First Year Results of the Impact of a Novel Pest Management Technology on Apple Fruit Quality

M.E. Garcia, L.P. Berkett and T. Bradshaw
Department of Plant & Soil Science
University of Vermont
Burlington, VT 05405
USA

Keywords: Kaolin, IPM, particle film, weight, color, size, starch index

Abstract

A new, 'reduced risk' biopesticide, kaolin, is commercially available as a potential replacement for insecticides that manage key apple insect pests. When kaolin is sprayed onto the tree, it forms a physical barrier that repels insects or makes the site unrecognizable and/or unsuitable. Initial research indicated that kaolin also might have non-target impacts such as a reduction in heat stress and a reduction in canopy temperature. However, most of the research on non-target effects, such as impacts on fruit quality, has been conducted in warmer, semi-arid environments. These potential impacts may not be beneficial in cooler orchard environments. One of the objectives of this three-year study is to determine the effects of kaolin-based particle film on fruit quality. Using a completely randomized experimental design, five treatments, replicated six times, will be applied yearly to the plots: (1) kaolin starting at the Silver Tip growth stage and continuing on a weekly schedule through Petal Fall, then bi-weekly to the end of the growing season, plus fungicides; (2) kaolin starting at Silver Tip and continuing on a weekly schedule through Petal Fall, then bi-weekly to the end of the growing season but trees would not receive any fungicides; (3) kaolin starting at the Petal Fall growth stage and continuing on a bi-weekly schedule through the end of the growing season, plus fungicides; (4) a typical IPM spray program consisting of applications of phosmet plus fungicides; and (5) a 'control' where no insecticide (kaolin or phosmet) will be applied but trees will receive fungicides. All treatments will receive horticultural sprays (i.e., thinners, nutrient applications) according to Extension Service recommendations. The 2001 data indicate significant differences in the treatments in fruit weight, height, width, firmness and starch index. There were no significant differences in percent red color. This study will continue through 2004 to determine kaolin's potential non-target horticultural impact under cooler growing conditions.

INTRODUCTION

On most apple cultivars in the USA, production of fruit is dependent on repeated applications of pesticides. In New England, growers annually spray 5-7 insecticide applications, 8-10 fungicide applications, 1-2 miticide applications, and 1-2 herbicide applications (*unpublished*, IPM Phase I New England Apple Survey, 1996). Currently, growers rely on a number of pesticides classified by the Environmental Protection Agency as being within a group (i.e., Group 1) that pose the greatest risk to the public health under the standards set forth by the Food Quality Protection Act of 1996 (Public Law 104-170, August 3, 1996). This group includes phosmet, azinphos-methyl, and chlorpyrifos used for management of key insect pests and captan, mancozeb, metiram, and myclobutanil which are very important in apple disease and resistance management (Koehler, 2000). Loss or further restrictions on use of these materials and other apple pesticides under tolerance reassessment could serious affect apple production. As new, 'reduced risk' IPM alternatives become commercially available, such as kaolin-based particle film technologies that suppress arthropod pests, it is important that these new technologies be thoroughly evaluated in a holistic, comprehensive manner, looking not only at efficacy against arthropod pests and beneficials, but also at potential non-target effects within the orchard to determine their optimal role under cold-climate orchard conditions. The overall objective of this comprehensive, three-year project is to determine the potential non-target impact of white kaolin film on phenological development of buds, fruit maturation, thinning, foliar nutrient uptake, fruit quality, yield, and tree growth. In addition, the impact of kaolin particle film on disease incidence and bird damage will be examined. The information presented here only includes the first year's results of the effect of kaolin on fruit quality.

