THE UNIVERSITY OF BRITISH COLUMBIA

Plant Care Services

VP Research & Innovation

Efficacy of Silamol in the prevention of powdery mildew on Roses and Tomato

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Acknowledgments

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Introduction

Silamol® is a concentrated form of available liquid Potassium Silicate, which forms [Si(OH)4] upon dilution, is capable of being introduced through standard hydroponic systems. Silica has long been investigated for its beneficial attributes in reducing disease incidence.

This project focused on the disease prevalence of powdery mildew *Sphaerotheca pannosa var. rosae* on miniature roses (Sun made) and *Oidium neolycopersici* on tomato (Red robin). Powdery mildew causes substantial loses in both crops if not treated.

Tomatoes are deemed as silica excluders due to lower concentration of silica in the leaves than found in the roots (Mitani and Ma, 2005) but recent work has shown that plants will accumulate Silica in the leaves and petioles if not in competition with high concentration of other elements (Wendy L. Zellner ,2021). Under normal commercial growing environments silica fed through drip systems would accumulate in the rootzone but be limited in the leaves.

Roses have been shown to absorb silica through drench but vary in doing so by variety (R. Shetty,2011). We saw that the foliar treatments had no beneficial effect on the powdery mildew but the drench group showed a strong suppression of powdery mildew. The drench group also produced more flowers than the drench control. We suspect that the waxy coating of the cuticle inhibits absorption of foliar treatments.

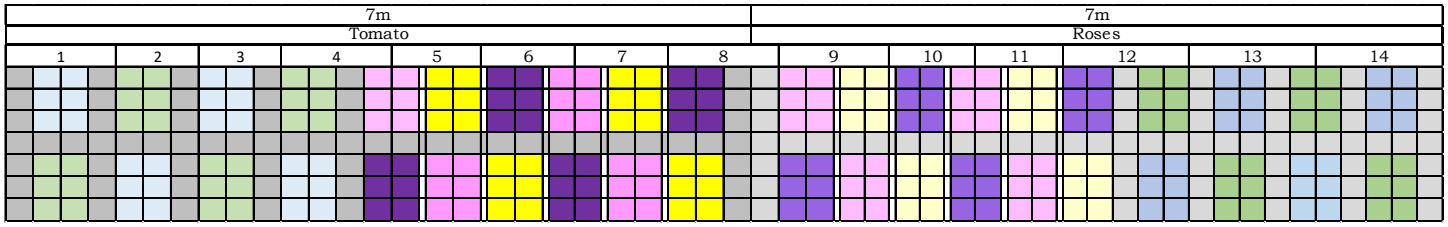
We saw completely opposite response in the tomato trials where the foliar treated plants showed the best mildew suppression. This supports the findings that when applied directly to the leaf surface the plants were able to absorb and mobilize the silica without competing with other elements as exists in the media.

1. Materials and Methods

Rose plants were supplied by Burnaby lake Greenhouses as untreated rooted cuttings of cultivar Sun Made. Three cuttings were placed in a one-gallon pot of our base potting media (fig 3) Tomato seeds of Red Robin were sown 72-hole flats and up-potted to 1-gallon pots (one plant per pot). Tomato plants were grown to match the development mass of the roses and then put in situ with the roses to allow for even water treatments. Plants were drip irrigated with each plant getting a base fertilizer dripper and the other dripper either water or treatment. This made sure each plant got exactly the same amount of water and fertilizer (fig 2) with or without silica. Silamol® was provided by Front line Growing. The treatments were mixed every day to ensure stability of the product. The Once a week treatment was done by isolating one fresh water tank, irrigating and then flushing the tank and line back to fresh water. Foliar applications were made once a week.

Treatments for both Rose and Tomato
Silamol® Drench all the time tomato (SDAT) rose (SDAR) diluted to 1ml/10,000ml of water
Silamol® Drench once per week tomato (SD1T) rose (SD1R) diluted to 1.5ml/1000ml of water
Control Drench control tomato (CDT) rose (CDR) Standard fertilizer recipe
Silamol® Foliar tomato (SFT) rose (SFR) diluted to 1ml/1000ml and applied by spray method.
Control Foliar tomato (CFT) rose (CFR) fresh water applied by spray method.

1.2 Experimental layout



T1	Silamol Drench	Continuous drench 1ml/10,000ml
T2	Silamol Drench	Drench once a week 1.5ml/1000ml
T3	Control Drench	Fertilizer
T4	Control Foliar	Fresh water
T5	Silamol Foliar	Foliar once a week 1ml/1000ml
	Tomato border plants	
	Rose border plants	
	space	

Figure 1 Trial Coding

1.3 Experimental Design

The trial was set up with 4 replicates of each treatment existing of 6 plants per group. The foliar plants were bordered by plants that surround the trial. The drench group did not have boarder plants as there were no concerns of foliar spray mist. Just a small space was left between the groups. The roses and tomatoes shared the same table and were separated by a border of each type. One member from each treatment group was selected to photograph and record metrics on. They were identified with painted bamboo sticks.

The plants were grown under standard greenhouse growing conditions using a Priva Connext operating system. Climate set points were day temperature of 22C, night temperature 18C and 16hrs LED supplemental lighting (Signify' s Philips Greenpower Top light DRWLB 50% and DRWMB 50%). There was an average of 200mmol of lighting at the surface of the plants leading to an average Daily light integral (DLI) of 11.5 with an average DLI of 5-7 coming from the winter sun. Plants were lifted to determine watering needs while they were young. We did not start drench treatment watering until they were 6 weeks old. We however started spray treatment in week 1. The project took place between weeks 39 and 52.

