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EFFECT OF SOME PLANT POWDERS ON THE BIOLOGY OF *Sitotroga cerealella* OLIVIER (LEPIDOPTERA, GELECHIIDAE) ON WHEAT

Al-Khawass, K. A. M. H.
Plant Protection Dept., Fac. of Agric., Al-Azhar University, Cairo, Egypt

ABSTRACT

The efficacy of four plant materials (*Mentha crispate*; *Ocimum gratissimum Artemisia absinthium* and *Curcuma longa*) was evaluated against the grain moth *Sitotroga cerealella* (Olivier) on wheat grains under laboratory conditions. In all trials, mortality percentages caused by *O. gratissimum* treatment was observed to be relatively high (58.7%) in comparison with the other tested host. Survival rate of *S. cerealella* was significantly affected by *M. crispate*; *A. absinthium* and *C. longa* treatments. Plant powders usually did not affect the adult longevity, while *O. gratissimum* treatment significantly reduced the fecundity and the hatchability of *S. cerealella.*

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most widely grown food crop in the world, which ranks first in terms of area and production in the world (FAO 1988). Wheat is a major cereal crop in Egypt as most of the population utilizes it daily in one or more of the three meals. Interest in storing wheat is increasing to face the increasing demand for human consumption.

Angoumois grain moth *Sitotroga cerealella* (Olivier) is one of the major insect pests of stored grain in the tropics and subtropics. Sorghum, maize, wheat, barley, and millets are the main crops infested by this pest. Infestations start in the field when crops are carried to storage facilities, immature stages from the field infestations complete their life cycles to pupate and emerge as adult in storage. Population of *S. cerealella* multiplies 112.27 times between two successive generations (Teotia and Singh, 1976). Cogburn and Bollich (1980) reported that *S. cerealella* usually found in the upper 40 cm layer of the grain. Historically, retailers and pest control operators have relied heavily on chemical pesticides, but increasing awareness of risk to environmental quality and human health has made it necessary to seek safer methods (Athanassiou *et al.,* 2005). *Sitotroga cerealella* attacks all types of cereal grains, particularly wheat where weight losses can be as much as 50%. Badly infested grain has a sickening smell and taste that makes it unpalatable. This leads to considerable quantitative and qualitative economic losses represented in weight loss, decrease the nutritional value of wheat and reduction of germination.

Alternatives to traditional chemical insecticides such as predators, parasitoids, microbes and natural products have been gaining interest among researchers concerned with developing integrated pest management (IPM) approaches for insect control (Copping and Menn, 2000).

The purpose of this study is to check the possibility of using different plant powders to reduce the infestation of *S. cerealella* on the stored wheat (menthol, *Mentha piperita* L.; basil, *Ocimum basilicum* L., wormwood, *Artemisia absinthium* L. and turmeric, *Curcuma longa* L.) as natural control agents instead of using chemical control at least partially.

MATERIALS AND METHODS

The present experiment was carried out to compare the efficiency of some plant powders (crashed plant leaves) against *Sitotroga cerealella* (Olivier). The tested plant powders were *Mentha piperita* L.; basil, *Ocimum basilicum* L., wormwood, *Artemisia absinthium* L. and turmeric, *Curcuma longa* L.

Fresh leaves were collected from the farm of Faculty of agriculture, Al-Azhar University, and taken to the laboratory where they were cleaned from dust. The leaves were left to dry at room temperature. The dried leaves were then crashed to be medium fine powder.

At the beginning of every observation an amount of 400 wheat grains for each treatment were divided into four replicates (each replicate contains 100 g wheat grains placed into plastic jar covered with muslin). In each treatment plastic jars were infested with 25, 50 and 100 newly hatched larvae of *S. cerealella*.