MATERIAL AND METHODS

This is a three-year research project that began during the 2001 growing season and will be terminated at the end of the 2004 growing season. It is being conducted in a 0.6 ha orchard at the University of Vermont Horticultural Research Center, South Burlington, Vermont (USA) on 'McIntosh' trees on M.26 rootstock planted in single tree plots. Trees were planted in 1988 at a spacing of 3.6 m within rows by 6.1 m between rows. Using a completely randomized experimental design, the following five treatments, replicated six times have been applied to the plots: (1) kaolin (Surround™ WP, Englehard Corp., Iselin, NJ) at recommended label rate, starting at the phenological bud stage of Silver Tip and continuing on a weekly schedule through Petal Fall, then bi-weekly to the end of the growing season, plus fungicides; (2) kaolin at recommended label rate, starting at the phenological bud stage of Silver Tip and continuing on a weekly schedule through Petal Fall, then bi-weekly to the end of the growing season but trees would not receive any fungicides; (3) kaolin at recommended label rate, starting at the Petal Fall stage and continuing on a bi-weekly schedule through the end of the growing season, plus fungicides; (4) a typical IPM spray program consisting of applications of phosmet (Imidan 70WP) based on standard IPM monitoring (Koehler, 2000), plus fungicides; and (5) a 'Control' where no insecticide (kaolin or phosmet) would be applied but trees would receive fungicides. All treatments will receive horticultural sprays (i.e., thinners, nutrient applications) according to Extension Service recommendations (see Table 1 for summary of treatments).

All treatments have been applied dilute with a handgun following label directions to ensure complete coverage. Each plot will receive the same treatment each growing season for the duration of the three-year study to evaluate any carry-over or long-term effect of the treatments. Environmental orchard conditions such as rainfall, (i.e., time, duration, and amount), ambient air temperature, and leaf wetness have been continuously monitored by a weather station/data logger (Davis Comprehensive GroWeather) and data will be used in disease and arthropod models to aid in management decisions. Standard IPM scouting techniques (Agnello, et al., 1993; Agnello, et al., 2000; Koehler, 2000) have been used to determine the need for and timing of phosmet applications and for determining optimal time for data collection. In 1996, *Typhlodromus pyri*, a predator mite, was released throughout the orchard and no miticides, other than oil applied prebloom, have been applied in the orchard and this will continue on all trees for the duration of the study. Horticultural management has followed established Extension Service recommendations. Analysis of variance in PROC GML was used to separate mean differences between treatments. Alpha was held at 0.05 for all tests. (SAS Institute, 1999).

During the 2001 growing season, the fungicide mancozeb (Penncozeb 75DF) was applied through bloom (Koehler, 2000) and captan (Captec 4L) was applied post-bloom at recommended rates based on standard evaluations of disease pressure and environmental conditions for disease development (Berkett, 2000).

Fruit Quality Measurements

A random sample of 10 fruit was collected from each tree and evaluated for weight (g), size (cm, diam.), skin color (visual estimate of % red blush), flesh firmness (N), soluble solids (% brix), and starch-index (Cornell chart).

RESULTS AND DISCUSSION

Although the commercially available kaolin (Surround™ WP, Englehard Corp., EPA Reg. No. 70060-14) is not specifically labeled for use against any apple diseases, research by Glenn et al.(1999), demonstrated that particle film reduced the incidence of apple scab in West Virginia. The 2001 data on the effect of kaolin on pest management have not been statistically analyzed, but observations of fruit indicate that the incidence of scab *Venturia inaequalis* (Cooke) Wint. was higher for the kaolin treatment that received fungicide applications during the season (Trt.1) compared to the standard IPM treatment (Trt. 4) (data not shown). Treatment mean damage caused by insect pests varied with the specific pest and treatment. However, when kaolin treatments were initiated at the Silver Tip growth stage (Trt. 1 and 2), kaolin provided similar control of damage caused by the apple maggot, *Rhagoletis pomonella* (Walsh), as the standard IPM treatment (Trt.4) (data not shown). Particle film has been reported to have important horticultural impacts due to its effect on canopy temperature (Glenn et al., 2001; Glenn et al., 1999; Puterka et al., 2000). In seven of eight apple trials conducted in 1997-1998 in PA, WA, WV and Santiago, Chile, canopy temperatures were reduced and leaf carbon assimilation was increased (Glenn et al., 2001) after particle film treatments. Data from these trials indicate that particle film treatment may increase the carrying capacity of apple trees by either increasing fruit set or increasing fruit size. The Surround™ WP label for use on apple states: "When applied at recommended rates and frequencies, benefits such as increased plant vigor and improved yields may occur in certain apple cultivars….Many apple cultivars have shown improved fruit color, smoothness, and size with less sunburn when SURROUND™ WP is used." Research by Glenn et al. (2001) has found that particle film treatments have delayed harvest of apple by 1-2 days. The analysis of data on fruit quality collected during the 2001 growing season indicate significant differences in the treatments in fruit weight, height, width, firmness and starch index. There were no significant differences in percent red color (Table 2). This is a comprehensive, three year project study and these results represent the effects of kaolin particle film for one season. The researchers will continue collecting data through 2004 to determine kaolin’s potential non-target horticultural impact under cooler growing conditions and to evaluate any carry-over or long-term effect of the application of kaolin to apple trees.

