

Can Surround® CF reduce infestation of apple saw fly in organic apple production?

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Abstract

In 2013 and 2014, different products to control the larvae of apple sawfly (*Hoplocampa testudinea* Klug) was tested in an organic apple orchard at the Department of Food, Aarhus University, Denmark. The orchard was established in 2010 as two-year-old trees on M9 and a planting distance of 1 x 3.3 m. In 2013, the effect of Kaolin ($Al_2Si_2O_5(OH)_4$) and Magnesium Sulphate ($MgSO_4$) against apple sawfly was tested in 'Santana' apples timed at egg hatching. In 2014 the effect of formulated Kaolin 'Surround® CF', Spruzit Neu and NeemAzal-T/S was tested in 'Red Topaz' at egg hatching. The number of flower clusters, number of dropping infested fruitlets, number of fruit harvested per tree and number of fruits damaged by apple saw fly was determined.

In 2013 Kaolin (100 kg/ha) and Magnesium Sulphate 15 kg/ha) was applied three times around egg hatching. The treatments had no effect neither on the yield nor on the percentage of fruits damaged by apple saw fly. In 2014, Spruzit Neu (6 l/ha) and NeemAzal-T/S (3 l/ha) was applied once at egg hatching. Surround® CF (50 kg/ha) was applied four times in three days intervals with the final application coinciding with the NeemAzal-T/S and Spruzit Neu applications. The single treatment with Spruzit Neu had no significant effect on yield of 'Red Topaz'. The treatment with NeemAzal-T/S reduced the number of dropping fruitlets and the percentage of infested fruitlets. However, there was no reduction in percentage harvested fruits damaged by apple saw fly nor increase in yield. The four treatments with Surround® CF significantly reduced the drop of fruitlets and the percentage of infected fruitlets. Surround® CF also reduced the percentages of damaged fruits at harvest, increased the number of fruit per 100 flower clusters and significantly increased the yield. More work is needed to find the right timing of the Surround® CF treatments. The effect of a further treatment with Surround® CF three days after the first egg had hatched would have been interesting to include in the trial.

Keywords: *Hoplocampa testudinea*, *Malus domestica*, Kaolin, Spruzit Neu, NeemAzalT/S

Introduction

Apple sawfly (*Hoplocampa testudinea* Klug) is one of the most damaging pests in organic apple production in Denmark. The use of extract from the shrub *Quassia amara* has never been permitted in Denmark. The product Spinosad (Tracer) and *Quassia amara* (Quassia-MD) are not expected to be permitted for use in apples in the near future. However, in Danish trials both products have shown a rather high efficacy against apple sawfly of 80 and 70 % respectively (Paaske, 2014). The Danish growers need new methods or products to control apple sawfly 'as fast as possible'. Magnesium Sulphate has shown some effect on sawfly infestation in Ribes (Helsen, 2013). A formulated product of Kaolin (Surround® CF) is used in United States to control apple saw fly (NN., 2016). The products Spruzit Neu and NeemAzal.T/S are insecticides which are used in organic apple production in some countries and are at presently available for Danish growers on yearly dispensation.

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Material and Methods

In 2013 and 2014, different products to control the larvae of apple sawfly (*Hoplocampa testudinea*) was tested in an organic apple orchard at the Department of Food, Aarhus University, Denmark. The orchard was established in 2010 as two-year-old trees on M9 and a planting distance of 1 x 3.3 m. The orchard was sprayed organically to control diseases, using sulphur and potassium bicarbonate. A split pot design with three blocks was used in the trials. A plot size of four trees was used in 2013 and of seven trees in 2014.

The development of the apple sawfly larvae in the eggs in the fruitlets was followed after flowering. The treatment with different compounds was timed around the time for the first larvae emerging. In 2013, the effect of Kaolin ($\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$) (100 kg/ha) and Magnesium Sulphate (MgSO_4) (15 kg/ha) was applied three times in 'Santana' apples around egg hatching against apple sawfly. Treatments were done using a knapsack sprayer. In 2014 the effect of formulated Kaolin 'Surround® CF' (50 kg/ha), Spruzit Neu (6 l/ha) and NeemAzal-T/S (3 l/ha) was tested in 'Red Topaz' apples at apple sawfly egg hatching. A tractor driven orchard sprayer was used. In both years an unsprayed control treatment was established. In 2013 the trees were sprayed until drip-off and in 2014 800 to 1000 l water/ha were used. Spruzit Neu and NeemAzal-T/S was applied once at egg hatching. Surround® CF was applied four times in three days intervals with the final application coinciding with the NeemAzal-T/S and Spruzit Neu applications.

In 2013, number of dropping infested and not infested fruitlets per tree, yield and number of fruit harvested per tree and number of fruits damaged by apple saw fly per tree was determined. In 2014 the number of flower clusters per tree, a score for number of infested apples per tree late June, 1-5, where 1 = none, 2 = one per tree, 3 = 1-5 per tree, 4 = 5-10 per tree and 5 = more than 10 damaged apples per tree, number of dropping infested and not infested fruitlets per tree, yield and number of fruit harvested per tree and number of fruits damaged by apple saw fly per tree was determined.