Three different weights of the four plant powders were used (3, 4 and 5g of menthol, basil and wormwood) while the treatments with turmeric were 1, 2 and 3g; each treatment was replicated four times. Observations were made daily to notice the emergence of adults in order to determine their mortality, sex ratio, fecundity and adult longevity. One male and one female (replicated ten times) *S. cerealella* were put into a glass vial 3X8 cm containing a black paper to collect the eggs daily and to determine the pre-oviposition, oviposition and post oviposition periods. Also the weight loss was calculated in all treatments according to Khare and Johari (1984) using the following equation:

$$\text{Weight loss \%} = \frac{\text{Initial dry weight} - \text{Final dry weight}}{\text{Initial dry weight}} \times 100$$

Statistical analysis:

Mortality percentages were corrected from natural mortality according to Abbott (1925) and subjected to log-probit analysis method (Finney, 1952). Data were subjected to statistical analysis by Analysis of Variance (ANOVA) test using a computer software SAS (SAS Institute, 2003). Means were detected and compared by Duncan multiple range tests at 0.05% probability level (Duncan, 1955).

RESULTS AND DISCUSSION

1. Effect of different plant powders on the mortality of *S. cerealella*:

The mean numbers of emerged moths were determined from wheat for the four tested powders. Table (1) shows that almost no difference could be found as regard the effect of crowding for all tested plant powered. Also not so such difference between the tested amounts of plant powders was detected suggesting implementing the lowest amount in all plant species.

Basil powder merged with wheat grains caused significantly higher mortality (58.67%) than turmeric powder (48.58%) while the other two plant species caused intermediate mortality percentage (53.30 and 51.31% for wormwood and menthol powders (fig. 1).

As regard the effect of crowding in the control there was a significant difference between the mortality in the low density (25 larvae) and each of mortality in other densities (50 and 100 larvae) (Table 1).

Table (1): Mortality percentage of *S. cerealella* under the effect of different plant powders.

Plant powder	g powder/100g wheat	Larval density/ plastic jar			Mean
		25	50	100	
Menthol	3	51.00 ± 2.6a	56.50 ± 3.5a	52.25 ± 1.7a	**53.25**
	4	51.00 ± 2.4a	55.00 ± 2.6a	52.50 ± 2.3a	**52.83**
	5	50.00 ± 3.9b	54.50 ± 3.8ab	57.00 ± 3.6a	**53.83**
	Mean	**50.67a**	**55.33a**	**53.92a**	**53.30**
Basil	3	54.00 ± 2.1a	56.50 ± 3.3a	58.25 ± 3.5a	**56.25**
	4	57.00 ± 4.2a	59.50 ± 2.8a	60.25 ± 2.3a	**58.92**
	5	59.00 ± 3.2a	61.50 ± 4.6a	62.00 ± 3.7a	**60.83**
	Mean	**56.67a**	**59.17a**	**60.17a**	**58.67**
Wormwood	3	50.00 ± 2.8a	54.00 ± 2.3a	50.50 ± 0.9a	**51.50**
	4	49.00 ± 1.7a	54.50 ± 2.0a	51.00 ± 2.6a	**51.50**
	5	48.00 ± 2.4a	51.50 ± 2.9a	53.25 ± 1.6a	**50.92**
	Mean	**49.00a**	**53.33a**	**51.58a**	**51.31**
Turmeric	1	49.00 ± 4.4a	47.00 ± 4.5a	47.25 ± 3.0a	**47.75**
	2	49.00 ± 2.4a	48.00 ± 4.2a	47.25 ± 2.4a	**48.08**
	3	50.00 ± 2.8a	50.50 ± 2.4a	49.25 ± 2.6a	**49.92**
	Mean	**49.33a**	**48.50a**	**47.92a**	**48.58**
Control		22.00 ± 3.5b	28.50 ± 3.6a	30.25 ± 2.7a	**26.92**

Different letters between columns indicate a significant difference (Duncan, 1955).

Differences in mortality of *S. cerealella* on wheat indicate that the powders of different plants tested had marked effect on the developmental stages which in turn affected emergence. This difference was caused by these powders and not merely by nature as found by Flinn *et al,* (2006) and Danjumma *et al*, (2009).

