1000	26.67 ± 8.41 a	81.86	180.00 ± 21.38 b	15.09	148.67 ± 4.14 b	19.93	149.33 ± 8.51 b	18.70	127.00 ± 11.02 b	16.27
500	114.67 ± 13.20 b	21.99	201.33 ± 5.04 b	5.03	170.00 ± 4.93 bc	8.44	168.67 ± 13.04 b	8.17	150.00 ± 7.37 b	1.10
Control	147.00 ± 9.45 b	0	212.00 ± 2.65 b	0	185.67 ± 7.36 c	0	183.67 ± 12.86 b	0	151.67 ± 11.20 b	0

* Ten pairs of insects in 20 g of wheat in each test sample; 3 replicates per dose.

† % Reduction = $100 - \frac{\text{No. of } F_1 \text{ adults from test sample}}{\text{No. of } F_1 \text{adults from control}} \times 100$

‡ SE = standard error of the mean. Values followed by the same letter within a column are not significantly different at P = 0.05 level according to Duncan's multiple range test.

at 1-day after treatment only reduced the F_1 generation 21.99% which was not significantly different from the control at the 5% level according to Duncan's multiple range test (1955).

The acetone extract of dill seed contains two major components, dillapiol and *d*-carvone, from HPLC analysis (Su and Horvat 1988). Dillapiol is a snyergist for pyrethrins in dust formulations against *Tribolium casteneum* (Herbst) (Handa and Dewan 1975). *d*-Carvone is a volatile liquid and it repelled rice weevils (Su, unpublished), but the repellency decreased very rapidly. Other minute constituents of dill seeds are identified as coumarin derivatives and phenolic acids (Dranik and Prokopeuko 1969), flavonoid compounds (Dranik 1970), and several glucosides.

The dill seed acetone extract was shown here to be an effective material for reducing infestation in stored wheat by rice weevils in the laboratory. It also has been shown to give long-lasting repellency to confused flour beetles (Su 1987). These results suggest that dill seed is a good candidate to develop as a naturally occurring control agent for these harmful insects.

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