Organic Control of Anthracnose Leaf Spot in Gooseberry

Chris McGuire • Two Onion Farm, Belmont WI • twoonionfarm@gmail.com
February 2023

Summary

With funding from a USDA-SARE Farmer Rancher grant, we compared several methods of controlling Anthracnose Leaf Spot in an organic gooseberry planting. We found that: (1) varieties differed enormously in their susceptibility to Anthracnose infection, with Hinnomaki Red being particularly resistant, and Tixia being particularly susceptible, (2) plants trellised with the cordon trellis method suffered slightly less Anthracnose infection and defoliation than untrellised, bush plants, and (3) regular sprays of Cueva mixed with Double Nickel substantially reduced infection, and Regalia also provided significant protection against early season infection, but Carb-o-nator was ineffective at controlling Anthracnose. Although no methods eliminated Anthracnose, this experiment identified several effective control measures which organic growers can employ against this troublesome disease.

Background and Objectives

Although gooseberries are not commonly cultivated in our region, they are a promising new crop which produces a flavorful fruit suited for fresh eating and processing. Along with other organic fruit farmers in the region, we have grown gooseberries but found that the Anthracnose leaf spot disease is extremely devastating: it defoliates plants by mid-late summer in most years, increases in severity over the years as a planting ages, and appears to reduce plant vigor and yield.

Anthracnose leaf spot on Captivator gooseberry. Left picture shows leaf lesions and immature fruit on June 19, 2021. Right picture shows heavy defoliation which has occurred by July 8, 2022, shortly before harvest.

We have observed that varieties differ in susceptibility and that trellising the plants may lessen the severity of the disease, but we have not found a truly effective organic control that is environmentally benign and effective. Over two growing seasons, we measured the effects of several factors on disease severity:

1. Gooseberry variety
2. Training method (freestanding bush vs. cordon trellis)
3. Organic spray regimen (potassium bicarbonate, copper soap plus Bacillus amyloliquefaciens, Reynoutria sachalinensis extract, and no sprays)

We studied multiple factors because it is likely that a combination of several methods may be required for effective control.

Research Methods

This two year study was conducted in the 2021 and 2022 growing seasons.

Organic. Our entire farm is certified organic by MOSA (mosaorganic.org) and only organic methods were used in this research.

Plot Layout. We conducted this research in an existing 1/4 acre gooseberry planting with four 288' rows spaced 10' apart. This planting was established in April 2020 as part of an on-farm research project to compare the effects of two training methods (cordon trellis and freestanding bush) on yield, labor, and profitability in four varieties. The planting was laid out in a randomized complete block design. Each row was divided into 12 plots, each 24' long (48 plots total). The entire planting was divided into three blocks, with one-third of each row contained in each block. Each block contained sixteen plots (four plots from each of the four rows). Each plot contained one variety grown with one training method; each combination of variety and training method was replicated twice within each block. Because the planting contained a randomized arrangement of training methods and varieties, it provides an excellent opportunity to analyze the effects of these factors on disease.

Varieties. Black Velvet, Captivator, Hinnomaki Red, and Tixia were the varieties grown in this study. Note that Black Velvet and Captivator plants were purchased as bare-root stock from Indiana Berry & Plant Company, Plymouth, IN, whereas the Hinnomaki Red and Tixia were purchased as plugs from Nourse Farms, Whately, MA. The bare-root stock was larger at planting and grew more rapidly after planting. This experiment on anthracnose leaf spot control was performed during the 2nd and 3rd years in the life of these plantings, and it is likely that early differences in size and growth between the varieties were still affecting yields and plant size at the time of this experiment.

Other Growing Methods. The gooseberry rows were mulched with two strip of landscape fabric, each three feet wide, with a narrow strip of exposed soil (approximately 2-3 inches wide) between landscape fabric strips. The narrow bare strip of soil was hand-weeded as needed during the growing season. A 4’ wide creeping red fescue sod strip grew between gooseberry rows and was mowed approximately weekly during the growing season. Plants were irrigated as needed via driptape installed next to each row.

Untrellised Black Velvet Gooseberry Plants, showing landscape fabric on each side of the row, together with sod between rows.

In both years, we introduced purchased bumblebee colonies to augment wild pollinators. On 4/7/2021, 2 Natupol Excel Startup bumblee colonies were installed in high tunnels located approximately 200-300 feet away from the gooseberry planting, and gooseberry bloom began around 4/16/2021. These high tunnels had sidewalls which were opened for ventilation most days, and bumblebees were frequently seen flying out of the tunnels. On 5/3/2022, 2 quads of bumblebee colonies from Koppert were installed approximately 125' from the gooseberry planting, and gooseberry bloom began on 5/7/2022. Note that the gooseberries were grown adjacent to ¼ acre of currants and 2 acres of apples whose bloom overlapped with the gooseberry bloom.

Left: A Koppert bumblebee quad installed in 2022. Right: A bumblebee visiting gooseberry blooms on 5/11/2022

Pest Management. This study focused on control of Anthracnose Leaf Spot, but other insect and disease pests were present in the planting. The fungal disease cluster cup rust occurred on leaves at low levels, with symptoms becoming evident in mid-May. We did not actively attempt to control this minor disease.

Cluster cup rust lesion

Currant spanworm is a potentially devasting pest. Large aggregations of voracious larvae can defoliate plants, and this insect was considered a serious economic pest when currant and gooseberry production was widespread in the Midwest 100+ years ago. On 6/13/2021, currant spanworm was found on one Black Velvet plant and adjacent plants, and a spray of Dipel was made with a tractor-mounted Rear Pakblast 50 airblast sprayer on 6/17/2021 specifically to target this pest (2 lbs Dipel in 32 gallons of spray water per acre). Another Dipel spray was made 5/27/2022, timed shortly after currant spanworm emergence, and subsequent scouting did not reveal any currant spanworms in 2022.

Left to right: Currant spanworm moth, a dense aggregation of young currant spanworm larvae, and a late instar larva

Oblique-banded leafrollers are a common summer pest of shoot terminals. Dipel sprays were made on 6/27/2021 and 7/4/2021 to target peak emergence of these insects, timed based on pheromone-baited trap captures and degree-day models.

Cordon Trellis Method. A complete description of the cordon trellis training method practiced in this project is available online. Briefly, in the cordon trellis method, each gooseberry plant is trained to a single permanent vertical stem (the cordon). Fruit is produced on horizontal branches from the cordon, and these branches are pruned back annually after fruiting. This method produces an open canopy which is easy to harvest from and which may reduce disease.

Captivator Gooseberries on May 6, 2022: Trellised (left) and Untrellised (right).
Note approximately 6' tall cordon in trellised plants.

Spray treatments. To evaluate the effects of organically approved spray treatments, we used a split-plot design and divided each existing 24' plot into 4 sub-plots, each 6' long. In each plot, the four sub-plots were randomly assigned to one of four spray treatments:

- Regalia (Reynoutria sachalinensis extract) (2 quarts/50 gallons spray solution). In the first two spray applications in 2020, we tank mixed the Regalia with JMS Stylet Oil (horticultural oil) (2 quarts/50 gallons) but thereafter we omitted the oil because we saw severe phytotoxicity in the variety Captivator (leaf cupping and bronzing followed by rapid defoliation). We saw no phytotoxic reaction when the Regalia was sprayed alone.
- Carb-o-nator (potassium bicarbonate) (2.5 lb/50 gallons)
- Mix of Cueva (copper soap) (2 gallons/50 gallons) and Double Nickel (Bacillus amyloliquefaciens) (1 lb/50 gallons)
- Unsprayed control

These products are preventative, not curative, and Anthracnose infection occurs repeatedly during the growing season. Therefore we sprayed at approximately 10 day intervals from May-September. Specific spray dates in 2021 were 4/23, 4/30, 5/11, 5/22, 5/31, 6/11, 6/22, 7/3, 7/13, 7/23, and 8/2. The first spray on 4/23 was made when the earliest flowering variety in our study (Black Velvet) was in early bloom. In 2022, sprays were made on 5/2, 5/10, 5/24, 6/7, 6/17, 6/27, and 7/18. In 2022, bloom started on 5/7, so sprays were begun 5 days before bloom.