In our spray method we used a standard 1L spray bottle with the spray setting on the nozzle. We held the spray bottle 15cm above the plants and angled the spray inwards to the group. The border plants supplied a good buffer between treatments 30cm on each side. For both the control treatment and Silamol treatment we used distilled water.

A complex irrigation drip system was set up using 3L pressure compensated emitters and Little Giant blue pumps. Solutions were held in tanks that supplied the various drip lines. There was one tank designated for the continuous drench, one tank for our fertilizer mix and one tank that was twined for

the fresh water and Once a week treatment. We had an isolation valve set up between the two fresh water tanks that allowed us to perform the once a week drench. We then rinsed the tank thoroughly and dumped the once a week line with fresh water. We then reset the system for the rest of the week. Each of the lines were set up with a dump system.

UBC HORTICULTURE GREENHOUSE FERTILIZER RECIPE										
Date	**November 25, 2021**									
Tank A	**Kg**									
Ca(NO3)2 + amm	**15.0**	**kg**								
Ca(NO3)2 - amm	**0.0**	**kg**								
KNO3	**0.0**	**kg**								
CaCl2	**11.4**	**kg**								
NH4NO3	**0.0**	**kg**								
$K2SO_4$	**0.0**									
Fe DTPA 3.8 Liquid.	**1.0**	**Kg**								
B TANK										
$MgSO_4$	**12.5**	**kg**								
$MgNO_4$	**0.0**	**kg**								
20-20-20	**0.0**	**Kg**								
15-5-15	**0.0**	**Kg**								
15-30-15	**0.0**	**kg**								
KH_2PO_4	**3.8**	**kg**								
Mg EDTA 5.8%	**0.0**	**mL**								
KNO_3	**6.8**	**Kg**								
KCl	**0.0**	**grams**								
Urea	**0.0**	**litres**								
Amway adjuvant		**kg**								
Urea	**0.0**	**kg**								
$CuSO_4$	**7**	**grams**								
Molyb	**3**	**grams**								
Solubor	**60**	**grams**								
$MnSO_4$	**60**	**grams**								
$ZnSO_4$	**30**	**grams**								

Figure 2 Fertilizer concentrate recipe

Report Number: C19212-10028
Account Number: 07106

A & L Canada Laboratories Inc.

2136 Jetstream Road, London, Ontario, N5V 3P5
Telephone: (519) 457-2575 Fax: (519) 457-2664

C19212-10028

To: CPS CANADA INC 01817
7430 HOPCOTT ROAD
DELTA, BC V4G 1B6

For: UBC HORT GREENHOUSE

Attn: EVERGO HORT
604-940-0258

Reported Date:
Printed Date: Aug 2, 2019

ORGANIC SOIL REPORT

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Sample Number	Lab Number	pH	Lime Index	Total Organic Matter %	Phosphorus Bicarb ppm	Phosphorus P ppm	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Aluminum Al ppm
5NORTH	**50367**	**6.0**	**6.6**	**48.3**	**51**	**190**	**283**	**313**	**2230**	**25**

Sulfur S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Sodium Na ppm	Nitrate-N NO3-N ppm	Soluble Salt ms/cm	Moisture %
367	**6.4**	**10**	**221**	**1.8**	**0.5**	**105**	**36**	**0.90**	

INTERPRETATION

CEC			Percent Base Saturation			Proportional Equivalents (meq)				Cation Ratio	
meq/100g	% BS	% K	% Mg	% Ca	% Na	K	Mg	Ca	Na	Mg/K	Ca/Mg
14.9	**100.0**	**4.87**	**17.27**	**74.80**	**3.06**	**0.73**	**2.57**	**11.15**	**0.46**	**4:1**	**4:1**
Optimum Range:		3 - 5	8 - 20	60 - 80		0.5 - 1.3				7:1	5:1

S8*

* Results reported on a dry weight basis.
The results of this report relate to the sample submitted and analyzed.
* Crop yield is influenced by a number of factors in addition to soil fertility.
No guarantee or warranty concerning crop performance is made by A & L.

Results Authorized By: Ian McLachlin, Vice President

A&L Canada Laboratories Inc. is accredited by the Standards Council of Canada for specific tests as listed on www.scc.ca and by the Canadian Association for Laboratory Accreditation as listed on www.cala.ca
Additional information available upon request

Figure 3 Potting mix media analysis

Metrics were taken weekly. Overall mildew severity scaled from 0-5, flower number counts, production and fruit weight were taken as the plants grew and started to fruit. The project ended after the first full tomato flush. A target EC of 3-3.5 was used and a pH of 5.8-6.5. Concentrated fertilizer (Figure 1), Potassium Bicarbonate and Phosphoric acid were used to adjust the feed solutions. Water samples were sent for analysis to ensure proper nutrition. The spray solutions were mixed and sprayed once per week. Fruit was counted and weighed using a 3kg digital scale (YamatPPC-300W).

Image 1 Tomato Red Robin with mildew infected leaves

To ensure project success, infected leaves with *Oidium neolycopersici* were placed down the middle of the bench between the border plants. We did not have a source of *Sphaerotheca pannosa var. rosae* to provide mildew inoculum for the roses. As such it took a little longer for the mildew to appear and the level of infection amongst the plants was lower than what we saw in the tomatoes. We addressed pest pressure with biological controls, aphids, spider mite and thrips appeared but were managed using beneficial insects provided by Koppert Canada.

