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A Particle Film Deters Oviposition by the Diaprepes Root Weevil, *Diaprepes abbreviatus* (Coleoptera: Curculionidae)

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Where did the Diaprepes root weevil come from?

Isabela, PR 2000 | Apopka, FL 1968 | Adjuntas, PR 2000

The weevil is known only from the Caribbean and shows greatest phenotypic diversity on Puerto Rico. It first appeared on the mainland U.S. at Apopka, Florida in 1964.

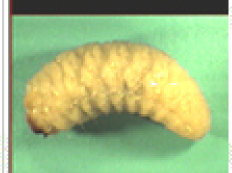
Today, the weevil is found in more than 20 counties throughout peninsular Florida where it causes an estimated damage of $75 million dollars per year.

Introduction

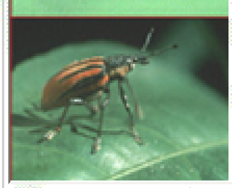
Kaolin-based particle films have been developed for suppression of arthropod pests and diseases (Glenn et al. 1999, Puterka et al. 2000). Kaolin is a nonabrasive, nontoxic aluminosilicate ($Al_4Si_4O_{10}(OH)_8$) mineral that has been recently formulated (Engelhard Corporation, Iselin, NJ) as a wettable powder (WP) for application with conventional spray equipment. We are testing the WP for possible inclusion in an IPM program aimed at control of the Diaprepes root weevil, a devastating pest of citrus in Florida.

Life stages of *Diaprepes abbreviatus*.

Fully developed first instar in chorion



Late instar larva



Adult in central Florida

Methods

Foliage was sprayed to runoff (equivalent to 400 g/acre of formulated product) with a hydrophilic kaolin formulation (M-97-009) and an adjuvant (MO3) (Engelhard Corporation, Iselin, NJ) and air-dried before being offered to weevils. Larvae of *D. abbreviatus* were reared at the U.S. Horticultural Research Laboratory as described by Lapointe & Shapiro (1999). Experiments were conducted in a screenhouse at ambient temperature, relative humidity, and photoperiod during May to June, 1999, at Apopka, FL. Mean nighttime and daytime temperatures were 22 $\pm$ 2 and 31 $\pm$ 2° C, respectively. Ambient RH fluctuated between 80 and >95%.

In Trial 1, bouquets of citrus leaves were placed in screened cages (30 by 30 by 30 cm). Ten reproductively mature adult weevils (5 males and 5 females, approximately one month old) were placed in each cage and held for 14 days. Each cage contained 2 bouquets arranged as no-choice (2 bouquets of treated or untreated leaves) or choice (1 treated plus 1 untreated bouquet). The period between placement of bouquets in cages and their removal is referred to as a feeding bout. The location of weevils was scored daily. Egg masses were removed and counted. Mortality was recorded daily for 28 days. In Trial 2, controls for adjuvant (M03) and starvation were included.

Conclusions

The insecticidal properties of inert dusts, including diatomaceous earth, derive from their capacity to adsorb cuticular lipids and to abrade the cuticle. In this study, the nonabrasive kaolin formulation strongly deterred feeding and oviposition without an insecticidal effect. This mechanism of activity may be related to interference with tactile perception of the host (Puterka 2000).

Adults of *D. abbreviatus* avoided and were deterred from feeding on kaolin-treated leaves. Contact with kaolin in choice tests may deter feeding and oviposition even of untreated foliage. *D. abbreviatus* adults are large, active weevils and spend considerable time walking and mating in the cages. As a result, weevils in choice as well as no-choice cages (kaolin) came in contact with kaolin-treated foliage. In the field, complete coverage of foliage may not be necessary to significantly reduce feeding and oviposition.

Very little oviposition occurred in cages with starved adults. It is not clear if the primary effect of kaolin was deterrence of feeding and thereby of oviposition as well, or if the kaolin more directly interfered with oviposition behavior. Two arguments can be made for direct interference. First, oviposition did not occur on treated leaves in the choice tests where weevils consumed and oviposited on untreated foliage. Second, fully mature, ovipositing adults were deterred from further oviposition when placed in cages with treated foliage.

These data indicate potential for kaolin as a barrier to oviposition in citrus groves and may prove to be an economically viable and environmentally sound component of an integrated approach to control of *D. abbreviatus* and related root weevils.