CONCLUSION

Data from the first year of this three year study indicate kaolin does have an impact on disease and arthropod management. However, it is too early in the study to develop firm conclusions. The 2001 data on fruit quality indicate significant differences in the treatments in fruit weight, height, width, firmness and starch index. There were no significant differences in percent red color. However, these results represent the effects of kaolin particle film for only one season. This study will continue through 2004 to determine kaolin’s potential non-target horticultural impact under cooler growing conditions.

Literature Cited

Agnello, A.M., Reissig, W.H., Nyrop, J.P., Kovach, J. and Morse, R.A.. 1993. Biology and management of apple arthropods. Cornell Coop. Ext. Pub. Information Bull. 231. 32 pp.

Agnello, A.M., Wilcox, W.F., Rosenberger, D.A., Robinson, T.L., Schupp, J.R., Curtis, P.D., Breth, D.I. and Hoying, S.A. 2000. Pest management guidelines for commercial tree-fruit production. Cornell Coop. Ext. Pub. 180 pp.

Berkett, L.P. 2000. 2000-2001 New England Apple Pest Management Guide. Disease Management, editor, Univ. of ME Coop. Ext. Orono. 188 pp.

Glenn, D.M., Puterka, G.J., Drake, S., Unruh, T., Knight, A., Baherle, P., Prado, E. and Gaugher, T. 2001. Particle film application influences apple leaf physiology, fruit yield, and fruit quality. J.Am. Soc.Hort.Sci. 126(2):175-181.

Glenn, D.M., Puterka, G.J., Vanderzwet, T., Byers, R.E. and Feldhake, C. 1999.

Hydrophobic particle films: a new paradigm for suppression of arthropod pests and plant diseases. J. Econ. Entomology. 92: 759-771.
Koehler, G.W. (ed.) 2000. 2000-2001 New England Apple Pest Management Guide. Univ. of ME Coop. Ext. Orono.
Puterka, G.J., Glenn, D.M., Sekutowski, D.G., Unruh, T.R. and Jones, S.K. 2000b. Progress toward liquid formulations of particle films for insect and disease control in pear. Environ. Entomol. 29: 329-339.
SAS Institute, 1999. SAS Institute Inc., Cary, NC.

Tables

Table 1. Treatments to Determine Target and Non-Target Impacts of Kaolin.

TRT #	Insecticide		Fungicide	Hort. Sprays (Nutrient and Thinning)
	Phosmet	Kaolin		
1	-	X (Starting at Silver Tip)	X	X
2	-	X (Starting at Silver Tip)	-	X
3	-	X (Starting at Petal Fall)	X	X
4 (IPM)	X	-	X	X
5 (Control)	-	-	X	X

Table 2. Effect of kaolin particle film treatment on fruit quality of ‘McIntosh’/M.26 during the 2001 growing season.

TRT #	Fruit Weight (g)[z]	Height (cm)[z]	Width (cm)[z]	% Red color[z]	Starch Index[z] (1-7)	Fruit Firmness (N)[z,x]	Soluble Solids[y]
1	194 a[w]	65 a	80 a	55 a,b	4.5 b	73.9 b,c	11.9 b
2	166 b	61 c	77 b	55 a,b	4.0 c	74.8 b	13.2 a
3	179 b	63 a,b	79 a,b	57 a	5.0 a	71.2 c	12.4 a,b
4	173 b	63 a,b	78 a,b	53 a,b	4.4 b	74.8 b	11.8 b
5	171 b	62 b,c	77 b	51 a,b	4.5 b	78.3 a	12.7 a,b

[z] Each individual apple of a 10 sample was measured and data represent mean average
[x] 4.45 N = 1 lb force
[y] Data represent one measurement of combined juice from a 10-apple sample
[w] Lower case letters indicate significant treatment differences within columns at $p < 0.05$