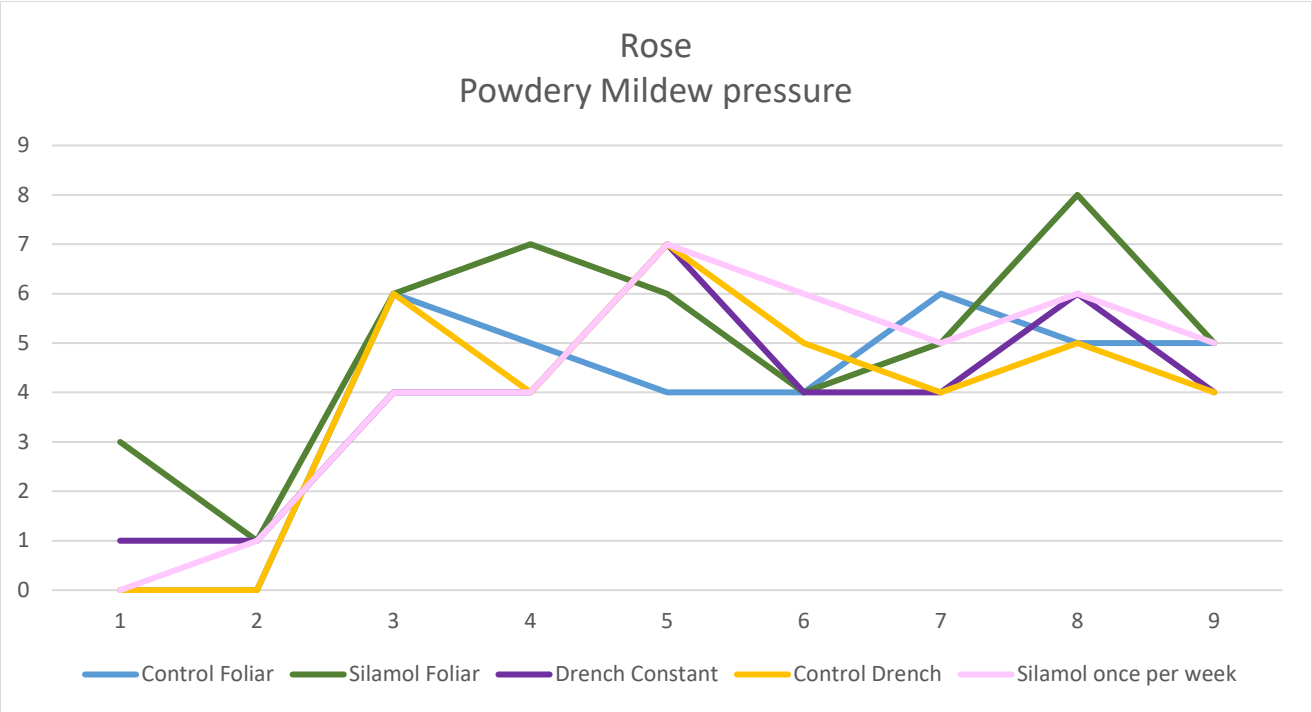
Image 2 Roses sun made with mildew infected leaf tissue

For crop maintenance we removed old dead leaves from the tomatoes and spent flowers in the roses. We used ARS pruning sheers for the roses and removed senesced leaves in the tomatoes by hand. The density of plants was very high 20 plants/m2 to discourage air flow. As a result, we should have staked the roses as they grew up leaning on each other. On their own they had no strength to hold up their flowers as you will see below.

2. Results

2.1 Roses

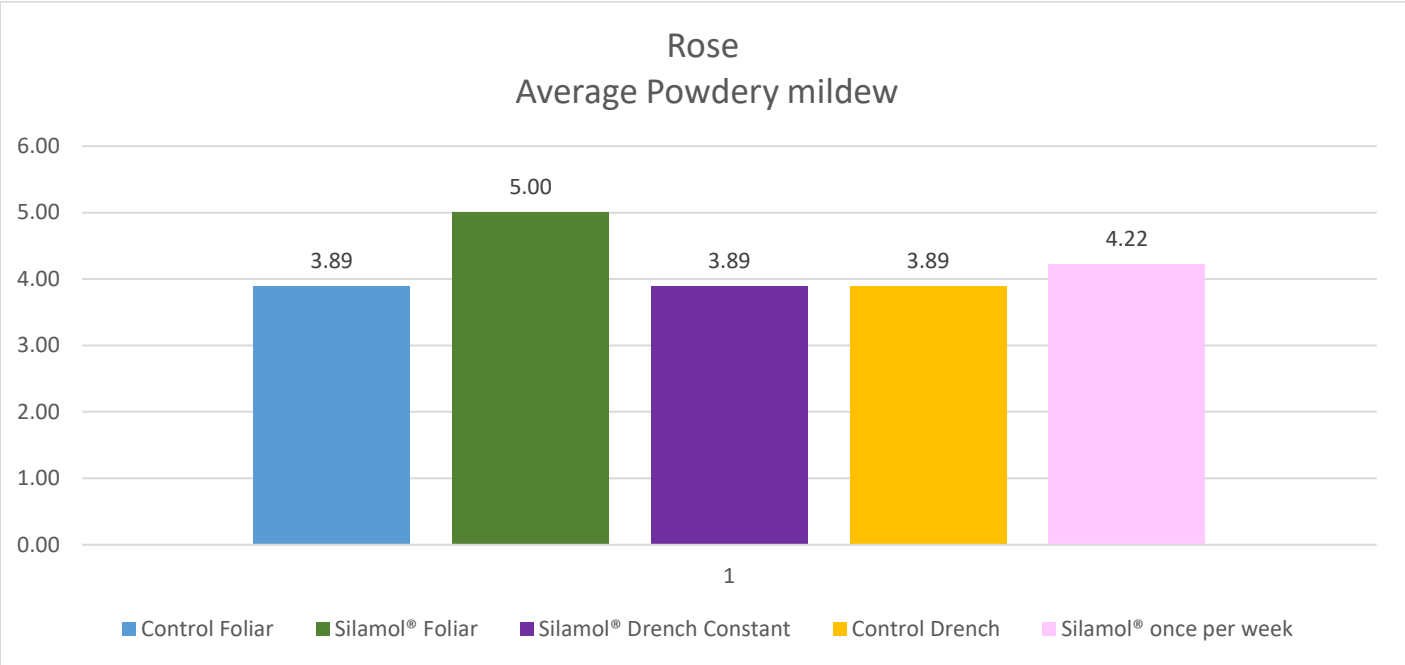
The powdery mildew in the roses took a little longer to get going but it managed to impact the number inflorescence. The fungal load on the plants was similar between groups but SFR suffered 22% more than the rest of the group which between them has a small deviation in mildew pressure (Graph 1.2). The impact of that pressure though had a strong impact on the ability of the plants to produce flowers (Graph 1.3).