All spray products have been approved by our organic certifier and are labeled for use on gooseberries. Tank mixes and spray rates were based on label guidelines and manufacturer recommendations. To avoid spray drift between adjacent

plots, we sprayed by hand with a motorized backpack sprayer (Stihl model SR200) in calm weather. Sprays were applied to achieve thorough leaf coverage, and the volume of spray varied widely between varieties and trellising methods, since plant size and canopy volume also varied. Averaged over all plots, the spray volume varied between 30-38 gallons per acre on different spray dates.

Data Collection. In June of each year (on 6/10/2021 and on 6/28/2022) we collected data from two shoots on one plant in each sub-plot. One of the two shoots was a vertical stem (the cordon on trellised plants or a strong vertical shoot on untrellised plants, hereafter called the high shoot) and the other shoot was a horizontal branch originating near 6" above ground, hereafter the low shoot. We purposefully selected shoots not growing near the edges of the sub-plot to avoid ones which may have experienced spray drift from neighboring sub-plots. On each stem we graded disease severity on each leaf growing on current year's growth. Disease severity was graded on the following scale: D=leaf no longer present, 0=no Anthracnose leaf spots, 1=leaf spots present but covering <1% of the leaf, 2=spots covering 1-5% of the leaf, and 3=spots covering >5% of the leaf. Few leaves were graded as "Not present" on these dates, and analysis showed no difference between treatments in percent of leaves not present. Ignoring leaves not present, we calculated an average disease severity over all leaves for each shoot.

In late summer, (on 9/8/2021 and on 8/8/2022), we again collected data from one high shoot and one low shoot per sub-plot, selected according to the same criteria as above. On this date virtually all leaves had leaf spots covering >5% of the leaf and we did not collect data on disease severity. However many leaves had dropped from the plants by this data, and Anthracnose causes premature defoliation. Therefore we counted the number of leaves which had dropped from each stem and the number of remaining leaves and calculated a percent of leaves defoliated for each shoot.

Only one variety, Captivator, yielded significantly in 2021. In 2022, three varieties, Black Velvet, Captivator, and Hinnomaki Red yielded significantly. We measured the yield separately in each sub-plot in half-pints of berries

Statistical Analysis was performed by Leslie Holland, UW-Madison Department of Plant Pathology. Separate ANOVA analyses were conducted for each of nine response variables:

- Mean June disease severity for low shoots in June 2021
- Mean June disease severity for high shoots in June 2021
- Mean June disease severity for low shoots in June 2022
- Mean June disease severity for low shoots in June 2022
- Mean percent defoliation for low shoots in late season 2021
- Mean percent defoliation for high shoots in late season 2021
- Mean percent defoliation for low shoots in late season 2022
- Mean percent defoliation for high shoots in late season 2022
- Mean yield per sub-plot, measured in half-pints, in 2022

Block, variety, spray treatment, trellising method were included as independent variables in each analysis along with the interactions variety x spray treatment, variety x trellising method, spray treatment x trellising method, and variety x spray treatment x trellising method.

Results

Disease Development. First Anthracnose symptoms were observed in late May of each year (on 5/21/21 and on 5/30/22), and symptoms developed throughout the season, particularly after wet weather. Defoliation of infected leaves was observed from early June onward. The first defoliation was on fruit-bearing spurs; current year's extension shoots did not defoliate significantly before July and August.

Anthracnose Leaf Spot lesions, 7/8/2022

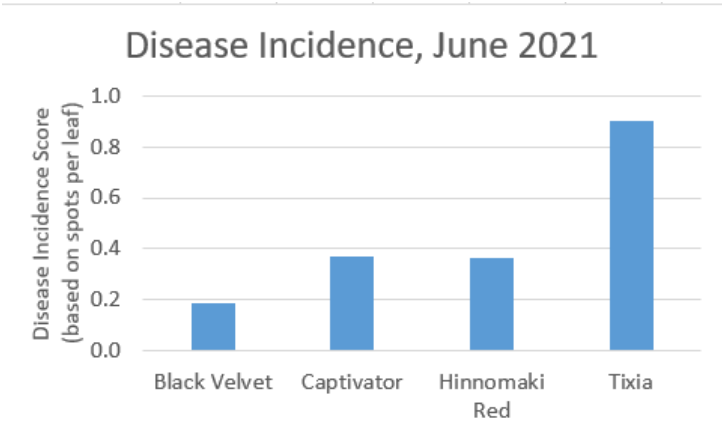
Defoliation of fruit-bearing spurs on Captivator, June 4, 2021

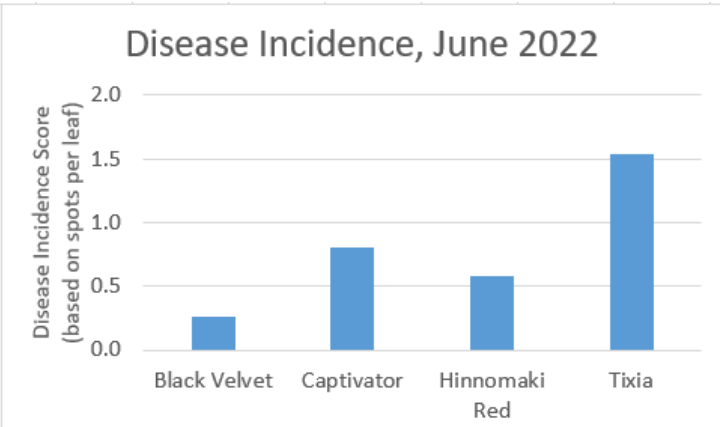
Overall Summary of Treatment Effects.

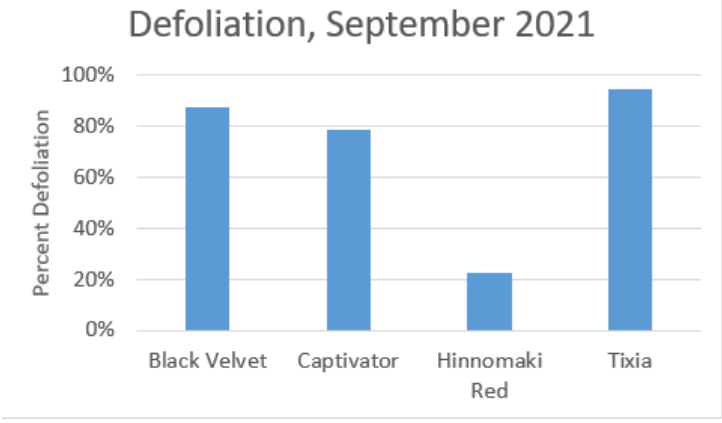
Varieties showed clear, obvious differences in both disease incidence and defoliation. From most resistant to most susceptible, the varieties were:

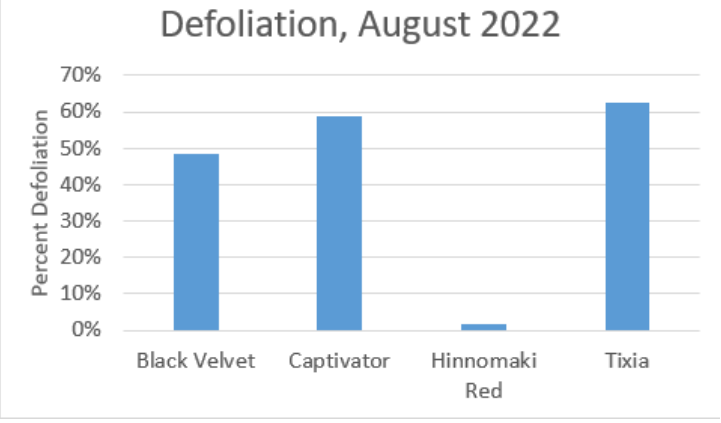
1. Hinnomaki Red was most resistant. In particular, it suffered astonishingly little late-season defoliation compared to the other three varieties.
2. Black Velvet showed similar disease resistance to Hinnomaki Red in June, but then suffered moderate late season defoliation.
3. Captivator was intermediate in both June disease incidence and late season defoliation
4. Tixia was clearly most susceptible to both June disease and late season defoliation.

Ripening fruit on July 8, 2022. Left: Hinnomaki Red. Right: Captivator. Note the healthy abundant foliage on Hinnomaki Red, compared to the massive defoliation and leaf spot on Captivator.

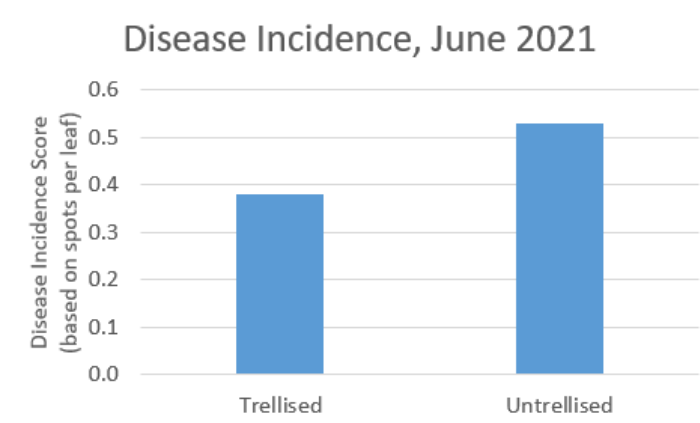


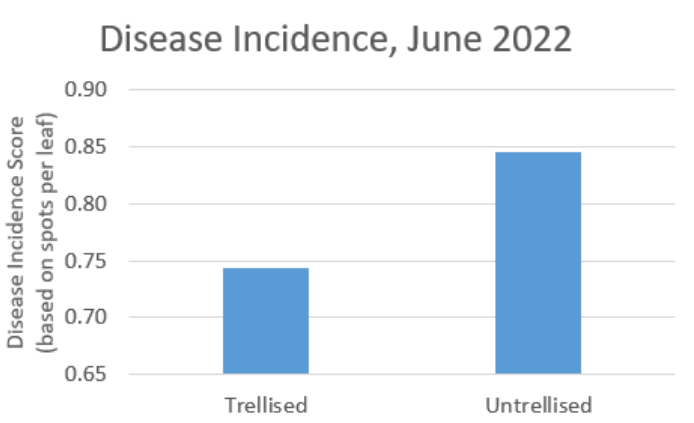


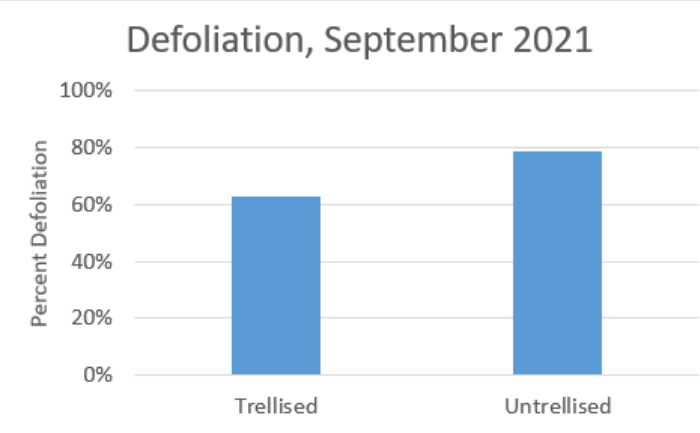


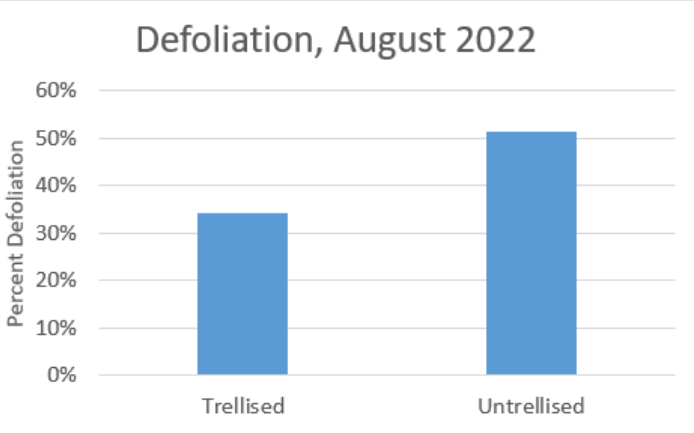


Trellising reduced June disease incidence and defoliation on high shoots, but not on low- growing shoots. However, the effects of trellising were slight and often varied by variety and/or spray method.