Table 1. Mean mortality and survival time (± SE, *n* = 3) of adult *D. abbreviatus* at 14 and 28 days caged on citrus leaves untreated, sprayed with M03 adjuvant only, or sprayed with a hydrophilic kaolin formulation (M-97-009 and MO3).

	14 days		28 days	
Treatment	Mortality (%)[a]	Survival days[b]	Mortality (%)[c]	Survival days[d]
Trial 1				
Untreated, no choice	0.0 ± 0.0	14.0 ± 0.0	4.7 ± 4.7a	27.7 ± 0.3a
Choice	3.3 ± 3.3	13.9 ± 0.1	34.0 ± 8.3ab	25.3 ± 0.9a
Kaolin, no choice	10.0 ± 10.0	13.8 ± 0.2	63.3 ± 14.5b	22.3 ± 1.0b
Trial 2				
Untreated leaves	0.0 ± 0.0	14.0 ± 0.0	0.0 ± 0.0a	28.0 ± 0.0a
M03 only	3.3 ± 3.3	13.8 ± 0.2	3.3 ± 3.3a	27.3 ± 0.7a
Starved control	0.0 ± 0.0	14.0 ± 0.0	6.7 ± 3.3a	27.8 ± 0.2a
Kaolin	0.0 ± 0.0	13.8 ± 0.2	20.0 ± 0.0b	26.6 ± 0.8a

[a] Means (untransformed) are not significantly different at $\alpha = 0.05$ by ANOVA on transformed data (Trial 1: $F = 0.7$, df = 2, 6; $P = 0.53$; Trial 2: $F = 1.0$, df = 3,8; $P = 0.44$).

[b] Means are not significantly different at $\alpha = 0.05$ by ANOVA (Trial 1: $F = 0.8$, df = 2, 6; $P = 0.49$; Trial 2: $F = 0.7$, df = 3, 8; $P = 0.59$).

[c] Means (untransformed) followed by the same letter are not significantly different at $\alpha = 0.05$ by ANOVA on transformed data (Trial 1: $F = 6.4$, df = 2, 6; $P = 0.03$; Trial 2: $F = 14.0$, df = 3,8; $P < 0.01$).

[d] Means followed by the same letter are not significantly different at $\alpha = 0.05$ by ANOVA (Trial 1: $F = 8.9$, df = 2, 6; $P = 0.02$; Trial 2: $F = 2.2$, df = 3, 8; $P = 0.16$).

Table 2. Oviposition per feeding bout (mean ± SE, *n* = 3) by *D. abbreviatus* caged for 14 days on untreated citrus leaves in choice (one untreated and one kaolin-treated bouquet per cage) and no-choice (two untreated bouquets per cage) trials.

Treatment	Design	Eggs per cage[a]	Eggs per bouquet[b]
M-97-009+M03	Choice	0.0	
	No-choice	0.0	
Untreated	Choice	104.5 ± 25.9a	104.5 ± 25.9a
	No-choice	350.9 ± 71.5b	175.4 ± 30.0a

[a] ANOVA for untreated bouquets ($F = 21.1$; df = 1, 4; $P = 0.01$).
[b] ANOVA for untreated bouquets ($F = 1.0$; df = 1, 7; $P = 0.35$).

One-year-old orange trees treated with a WP formulation of kaolin.

IPM components for *D. abbreviatus* in citrus are in various stages of development. An acoustic detection system for root-feeding larvae has been developed (Mankin et al. 2000). Commercial nematode products are available. Sources of rootstock resistance have been identified (Lapointe et al. 1999) but resistant cultivars are years away. The utility of traps or cover crops (Lapointe 2000c) would be enhanced by deterrents such as kaolin (Lapointe 2000b). Egg parasitoids have been tentatively established (Hall et al. 2001).

Table 3. Total leaf area consumed per feeding bout (mean ± SE, *n* = 3) by and daily presence of adult *D. abbreviatus* on foliage when caged for 14 days on bouquets of citrus leaves untreated or sprayed with a kaolin formulation.