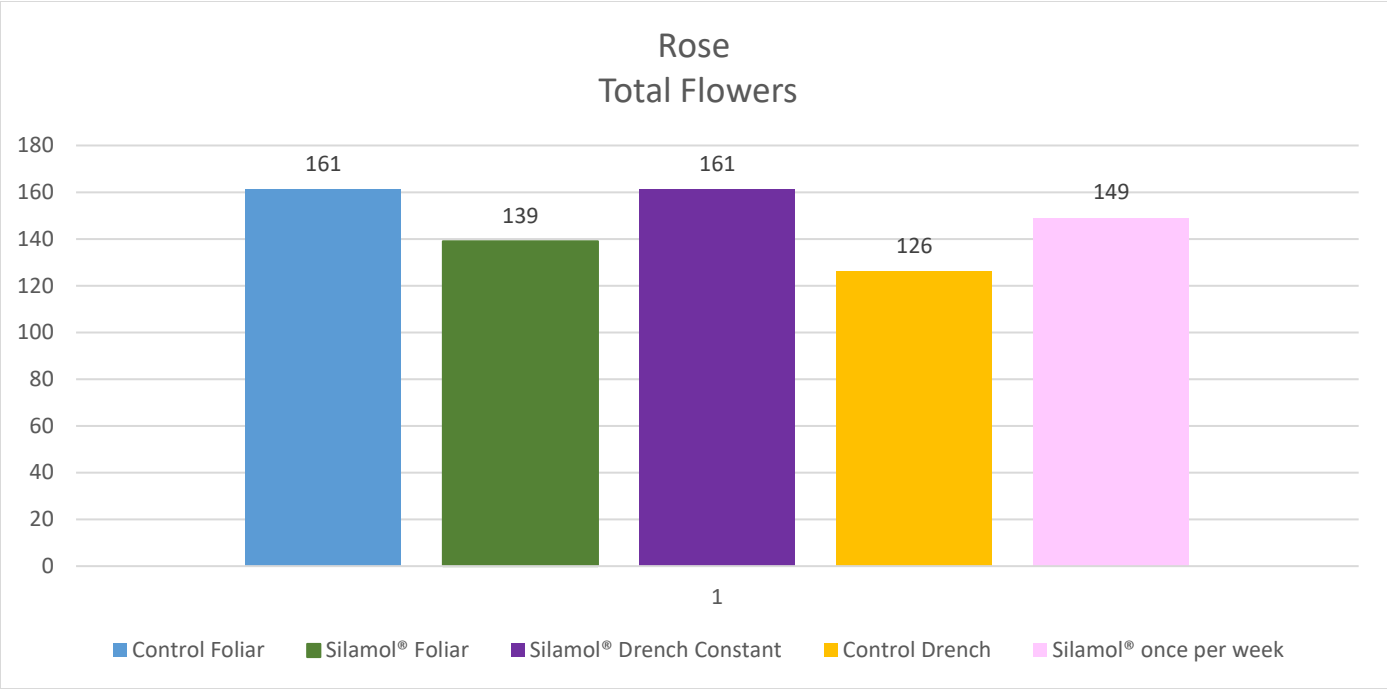
Graph 1 Roses powdery mildew trending

2.2 Rose Powdery Mildew

We started to see mildew leasions to appear in low numbers on lower leaves between weeks 1 and 2 but the pressure escalated in week 3 at which point infection levels increased and decreased between scores 4 and 7. The CFR only deviated between leasion levels of 4 and 6 whereas the otheres saw greater pressure swings throughout the weeks. Trial weeks 5 and 8 saw infection levels increase which corresponded to two bright weeks 43 (3306J/cm2) and 46(2234J/cm2). The average number of joules/cm2 in the same time period was 1400J/cm2. The stresses of large swings in light and temperature are what makes mildew so prevelent in the spring and fall.



Graph 1.2 Roses powdery mildew average score 5 being the most severe.