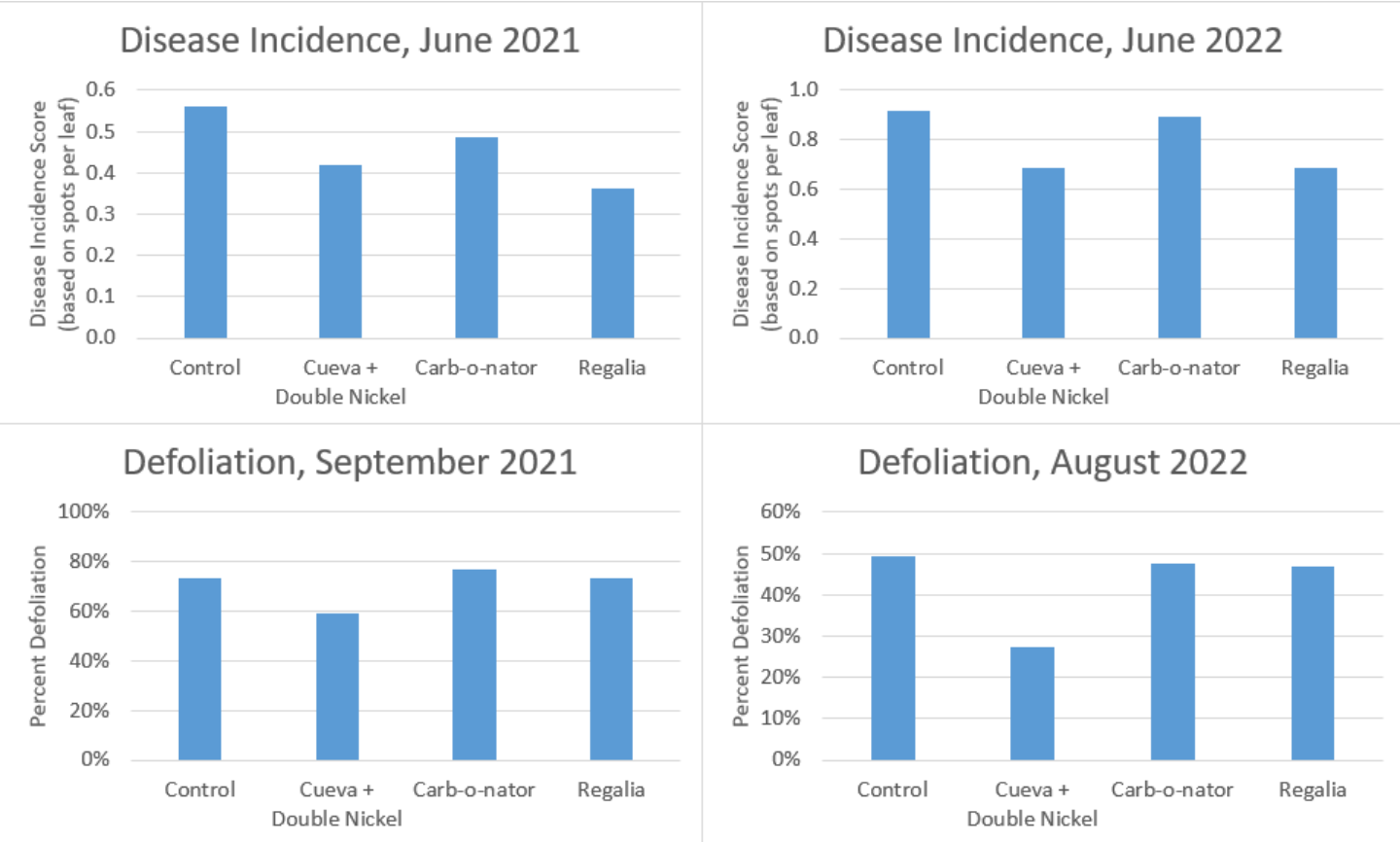






Cueva + Double Nickel and Regalia sprays both reduced disease in June, but only Cueva + Double Nickel sprays reduced late season defoliation. Differences among spray treatments were pronounced and visually obvious – see the photos below:

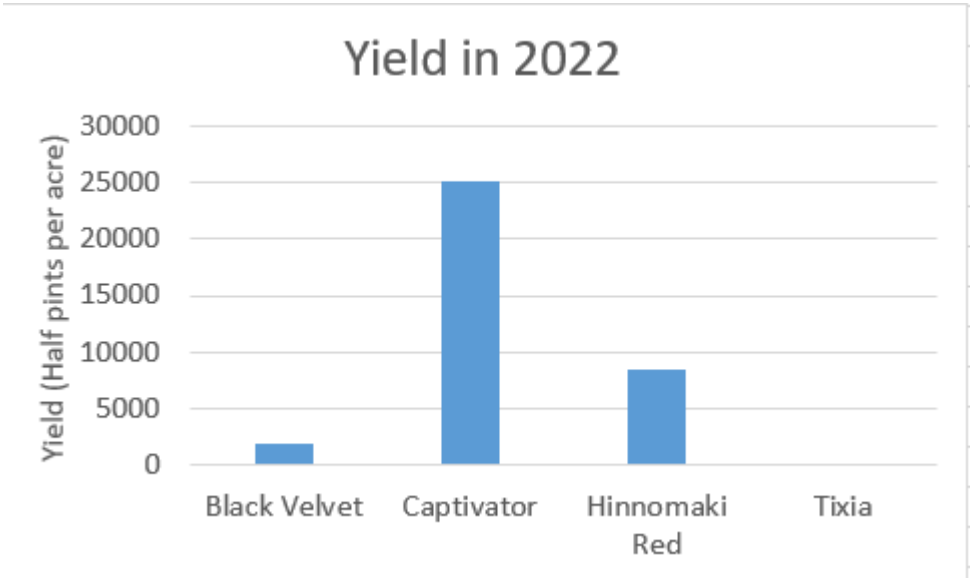
Untrellised Tixia on July 8, 2022. Left picture shows a plant from the untreated control treatment, and right picture shows a plant sprayed with Cueva and Double Nickel. Note much greater defoliation in the unsprayed plot.



In 2021, Captivator was the only variety to produce measurable yield. In 2022, yields of Captivator were much higher (approximately 120,000 half-pints per acre) than Hinnomaki Red (40,000 half-pints per acre), which was in turn higher than Black Velvet (approximately 12,000 half-pints per acre). Tixia again failed to produce significant yield. Captivator blooms and sets fruit heavily on large-sized plants. Black Velvet is a large bush and blooms heavily, but has failed to set heavy crops of fruit on our farm for unknown reasons. Hinnomaki Red is a small plant, although it set a dense crop of berries in 2022. In addition, the Cueva + Double Nickel spray treatment increased yield in the variety Captivator.

