TITLE: USING NOVEL CULTURAL CONTROLS FOR MANAGEMENT OF ONION THRIPS ON ONIONS

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ABSTRACT: Onion thrips has been identified by onion growers as their major pest. In 2005, uncontrollable infestations of thrips were common because of the hot, dry weather combined with some populations having developed resistance to some commonly used insecticides. To enhance an IPM approach for this pest in onions, a non-insecticidal approach is needed. We have been focusing on using straw mulch and kaolin clay to reduce thrips populations while not interfering with common agronomic approaches. The NYS IPM Program provided partial support to look at the use of kaolin clay, and these studies were conducted in the laboratory. Kaolin clay reduced the ability of thrips to lay eggs, reduced egg hatch, reduced feeding on the plant, and reduced the number of larvae that could develop into adults. Field trials conducted with other funding sources indicated that spraying with kaolin clay resulted in reduced thrips densities. One concern with the use of kaolin sprays is that they may have to be reapplied when the residues are washed away with rain. However, kaolin clay can be part of an overall IPM program for thrips control on onions and help to reduce thrips damage to onions while reducing the use of harder insecticides.

BACKGROUND AND JUSTIFICATION: The onion thrips, *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) is an important pest of onions in most onion-producing areas of United States. Thrips feeding damage leads to yield reductions and affects the onion bulb size and through the transmission of Iris Yellow Spot Virus imposes a serious threat to the onion production. Such problems are also exacerbated by insecticide resistance recorded in areas of Canada and New York state. Novel control strategies are required to be implemented in an integrated approach against insecticide resistance and spread of IYSV.

A novel development of disease and insect control is the utilization of aqueous formulations of particle films. Particle film is based on kaolin, a white, non-abrasive aluminosilicate mineral ($Al_4Si_4O_{10}[OH]_8$) and its coating serves as a physical barrier repelling arthropods and/or suppressing infestations by making the plant visually or tactually unrecognizable as a host and furthermore, hamper insect movement, feeding and other physical activities. Such technology has effectively suppressed plant diseases and several plant-feeding and also virus-vector arthropods such as *Bemisia argentifolii* Bellows and Perring (Homoptera: Aleurodidae) on melon; *Circulifer tenellus* (Baker) (Homoptera: Cicadelidae) on chile pepper; *Aphis spireacola* Patch (Homoptera: Aphididae), *Cacopsylla pyricola* Foerster (Hemiptera: Psyllidae), *Tetranychus urticae* Koch (Acarina: Tetranychidae) and *Empoasca fabae* (Harris) (Homoptera: Cicadelidae) in pear and apple; *Cydia pomonella* (Linnaeus) (Lepidoptera: Torticidae) in apple and pear; and *Anthonomus grandis grandis* Boheman (Coleoptera: Curculionidae) in cotton. In addition to the potential of kaolin-based particle films in IPM, such technology has also provided some physiological benefits to apple and pear orchards and significantly reduced virus incidence on chile pepper. Studies conducted on soybean, cotton, artichoke, melons and peach have shown that foliar applications of kaolin-particle films reduce plant stress, which is important for optimum plant growth, yield and quality. The porous nature of the film does not seem to affect plant photosynthesis or productivity, increasing the potential for its use.

Encouraging results on onion thrips control on onions by applying kaolin-clay during a field study in NYS, prompted the present study, which aimed to investigate the effect of such particle film on the feeding behavior, oviposition and development of *Thrips tabaci*.

OBJECTIVE: Determine the effectiveness of using kaolin clay for suppressing thrips populations on onions.

PROCEDURES: Experiments were conducted in an environmental chamber at 27 ºC, 60% RH, and a photoperiod of 16:8 (L:D) h. The kaolin particle formulation used was Surround WP (95% active ingredient) supplied by Englehard Corporation (Iselin, NJ). A rate of 60g/liter with the appropriate surfactant, as recommended by the manufacturer was used.

Insects and plant material. The *T. tabaci* used throughout the experiments were from a continuous culture maintained on onions at 27 ºC, 60% RH, and a photoperiod of 16:8 (L:D) h. The plant material used was 5 cm long onion leaf sections from the 3rd and 4th leaf of plants grown by yellow onion sets for 2-3 weeks at 25 ºC, 16:8 (L:D) h, in an environmental chamber. Unless otherwise stated, plant material was dipped and slightly stirred into the kaolin particle suspension and allowed to dry for at least 1 hour prior to experiments. Control plant material was similarly dipped in distilled water with surfactant and allowed to dry. To prevent thrips from occupying the onion leaf interior and to prevent the loss of moisture from the onion leaf, both sides of the leaf section were sealed by briefly dipping them in warm paraffin wax.