Graph 1.3 Roses Total Flowers

2.3 Inflorescence

We recorded the number of flowers of both tomato and roses understanding that inflorescence could be impacted by Silamol® (Evans, 2018). The CFR, SDAR and CDR all had the same mildew scores, CFR and SDAR produced the most flowers at the same level. The CDR produced the least and had no benefit of Silamol®. The SFR which had the highest mildew score ended up with fewer flowers. What is supported is that despite having mildew the drench trials produced more flowers than the drench control. This supports that Silamol® assisted the plants in growing through their fungal pressure and producing more flowers.

Image 3 Roses Foliar Control treatment

Image 4 Roses Silamol® Foliar treatment

Image 5 Roses Control Drench, fertilizer and fresh water

Image 6 Roses Once a week Silamol® Drench treatment, fertilizer and fresh water

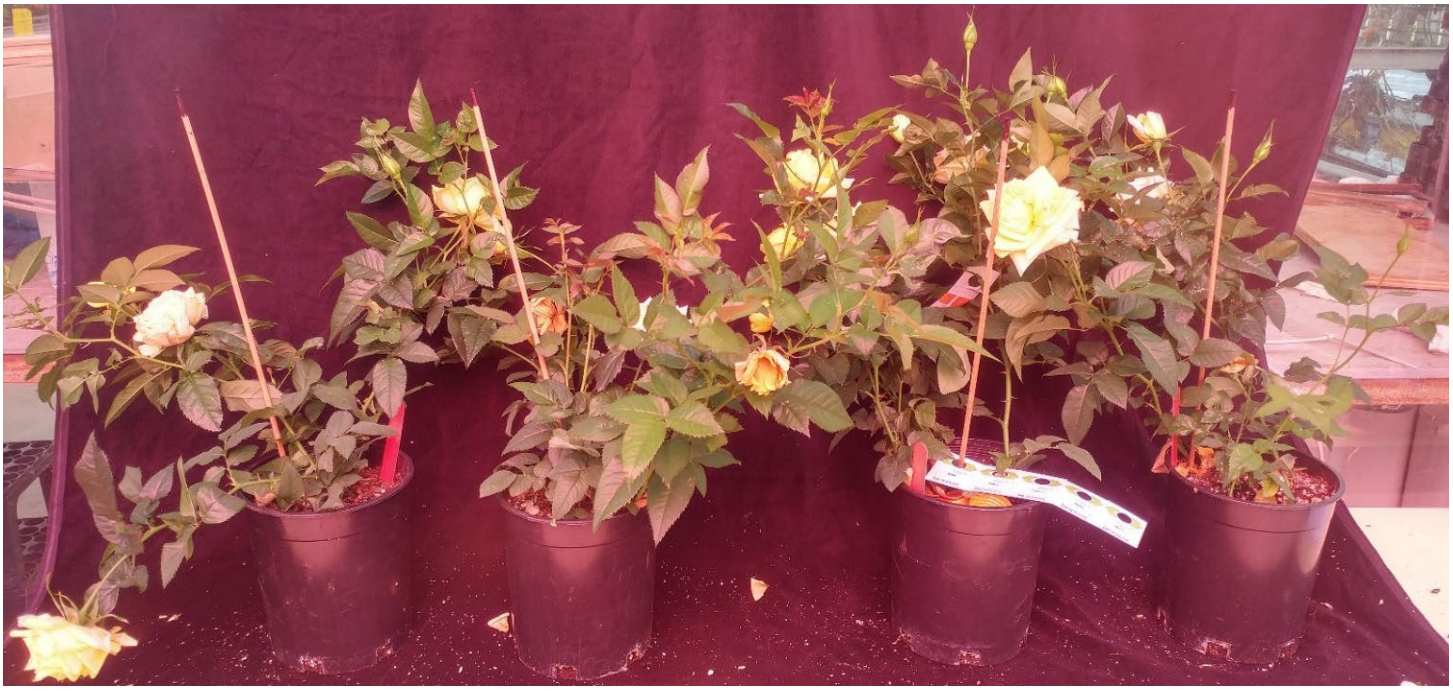


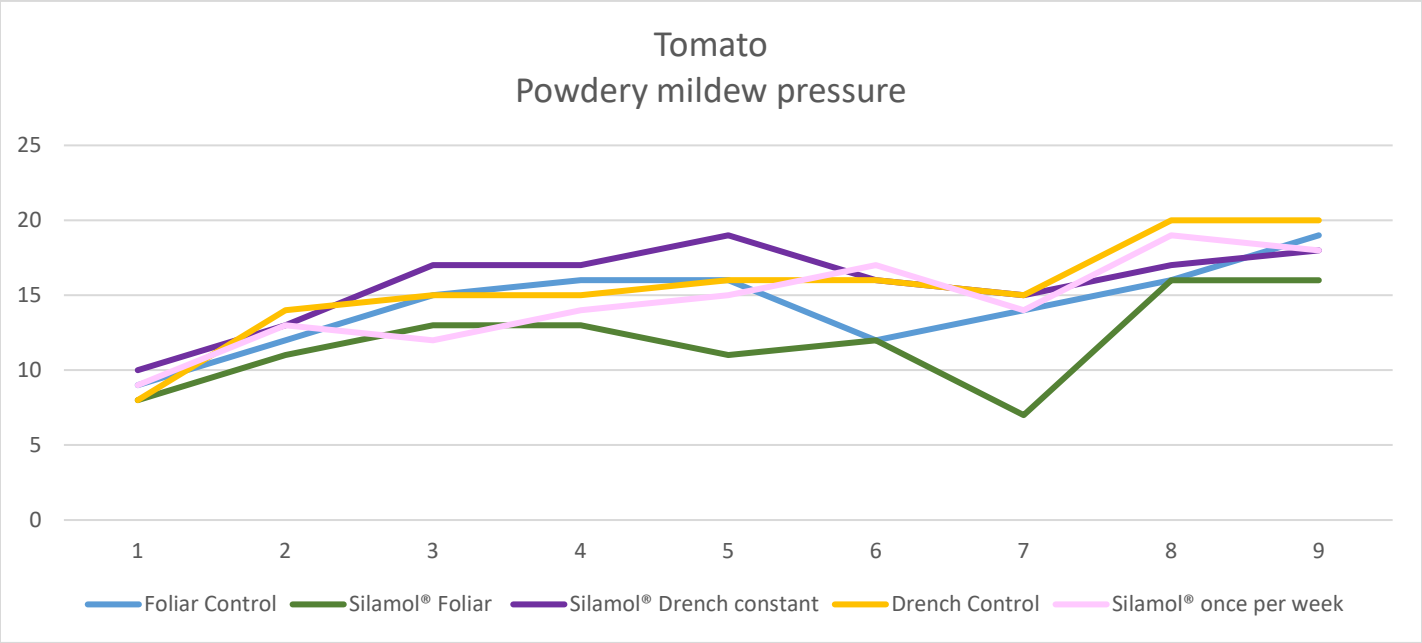
Image 7 Roses Silamol® Drench Constant treatment and fertilizer

2.4 Tomato

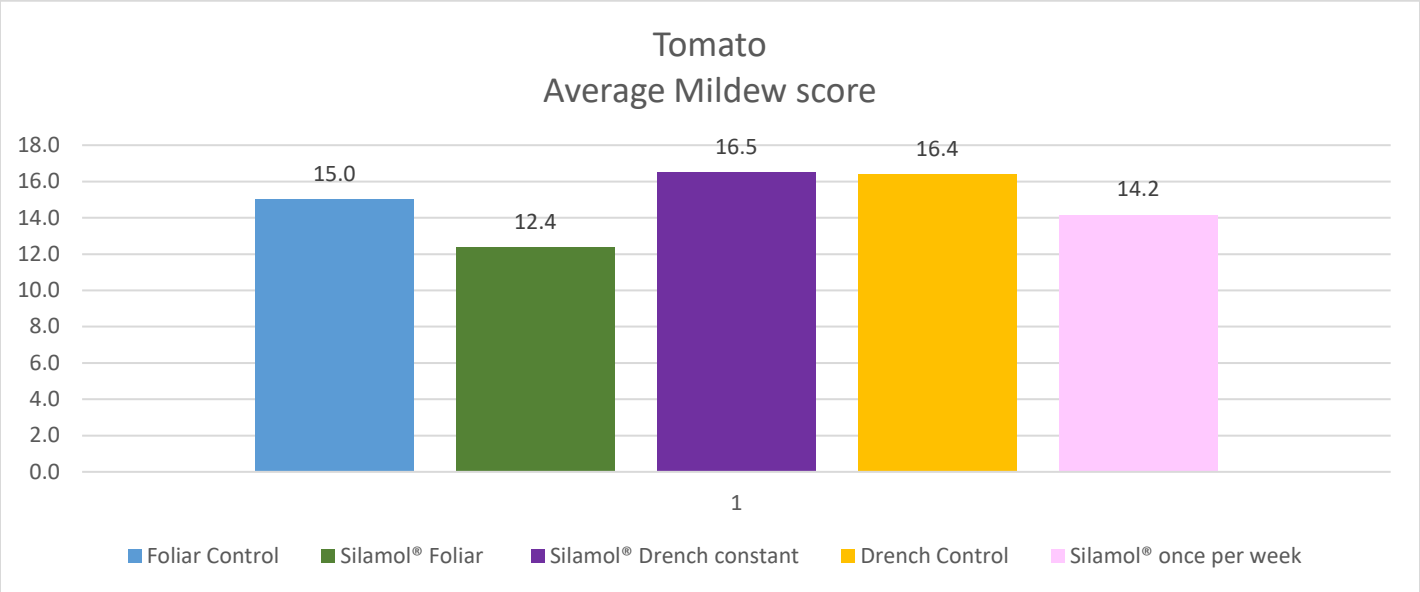
Tomatoes are very sensitive to powdery mildew and without treatment yearly pressure exists and infections are expected. The use of sulfur is a good prevention but impacts *Encarsia formosa* predators that are essential for whitefly control. The potential of Silamol® to be added to the basic fertilizer regime is something that would be welcome in standard production especially if sulfur could be removed.

2.5 Tomato Powdery Mildew

The tomatoes where more transparent in their responsive to the treatments. The nature of spraying the plants disrupts the mildew fungus from getting established on the leaf surface. Mildew prefers dry humid conditions with low air flow. The tomatoes have also been shown to absorb positively charged ions through fertilizer foliar treatments (Trinklien 2019). Silicic acid is effectively neutral and able to be absorbed through the micro pores on the leaf. So, in reviewing graph 2.1 you can see that in the tomato the most effective treatment in controlling mildew was the foliar treatment. As tomato is considered a silica excluder you can see that there was no difference in the mildew pressure between the constant Silamol® and the control. The once per week treatment scored in line with foliar control which indicates that the drench effect was positive with the once per week treatment. Just not as effective as the Silamol® foliar treatment. The once per week Silamol® treatment was at a 15-fold increase in concentration which may have given the plant more opportunity to find it in the concentration of other fertilizers.