Dense bloom on Black Velvet, 5/8/2022

Heavy crop of ripening fruit on trellised Captivator, 7/9/21

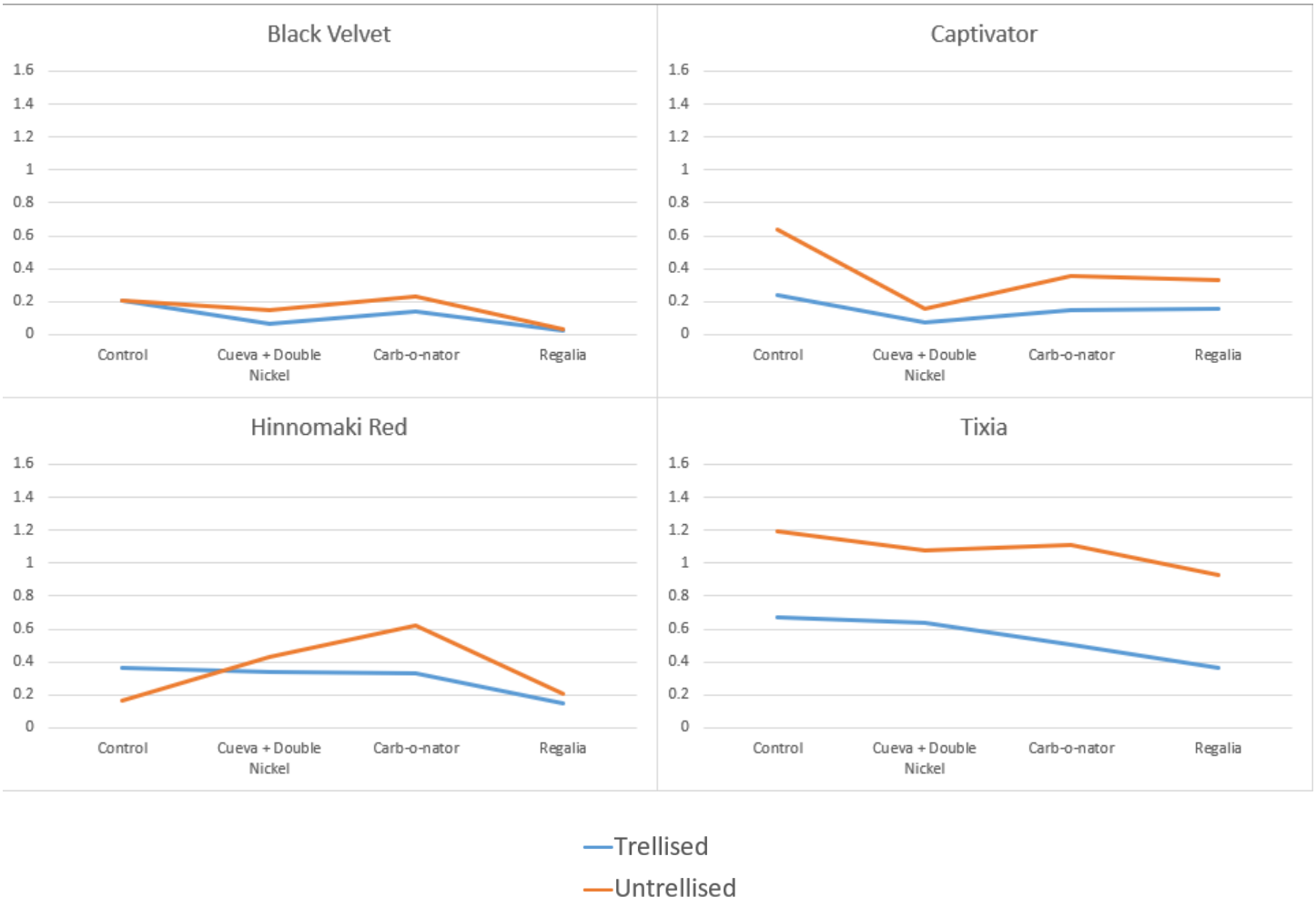


On the following pages, we present detailed results for each of the response variables we measured:

Mean Disease Incidence, High Shoots, June 2021

Independent Variable	Statistical Significance of Effect	Description of Effect
Block	*	
Variety	***	Tixia had more disease
Trellis	***	Untrellised plants had more disease
Spray Treatment	***	Cueva + Double Nickel and Regalia sprays reduced disease
Variety x Trellising Method	***	The beneficial effects of trellising were greatest for Tixia.
Variety x Spray Treatment	*	
Trellising Method x Spray Treatment		
Variety x Trellising Method x Spray Treatment		

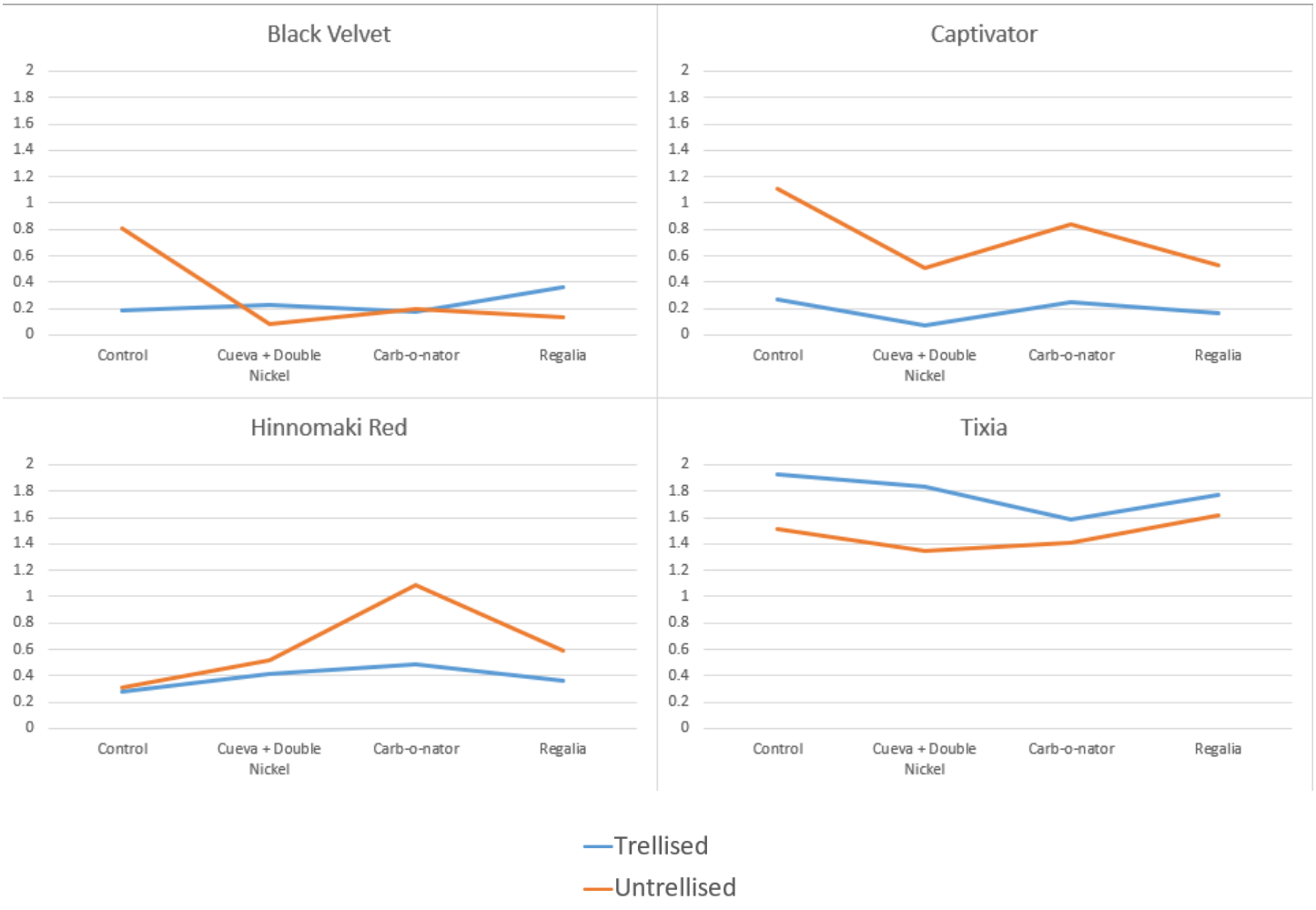
Statistical Significance Codes: *** p<0.001 ** p< 0.01 * p<0.05



Mean Disease Incidence, High Shoots, June 2022

Independent Variable	Statistical Significance of Effect	Description of Effect
Block		
Variety	***	Tixia suffered the most disease; Black Velvet and Hinnomaki Red the lease; Captivator was intermediate
Trellis	*	Untrellised plants had more disease
Spray Treatment		Cueva + Double Nickel and Regalia sprays reduced disease
Variety x Trellising Method	***	Untrellised Captivator plants had more disease than trellised plants, but untrellised Tixia plants had less disease than trellised plants
Variety x Spray Treatment	**	The beneficial effects of Cueva + Double Nickel and Regalia sprays were greatest in Captivator
Trellising Method x Spray Treatment		
Variety x Trellising Method x Spray Treatment		