Effect of kaolin particle on oviposition

No-choice experiment: Twenty one-week old adult female onion thrips were allowed to oviposit individually for 24 h on an onion leaf section either covered in kaolin particle film or distilled water. The ovipositional output was recorded 4 days later under the microscope by counting the number of empty egg sacs left behind by successfully emerged larvae.

Choice experiment: Half of the onion leaf section was dipped either in kaolin particle film or distilled water before introducing an adult female thrips to choose an oviposition site for 24 h. The experiment was replicated 20 times and ovipositional output on each treated side was recorded similarly to the no-choice experiment.

Effect of kaolin particles on egg hatch

Twenty-six adult female onion thrips from the thrips cultures (≈ 8 days old) were allowed to oviposit individually on onion leaf sections for 24 h. Preliminary experiments showed that thrips oviposit between 7-10 eggs per day but to avoid variation in numbers of eggs, 3 eggs on the same leaf section (6 eggs per leaf, 78 eggs per treatment) were smeared either with kaolin particle film or with distilled water. Such treatments took place 3 days after oviposition when eggs were visible under the microscope as swellings under the leaf epidermis. Larval emergence was recorded by the empty sacs on the treated parts of the leaf section.

Effect of kaolin particle on feeding

No-choice: three second-instar onion thrips were confined on an onion leaf section either treated with kaolin particle film or distilled water (20 replicates). Feeding damage was recorded after 24 h. On kaolin treated leaves the particle film was washed off with a water saturated cotton ball to allow the appearance of feeding marks. Furthermore, a single adult female thrips was tested for feeding behavior on treated or control leaves similarly to the larval experiment (20 replicates).

Choice: three second-instar onion thrips were confined on an onion leaf section half treated with kaolin particle film and half treated with distilled water (20 replicates). Their position and feeding damage was recorded after 24 h. similarly, individual adults were tested for their choice between kaolin treated and control leaf sections (20 replicates).

Effect of kaolin particle on development

Three newly emerged onion thrips larvae were confined on an onion leaf section either treated with kaolin particle film or distilled water (20 replicates). Larvae were provided with new onion leaves every day and their development was recorded until adult emergence. Upon pupation, a saturated filter paper section was introduced into the experimental cage to provide humidity and hiding place.

Effect of direct application of kaolin particle film

In order to examine the effect of direct application on thrips, an 1.5 ml Eppendorf tube was half filled with kaolin clay aqueous formulation and five second-instar onion thrips were introduced on the inside of the tube's cap (20 replicates). After sealing it, the tube was turned upside down for 10 seconds; thrips were recovered with a fine paintbrush and introduced on onion leaves for 24 h before assessing their mortality. As a control treatment, thrips were immersed into distilled water. The same procedure was repeated to assess adult mortality after direct application of kaolin particle film (20 replicates).

RESULTS:

Effect of kaolin particle on oviposition

On the no-choice experiment, significantly fewer eggs were laid on onion leaves treated with kaolin particle film than distilled water ($F_{1,39}$=73.44, P<0.001). Similarly adult thrips preferred to oviposit more eggs on the water treated part of the leaf than the one covered in kaolin ($F_{1,39}$=144.5, P<0.001) (Fig.1).

Effect of kaolin particle on egg hatch

Eggs covered in kaolin particle film were less successful in hatching than water treated eggs (x^2= 14.7, df=1, P<0.001) (Fig.2).

3.3 Effect of kaolin particle on feeding

Larvae and adults fed preferably on the clean leaf tissue (Fig. 3) but the leaf area damaged remains to be determined.

Effect of kaolin particle on development

Significantly fewer larvae completed adulthood when reared on kaolin treated leaf sections and 51.6% of the experimental population was dead before pupation. Mortality rate was only 6.9% in the control population and kaolin treatments significantly increased the development time of the surviving individuals (Table 1).

Effect of direct application of kaolin particle film

The survival of larvae was high for both treatments. Of the initial 100 larvae that were treated with either kaolin or water, only 5 of the kaolin treated larvae were dead after 24 h and none of the water-treated larvae. Fourteen of the kaolin treated adults were dead after 24 h which was significantly different with the 100% survival of the water treated adults (x^2= 15.0, df=1, P<0.001).