Graph 2 Tomato powdery mildew trending



Graph 2.1 Tomato Powdery mildew average group score

Image 8 Tomato Foliar Control

Image 9 Tomato Foliar Silamol® Treatment

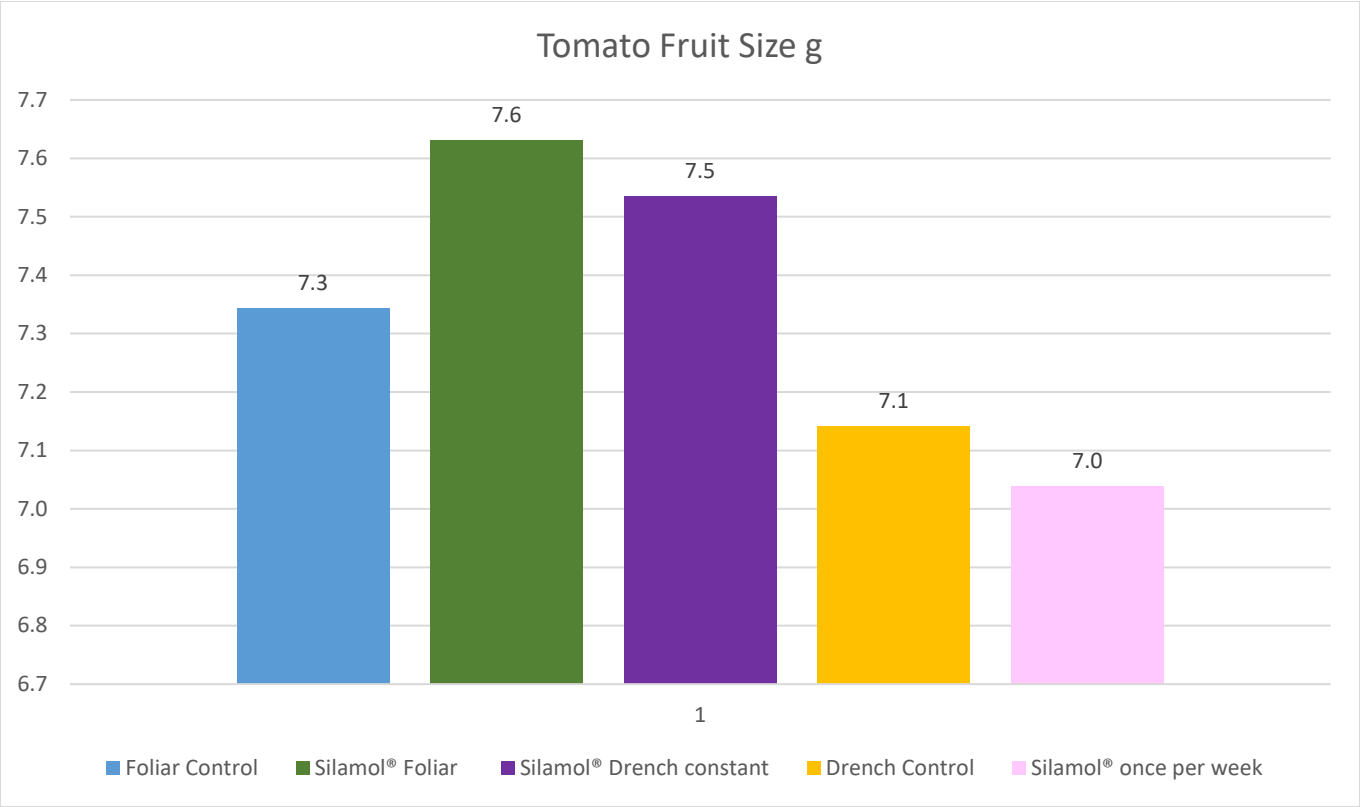
Image 10 Tomato Drench Control fertilizer and fresh water