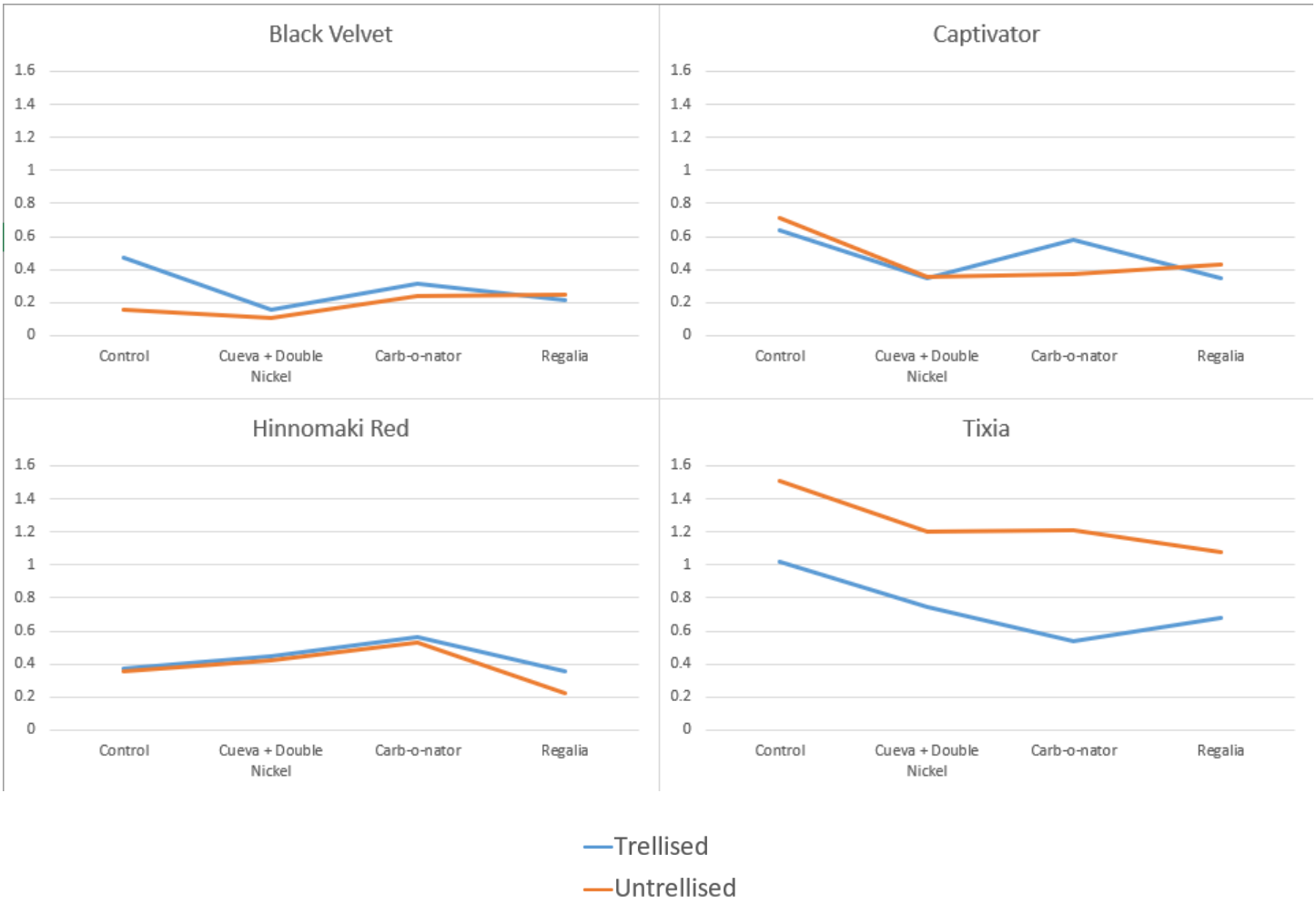
Statistical Significance Codes: *** p<0.001 ** p< 0.01 * p<0.05



Mean Disease Incidence, Low Shoots, June 2021

Independent Variable	Statistical Significance of Effect	Description of Effect
Block		
Variety	***	Tixia suffered the most disease; Black Velvet and Hinnomaki Red the lease; Captivator was intermediate
Trellis		
Spray Treatment	**	Cueva + Double Nickel and Regalia sprays reduced disease
Variety x Trellising Method	***	In the variety Tixia, untrellised plants had more disease than trellised plants.
Variety x Spray Treatment		
Trellising Method x Spray Treatment		
Variety x Trellising Method x Spray Treatment		

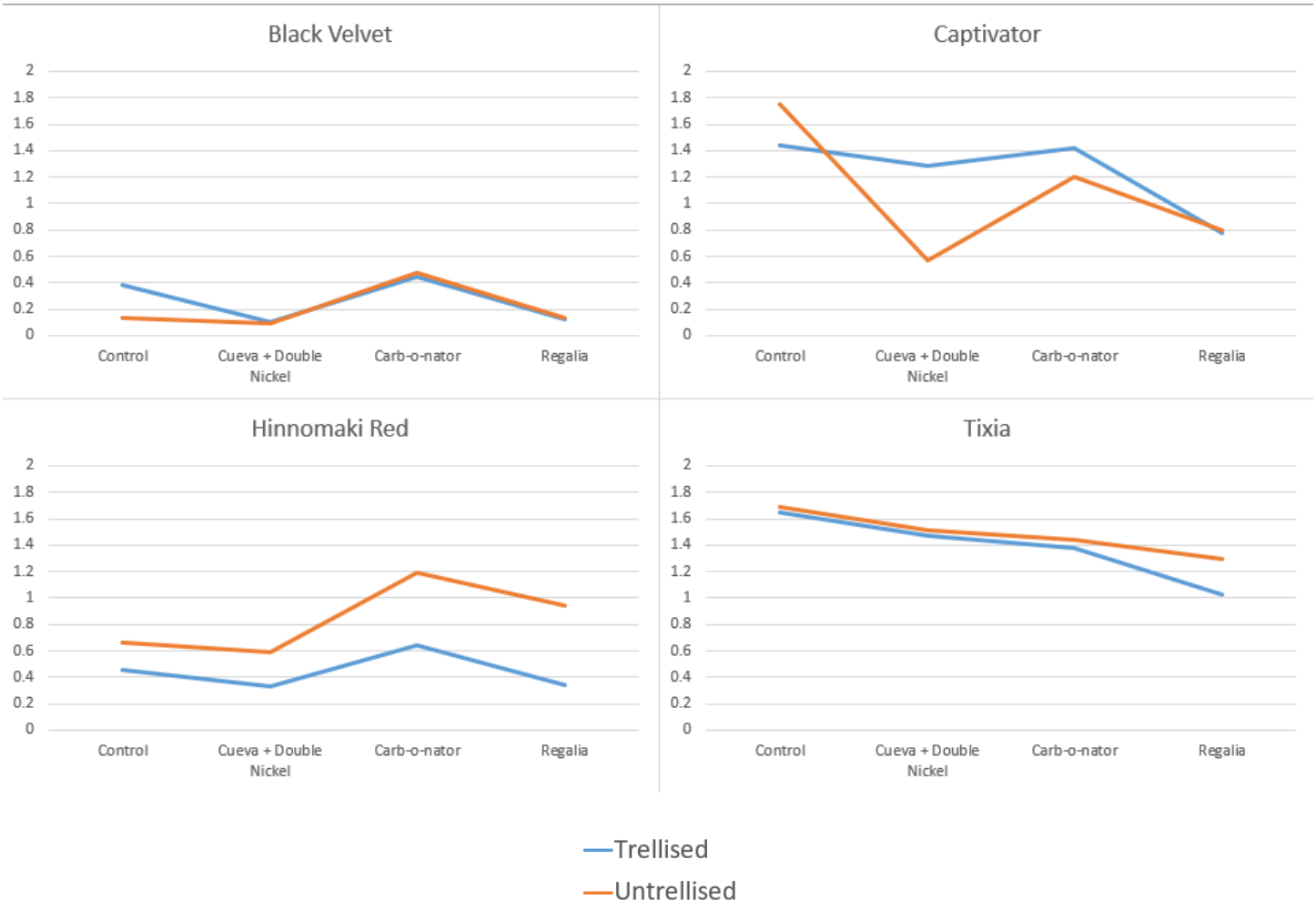
Statistical Significance Codes: *** p<0.001 ** p< 0.01 * p<0.05