Table 1: Mean development time (days ± SE) of *T. tabaci* larvae to complete development when reared on kaolin treated and control onion leaves.

Development (days ± SE)	Larva 1	Larva 2	Pupal stage
Kaolin	2.3 ± 0.1b	3.5 ± 0.2b	3.8 ± 0.5a
Control	2 ± 0a	2.45 ± 0.1a	3.9 ± 0.1a
	$F_{1,44}$=8.99, P<0.001	$F_{1,43}$=42.3, P<0.001	$F_{1,42}$=1.59, P>0.05

Fig.1: Mean number of eggs laid in no-choice and choice experiments with kaolin treated and water treated leaf sections. Bars represent standard error. Asterisks indicate significant differences with water-treated leaves.

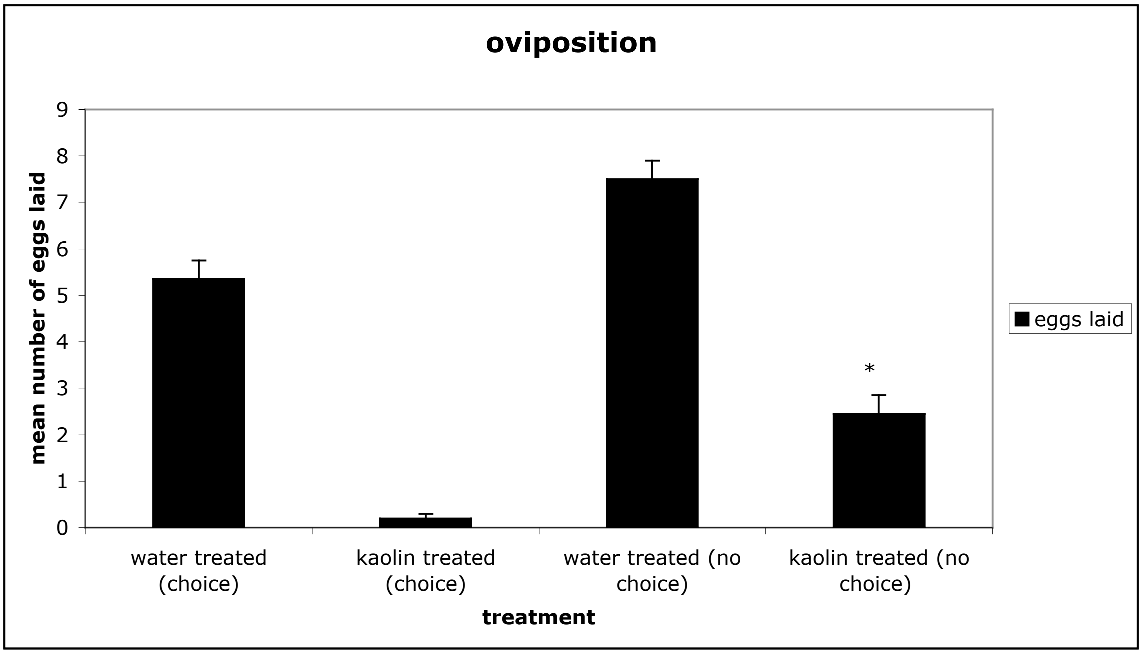


Fig.2: Percentage egg hatch by kaolin or water treated onion leaf sections.