Image 11 Tomato Drench Silamol® once per week, fertilizer and fresh water

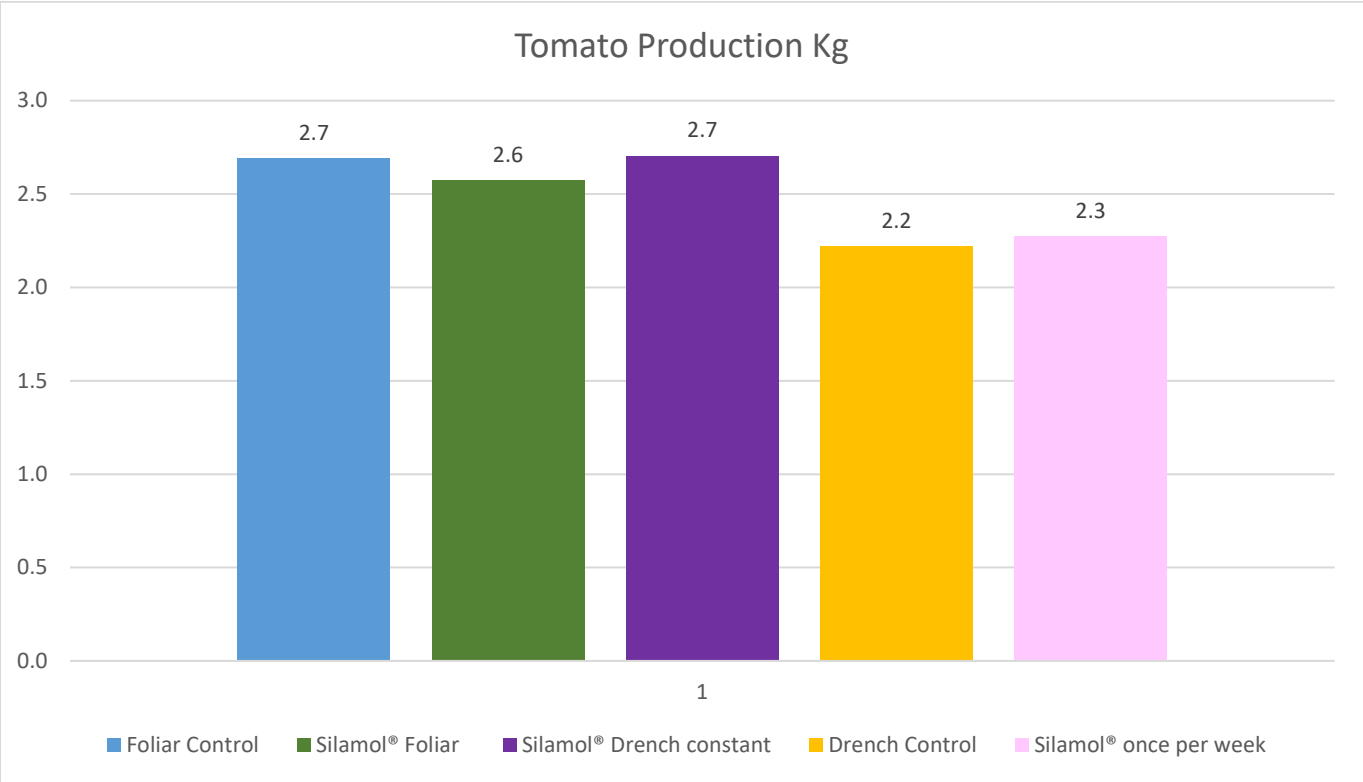
Image 12 Tomato Drench Constant Silamol® and fertilizer

2.6 Fruit Weight

So how does Silamol® translate to crop production? Fruit weight is influenced by the strength of the plant. Between the canopy and the root system. If there is a strong canopy and a good root system the fruit will be large. The largest fruit weights were found in SFT and SDAT. Despite having one of the highest scores for powdery mildew SDAT maintained its speed and fruit size, unlike SD1T which had the other high score for powdery mildew it failed to continue growing and setting. The fruit size ended up to be the smallest and it set the fewest fruit. Both the CDT and SD1T made a similar number of fruit but the fruit size was small due to the plants struggling more with their mildew infections. The big difference in the group is the SDAT which had a very high mildew score but the impact on the plant was much less. The SDAT performed incredibly well given the mildew pressure it had. It made larger fruit and set more flowers than the other drench treatments. The low rate of continuous Silamol® allowed the plants to manage the mildew while still producing good sized fruit. When you look at the photo of the SDAT compared to the SD1T you can see that the plants look fuller and healthier. There is less discoloration and the plants are fuller in nature.



Graph 2.3 Tomato fruit weight g



Graph 2.4 Tomato Total fruit production

2.7 Production

Production is a result of plant balance, fruit set and size. It falls more heavily on the number of fruit set, which comes back to flowers and the quality of flowers. SDAT set more flowers than SFT and had a slightly higher fruit weight. This supports that Silamol® does not hinder flowering but supports it. The foliar trials and the SDAT group set more flowers than CDT and SD1T by an average of 80 flowers. The fruit size was also substantially lower that indicates that the drench plants lacked vigor. They had high levels of powdery mildew and did not show the added benefit of having Silamol®. The high rate Once per week did not work as effectively than the low constant rate. These Red Robin dwarf tomato plants are not copies of each other, there is natural variability. The most important thing is to see is the trending where the foliar treated and Once per week were a separate group to the drench control and the Once per week treatment.

Image 13, Visual leaf cuticle comparison

3. Conclusions

What appeared consistent between the roses and tomatoes is that the low rate treatment of 1ml /10,000ml water is the best overall performer. The tomatoes were better at absorbing the Silamol® through the leaf surface than the roses. Looking at the picture of the leaves (image 13) you can see a visible cuticle sheen in the rose that is not as apparent in the tomato. The rugose nature of the tomato leaf compared to the glabrous leaf of the rose may be the reason for the difference in the foliar treated trials. The robustness of the cuticle plays heavily into leaf absorption. As it is with root excluders there are leaf excluders such as cabbage, rose is not a full excluder as has been shown (Farahani 2020), but in this trial, we saw no benefit from the foliar application. Instead the roses faired the best with the Silamol® 1ml/1000ml low rate trial. The foliar treated plants have the advantage of disturbing the mildew. The SDAR did not have that benefit and still produced the same number of flowers to the CFR. The low rate SDAR completely out competed the CDR showing that there was a significant benefit to having the treatment. In the Tomatoes we saw a great impact of mildew

suppression with the foliar treatment but the Silamol® drench at the low rate also performed very well by edging ahead in production. This trial has demonstrated the benefit of Silamol® supplied either foliar or drench. Plants with thick cuticles should benefit from the drench.

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