Mean Disease Incidence, Low Shoots, June 2022

Independent Variable	Statistical Significance of Effect	Description of Effect
Block	**	
Variety	***	Tixia suffered the most disease; Black Velvet and Hinnomaki Red the least; Captivator was intermediate
Trellis		
Spray Treatment	***	Cueva + Double Nickel and Regalia sprays reduced disease
Variety x Trellising Method	**	In the variety Hinnomaki Red, untrellised plants had more disease than trellised plants.
Variety x Spray Treatment	**	Beneficial effects of Cueva + Double Nickel and Regalia sprays were greater in Black Velvet, Hinnomaki Red, and Captivator than in Tixia.
Trellising Method x Spray Treatment		
Variety x Trellising Method x Spray Treatment		

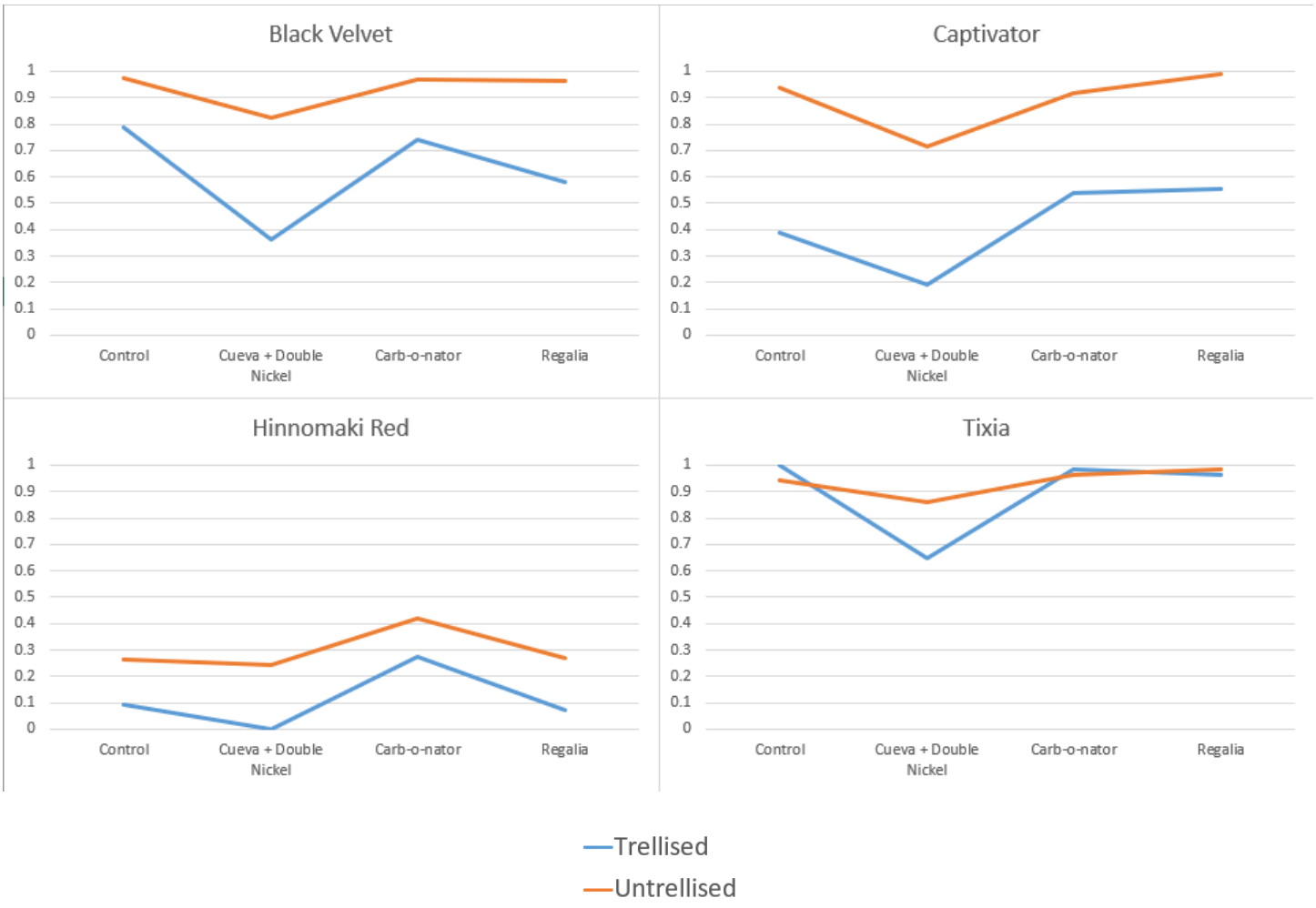
Statistical Significance Codes: *** p<0.001 ** p< 0.01 * p<0.05



Mean Percent Defoliation, High Shoots, September 2021

Independent Variable	Statistical Significance of Effect	Description of Effect
Block	*	
Variety	***	Tixia suffered the most defoliation; Hinnomaki Red suffered the least; Black Velvet and Captivator were intermediate
Trellis	***	Untrellised plants suffered more defoliation
Spray Treatment	***	Cueva + Double Nickel reduced defoliation; Regalia had a slight effect
Variety x Trellising Method	***	Trellising did not reduce defoliation in Tixia as it did in the other three varieties.
Variety x Spray Treatment	*	Complex effects
Trellising Method x Spray Treatment	*	Cueva + Double Nickel reduced defoliation in trellised plots more than in untrellised plots
Variety x Trellising Method x Spray Treatment		

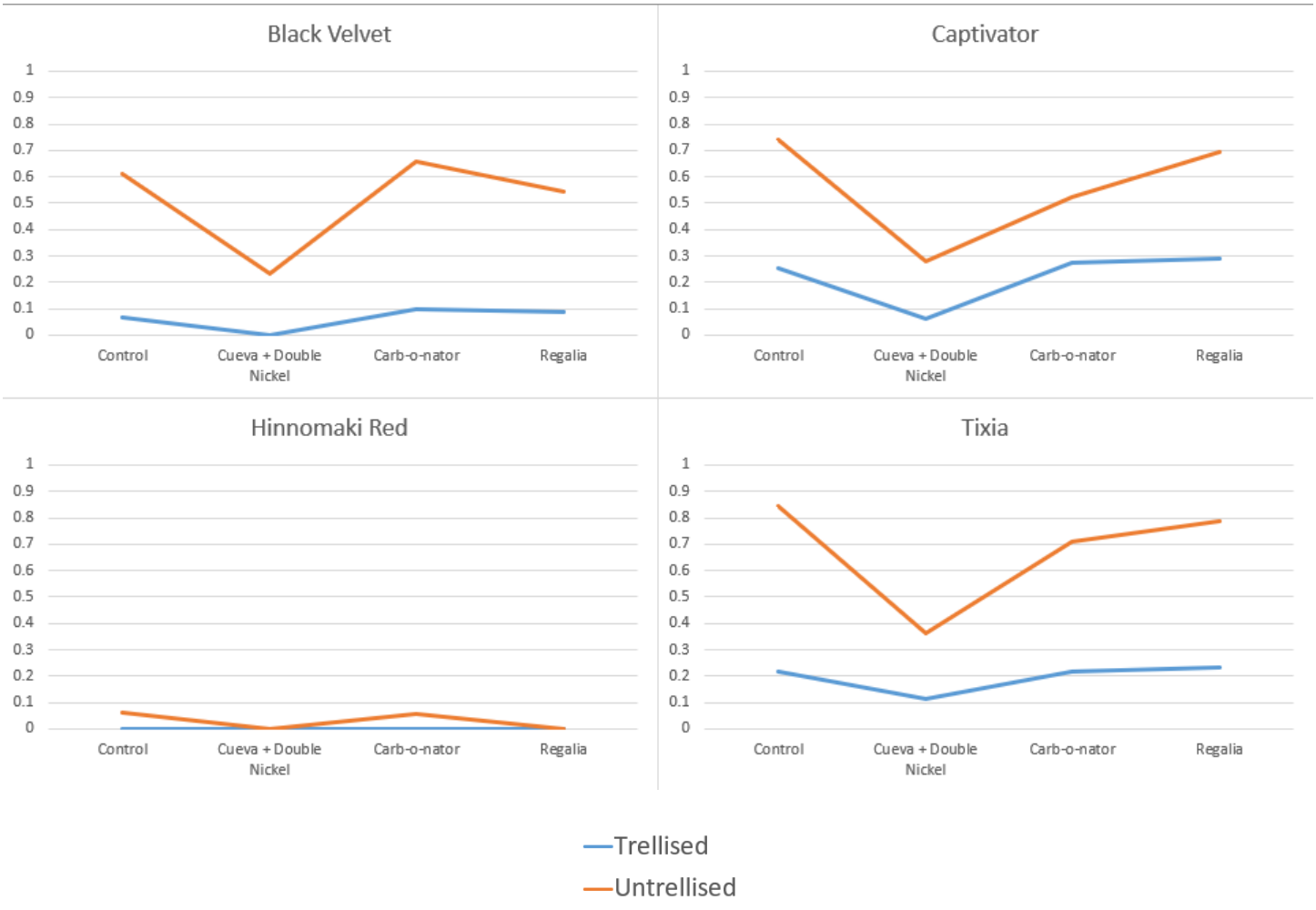
Statistical Significance Codes: *** p<0.001 ** p< 0.01 * p<0.05