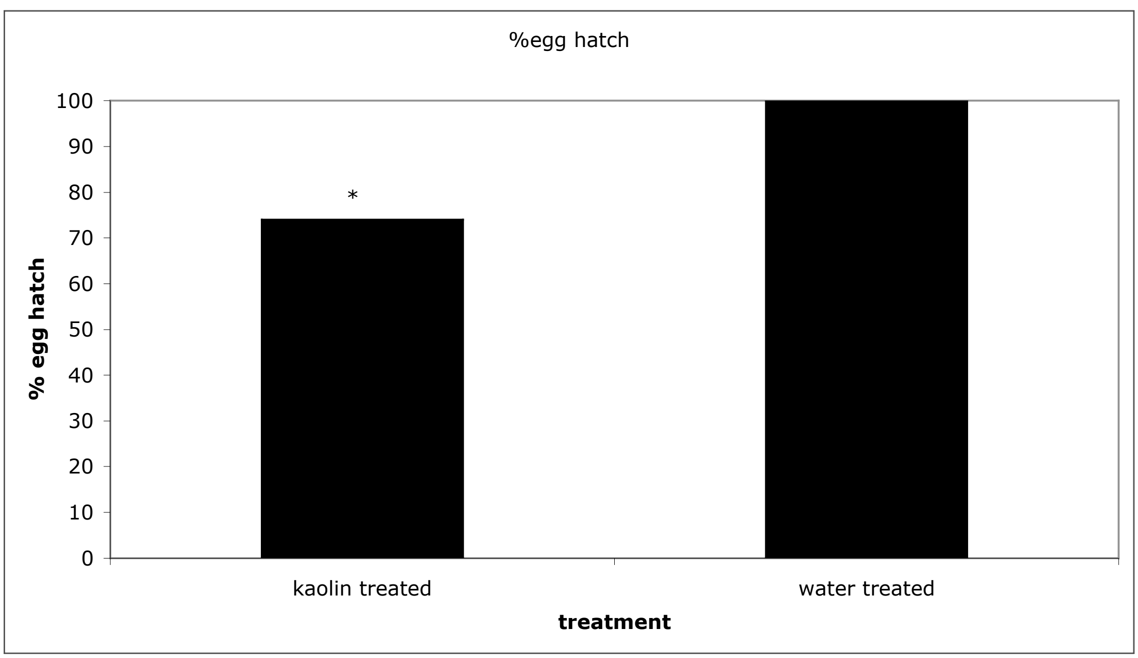
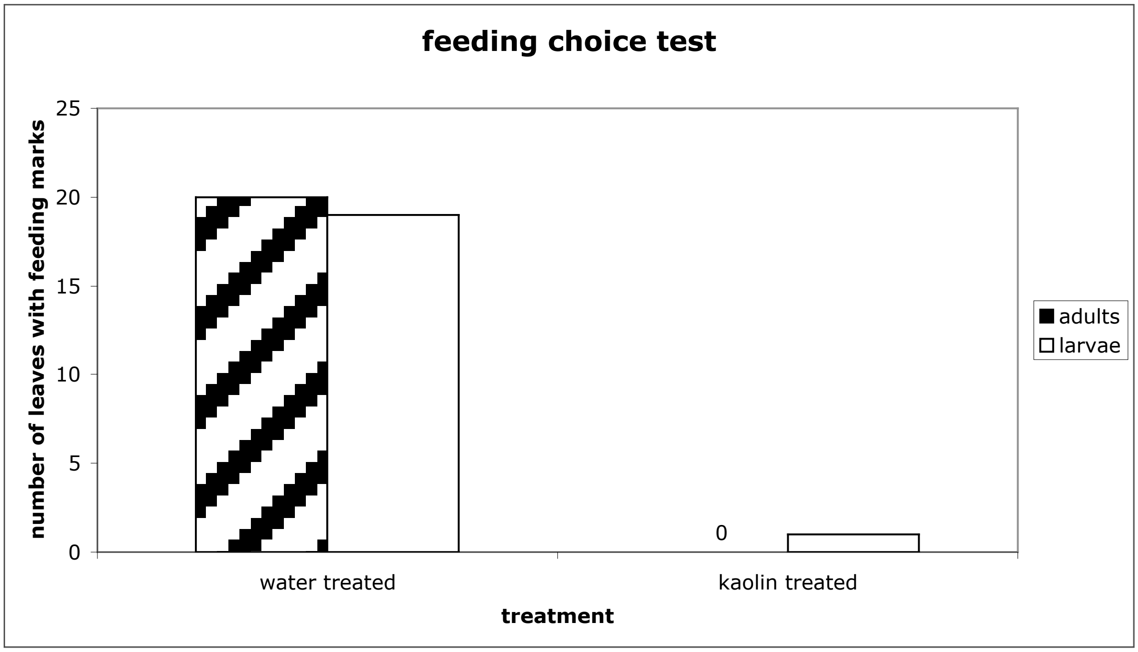


Fig. 3: Larval and adult choice feeding test 24 h after introduction to kaolin and water treated leaf sections.



DISCUSSION: These results clearly demonstrate that kaolin can reduce thrips populations and be a component of an overall IPM program. Furthermore, kaolin will reduce populations by "mechanical" rather than "physiological" methods such as traditional insecticides. Therefore, it would be of use in an overall insecticide resistance management program. A drawback of the use of kaolin clay is that is can be washed off in the field due to rain. Further field studies are needed to determine its usefulness under commercial situations.