Results are also comparable with those of Baptista *et al*., (2002) when evaluating the insecticide activity of medicinal plants essential oil against pests, such as, the fall armyworm (*Spodoptera frugiperda)*, verified that the essential oils of *Ocimum gratissimum* (basil), *Ocimum basilicum* (sweet basil) and *Ruta graveolens* (rue) were poisonous for caterpillars. Hill (1990) reports that, 2000 species of plants, which produce chemical

substances able to act against insects, are known. The substances can have poisonous and repellent effect, and can work as phagos restrainer, ovicide and can affect the insects' hormonal system. Moreover, a great number of essential oils can reduce the reproduction system of several insects found in stored products and they can also hinder the growth, the development and the reproduction of some herbivore insects. The main groups of chemical substances are the terpins, which are abundant compounds of many superior plants essential oils, such as, tannins and alkaloids.

F1

2. Effect of different plant powders on some biological aspects of *S. cerealella*:

The data in table (2) indicate the following:

1. Almost no difference could be found between the four tested plant powders as regard pre-oviposition period of *S. cerealella* where it ranged between 2.4 and 2.9 days (Table 2). Also slight differences were found randomly regarding the oviposition period where it ranged between 3.8 and 4.6 days in all treatments. However slight differences were noticed in the post oviposition period where it ranged between 3.6 and 5.2 days with no precise distinction between the four tested plant powders or between the three tested amounts.

Table (2): Adult longevity, fecundity and hatchability of *S. cerealella* under the effect of different plant powders.

Plant powder	g powder/100 g wheat	Adult longevity			No. of deposited eggs/female	Hatchability %
		Pre-oviposition period (days)	Oviposition period (days)	Post oviposition period (days)		
Menthol	3	2.4 ± 0.1a	3.9 ± 0.2a	3.6 ± 0.3c	277.3 ± 6.6ab	76.3 ± 2.4b
	4	2.7 ± 0.1a	4.2 ± 0.3a	4.5 ± 0.2ab	289.6 ± 8.9ab	77.4 ± 2.3b
	5	2.7 ± 0.1a	4.6 ± 0.3a	4.2 ± 0.2b	315.4 ± 7.6a	70.0 ± 2.1bc
	Mean	**2.5a**	**4.2a**	**4.1a**	**294.1a**	**74.6b**
Basil	3	2.7 ± 0.1a	4.4 ± 0.3a	4.4 ± 0.3b	215.9 ± 5.7c	64.3 ± 2.5c
	4	2.9 ± 0.2a	3.8 ± 0.2a	5.2 ± 0.3a	222.6 ± 5.3c	65.4 ± 3.2c
	5	2.8 ± 0.1a	4.3 ± 0.2a	3.7 ± 0.2bc	237.7 ± 6.5bc	67.8 ± 2.4c
	Mean	**2.8a**	**4.2a**	**4.4a**	**225.4c**	**65.8c**
Wormwood	3	2.7 ± 0.2a	4.3 ± 0.1a	4.1 ± 0.2b	265.4 ± 9.0b	71.5 ± 3.1bc
	4	2.7 ± 0.2a	4.4 ± 0.3a	4.8 ± 0.3a	234.5 ± 9.5bc	72.3 ± 2.1bc
	5	2.6 ± 0.1a	4.1 ± 0.2a	3.6 ± 0.1c	271.9 ± 7.9ab	70.2 ± 2.5bc
	Mean	**2.7a**	**4.3a**	**4.2a**	**257.3b**	**71.3b**
Turmeric	1	2.8 ± 0.1a	4.6 ± 0.2a	4.5 ± 0.4ab	255.5 ± 7.6b	76.5 ± 3.0b
	2	2.7 ± 0.2a	4.0 ± 0.3a	5.0 ± 0.1a	256.9 ± 6.9b	79.7 ± 2.1b
	3	2.5 ± 0.2a	3.9 ± 0.4a	4.1 ± 0.1b	231.1 ± 7.7bc	74.4 ± 2.2b
	Mean	**2.7a**	**4.2a**	**4.5a**	**247.8bc**	**76.9b**
Control		2.6 ± 0.1a	4.1 ± 0.3a	4.4 ± 0.3b	286.0 ± 5.4ab	91.5 ± 1.6a

Different letters between raws indicate a significant difference (Duncan, 1955).