Treatment	Leaf area (cm^2)[a]	Presence (%)[b]
Means by bouquet, cage:		
Untreated, no-choice	15.4 ± 1.5a	63.3 ± 4.0a
Untreated, choice	13.9 ± 1.7a	22.4 ± 4.3b
M-97-009 + M03, choice	3.1 ± 0.8b	8.8 ± 2.3c
M-97-009 + M03, no-choice	2.5 ± 0.7b	6.1 ± 1.8c
Means by cage:		
Untreated, no-choice	30.8 ± 2.5a	63.3 ± 4.0a
Choice	17.0 ± 1.7b	31.3 ± 4.7b
M-97-009 + M03, no-choice	5.0 ± 1.7c	6.1 ± 1.8c

[a] Means followed by the same letter are not significantly different at $\alpha = 0.05$ by Tukey's HSD after a significant repeated measures ANOVA (by bouquet, cage, $F = 20.2$; df = 3, 8; $P < 0.01$; by cage, $F = 26.7$; df = 2, 6; $P < 0.01$).

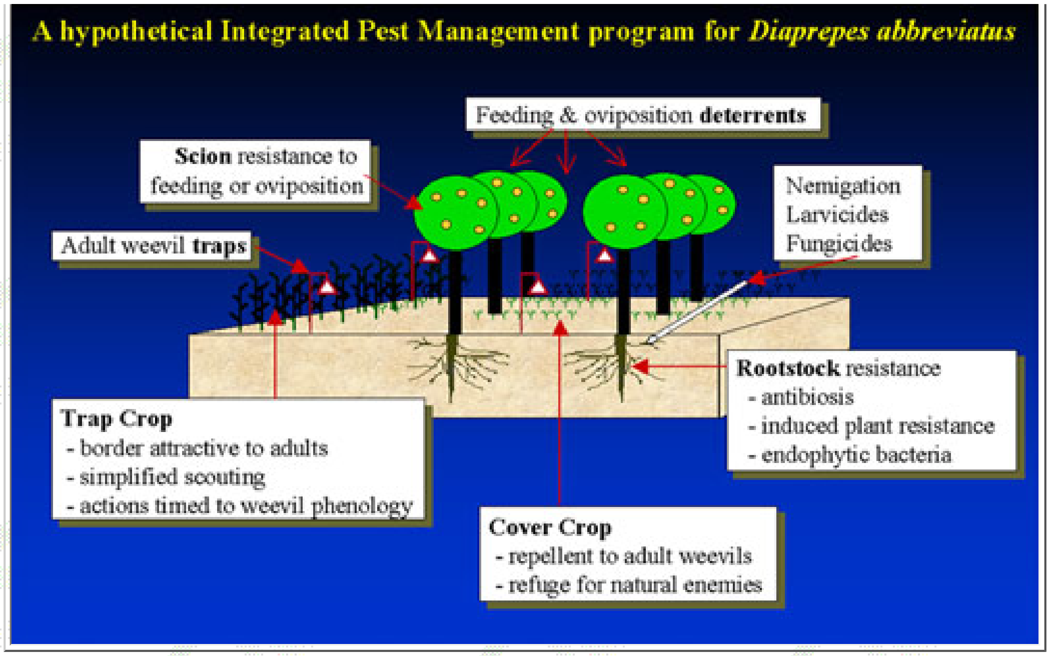
[b] Daily mean score (untransformed) over 20 days of proportion of weevils present on leaves; means followed by the same letter are not significantly different at $\alpha = 0.05$ by Tukey's HSD after a significant repeated measures ANOVA of transformed means (by bouquet, cage, $F = 120.3$; df = 3, 8; $P < 0.01$; by cage, $F = 80.2$; df = 2, 6; $P < 0.01$).

Table 4. Total leaf area consumed per feeding bout (mean ± SE, n = 3) by and daily presence of adult *D. abbreviatus* caged for 14 days on citrus leaves untreated, sprayed with M03 adjuvant only, or sprayed with a hydrophilic kaolin and sticker (M-97-009 + M03).

Treatment	Leaf area (cm^2)[a]	Presence (%)[b]
Untreated	21.2 ± 3.5a	61.3 ± 5.2a
M03	21.6 ± 2.2a	60.8 ± 4.4a
M-97-009 + M03	6.8 ± 1.4b	16.6 ± 2.7b

[a] Means followed by the same letter are not significantly different at $\alpha = 0.05$ by Tukey's HSD after a significant repeated measures ANOVA ($F = 7.7$, df = 2, 6; $P = 0.02$).

[b] Daily mean score of three replications of number of weevils present on leaves; means followed by the same letter are not significantly different at $\alpha = 0.05$ by Tukey's HSD after a significant ANOVA of transformed means ($F = 7.5$, df = 2, 6; $P = 0.02$).



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