Results

2013: The treatments to control apple saw fly had no increasing effect on the yield nor a reducing effect on the percentage of fruits damaged by apple saw fly. On the contrary, it seems as if the treatments decreased the yield (Table 1).

2014: The single treatment with Spruzit Neu had a significant reduction on harvested fruits damaged by larvae scars (Table 2 and 3). This resulted in a tendency to a higher yield of graded fruits without scar damage. The treatment with NeemAzal-T/S reduced the number of dropping fruitlets from primary and secondary infestations of sawfly (Table 2). However, there was no reduction in percentage harvested fruits damaged by apple saw fly nor increase in yield (Table 3). The four treatments with Surround® CF significantly reduced the drop of fruitlets and the percentage of infected fruitlets (Table 2). Surround® CF also reduced the percentages of damaged fruits at harvest, increased the number of fruit per 100 flower clusters and significantly increased the yield (Table 3). The used method of scoring the infestation of apple sawfly per tree, have shown the same tendency in infestation as the more time consuming methods (Table 2). Especially there is the same trend in the figures as for total number of fruit damaged by apple saw fly (Table 3).

Table 1: % apple sawfly infested dropped fruitlets, number of harvested fruits/tree, total harvested kg/tree, % harvested fruits damaged by sawfly larvae scars and yield per tree without larvae scars, in the apple cultivar 'Santana', 2013.

Treatment	% fruitlets dropped due to infestation.	Fruits harvested. Number/tree	Yield. Kg/tree.	% harvested fruits damaged by egg deposit.	% harvested fruits damaged by larvae scars.	Yield. Fruits without larvae scars. Kg/tree
Control, untreated	15.8	64.1	9.7	14.7	6.2	9.0
Kaolinite	18.2	51.8	8.4	17.1	7.4	7.8
Magnesium Sulphate	15.5	45.6	7.5	13.7	7.5	6.9

Table 2: Score for apple sawfly infestation per tree late June 1-5, where 1= none. Number of flower clusters per tree, number of fruitlets dropped due to primary and secondary infestations of apple sawfly per tree, % dropped fruitlets due to primary and secondary infestations of apple sawfly, and % dropped fruitlets without apple sawfly infestations in the apple cultivar 'Red Topaz' 2014.

Treatment	Score for Infestations 1-5, 1= none.	Number of flower clusters per tree.	Fruitlets dropped due to primary infestations. Number per tree.	Fruitlets dropped due to secondary infestations. Number per tree.	% Fruitlets dropped due to primary infestations.	% Fruitlets dropped due to secondary infestations.	% Fruitlets dropped without sawfly infestations.
Control, untreated	4	155	16.8	26.4	12	19	69
Spruzit Neu	3.8	169	16.5	23	13	19	68
Neem- Azal	3.2	134	8.6	16.5	9	18	73
Surround® CF	2.9	137	4.1	6.1	5	8	87
LSD		23	6	8	4	6	9

Table 3: Number of harvested fruits/tree, % harvested fruits damaged by sawfly egg deposit, % harvested fruits damaged by larvae scars, total number of fruits damaged by saw fly, fruitset per 100 clusters, number of fruits without damage by larvae scars and yield per tree without larvae scars, in the apple cultivar 'Red Topaz', 2014.

Treatment	Number fruit per tree.	% harvested fruits damaged by egg deposit.	% harvested fruits damaged by larvae scars.	Fruits damaged by apple saw fly total*. Number per tree.	Fruitset. Fruits per 100 clusters.	Fruits without damage from larvae scars. Number per tree.	Yield. Fruits without larvae scars. Kg per tree.
Control, untreated	66	4,4	18,8	58	41	50	7,7
Spruzit Neu	59	5,8	9,3	48	36	55	8,8
Neem- Azal	54	6	20,2	39	42	43	7,1
Surround® CF	68	4,2	8	20	49	63	9,8
LSD	11	ns	4	15	7	9	1,3

* Number of fruitlets dropped due to primary and secondary damage and number of harvested fruits damaged by egg deposits and larvae scars.

Discussion

A recent survey of particle films and their application in horticultural crops (Sharma *et al.*, 2015) name about a dozen papers where clay films have been tested for insect deterrence in apple, but none of these are specific against apple sawfly. The primary mode of action described in these papers is repellence and reduced oviposition, which are in line with our findings of a lower infestation level combined with fewer fruit showing larvae damage. The deviating results obtained in the present experiment where pure Kaolin (2013) show no effect, and its formulated version Surround® CF (2014) is highly effective, is in line with growers experiences from the USA (Phillips, 2011). The increased effect of Surround® CF is explained by smaller and more even particle size that enables clay particles to stick to the insect and flake off and thereby deter egg laying of apple sawfly (Phillips, 2011). The low toxicity of the clay compounds along with US grower experiences and our one year findings calls for further research into the possibilities of using Surround® CF against apple sawfly.

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