2. Basil powder caused a significant negative impact on the total number of eggs deposited by a single female *S. cerealella* with an average of 225.4 eggs/female irrespective to the tested amount of powder. Application of wormwood or turmeric powders resulted in low number of eggs laid by the females (257.3 and 247.8 eggs/female). Almost no effect was found by using menthol powder on the wheat grains (Table 2).
3. Hatchability percentage was significantly lower in the basil treatment than the other plant powders (65.8%) while the other three plant species caused marked decrease in the hatchability percentage (74.6, 71.3 and 76.9 for menthol, wormwood and turmeric powders, respectively). Table (2) shows that the untreated grains gave the opportunity to the laid eggs to hatch in a significantly higher percentage (91.5%). These results are comparable with what found by Consoli and Amaral Filho (1995) who said that the *S. cerealella* hatch ranged from 86.8 to 95.3%.

The results are comparable somehow with those of Jilani and Saxena (1990) who monitored the repellency of the oils of turmeric (*Curcuma longa*).

4. As per Figure 2, all the materials at all their application rates significantly reduced weight loss by *S. cerealella*. The minimum weight loss of 24.4% was recorded in basil treated jars at 5.0g which was significantly alike with all other treatments. The maximum weight loss (55.3%) was recorded in the control.

F2

The results of the present study indicate that basil provided the highest efficacy in protecting wheat from *S. cerealella* in storage. Considering all the materials, the trend in the protection of wheat grain from insect population showed the following decreasing order: basil> menthol> wormwood> turmeric. The results of this study may differ with that of the other researchers however it is logical because the efficacy of the used leaf powder and the efficacy of leaf extract may vary against different pests. From these results, it may be concluded that mixing some plant powders with wheat grain in at least small storages could be useful for storage of wheat.

So, the efficacy of these plant products in the protection of wheat grains against infestation by the *S. cerealella* reveals their considerable potential as stored product pesticides. Their effect on seed viability and equality are within manageable/tolerable levels and are not hazardous to man or the ecosystem.

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تأثير بعض مساحيق النباتات عل بيولوجية حشرة فراش الحبوب *Sitotroga cerealella* Olivier (Lepidoptera; Gelechiidae) على القمح

خالد أحمد محمود حسين الخواص
قسم وقاية النبات – كلية الزراعة – جامعة الأزهر

تمت الدراسة الحالية لتحديد كفاءة أربعة من مساحيق أوراق أربعة أنواع نباتية هي النعناع والريحان والشيح بمعدلات مختلفة هي 5، 4، 3 جم/100 قمح والكركم بنسبة 3، 2، 1 جم قمح ضد حشرة فراش الحبوب على حبوب القمح تحت الظروف المعملية. وأظهرت النتائج أن النسبة المئوية للوفيات كانت أعلى في مسحوق الريحان (58.7%) عن باقي المساحيق دون النظر إلى الكمية المستخدمة. أما مساحيق النباتات الثلاث الأخرى فقد أثرت معنوياً على حياة الحشرة (من 48.6 إلى 53.3%) بالمقارنة بالكنترول (26.9%). ولم تؤثر تلك المساحيق تقريباً على فترة حياة الحشرة بينما قلل الريحان من خصوبة الإناث ونسبة فقس البيض. وكانت نسبة الفاقد في المحصول عالية في كل المعاملات عنها في الكنترول وخاصة إذا استخدمت بالكميات العالية.

قام بتحكيم البحث

أ.د / عبد الستار ابراهيم عبد الكريم	**كلية الزراعة – جامعة المنصورة**
أ.د / عبد ربه عيد حسين	**كلية الزراعة – جامعة الازهر**