Mean Percent Defoliation, High Shoots, August 2022

Independent Variable	Statistical Significance of Effect	Description of Effect
Block		
Variety	***	Tixia and Captivator suffered the most defoliation, and Hinnomaki Red the least; Black Velvet was intermediate
Trellis	***	Untrellised plants suffered more defoliation
Spray Treatment	***	Cueva + Double Nickel reduced defoliation
Variety x Trellising Method	***	Trellising did not reduce defoliation in Hinnomaki Red as it did in the other three varieties.
Variety x Spray Treatment	*	Cueva + Double Nickel reduced defoliation in Black Velvet, Captivator, and Tixia, but not in Hinnomaki Red
Trellising Method x Spray Treatment	***	Cueva + Double Nickel reduced defoliation in untrellised plots more than in trellised plots
Variety x Trellising Method x Spray Treatment		

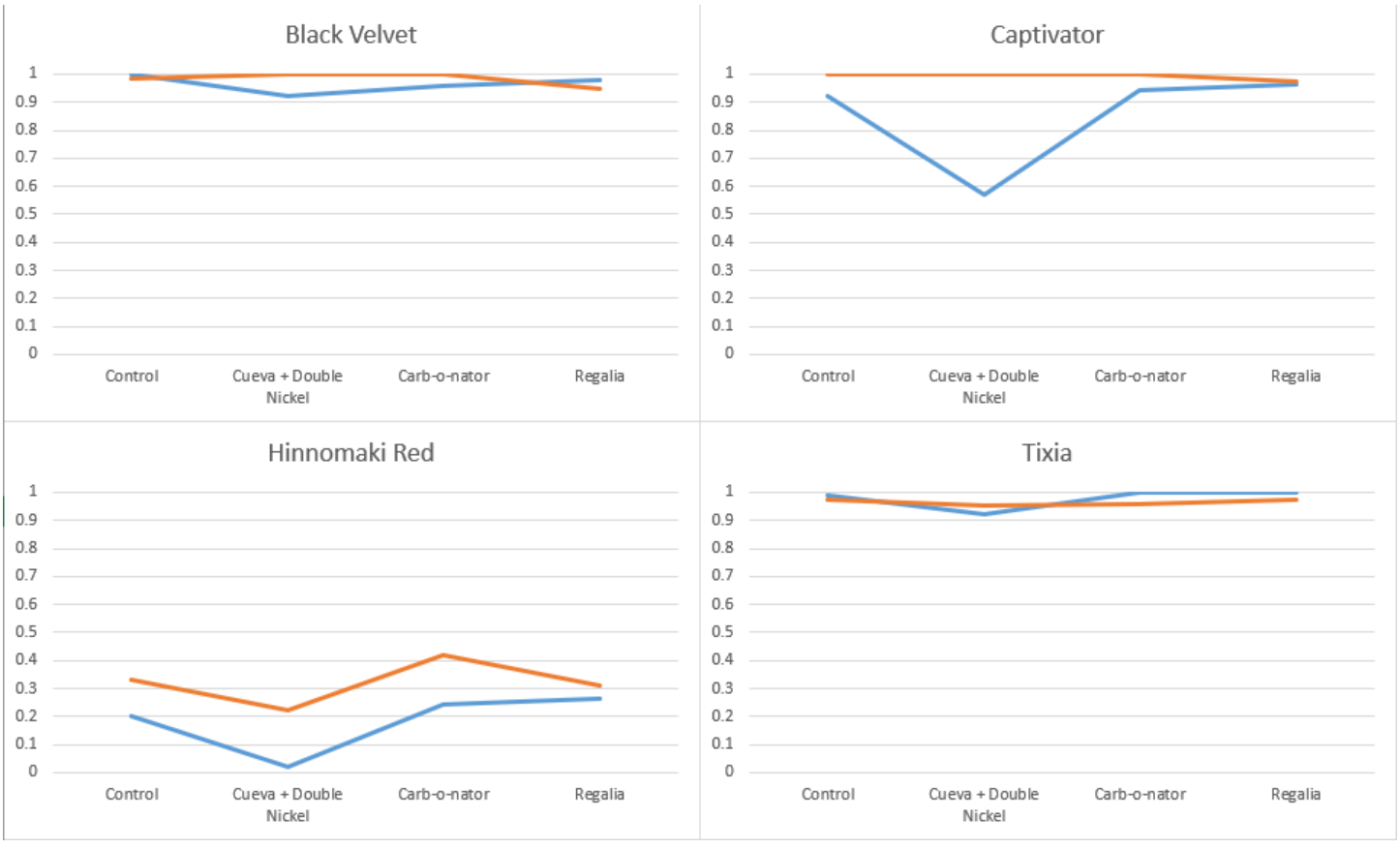
Statistical Significance Codes: *** p<0.001 ** p< 0.01 * p<0.05



Mean Percent Defoliation, Low Shoots, September 2021

Independent Variable	Statistical Significance of Effect	Description of Effect
Block		
Variety	***	Hinnomaki Red suffered much less defoliation than Black Velvet, Captivator, and Tixia.
Trellis	***	Untrellised plants suffered more defoliation
Spray Treatment	***	Cueva + Double Nickel reduced defoliation
Variety x Trellising Method	**	Trellising reduced defoliation in Captivator and Hinnomaki Red more than in the other varieties.
Variety x Spray Treatment	*	Cueva + Double Nickel reduced defoliation Captivator and Hinnomaki Red more than in the other varieties
Trellising Method x Spray Treatment	***	Cueva + Double Nickel reduced defoliation in trellised plots more than in untrellised plots
Variety x Trellising Method x Spray Treatment		

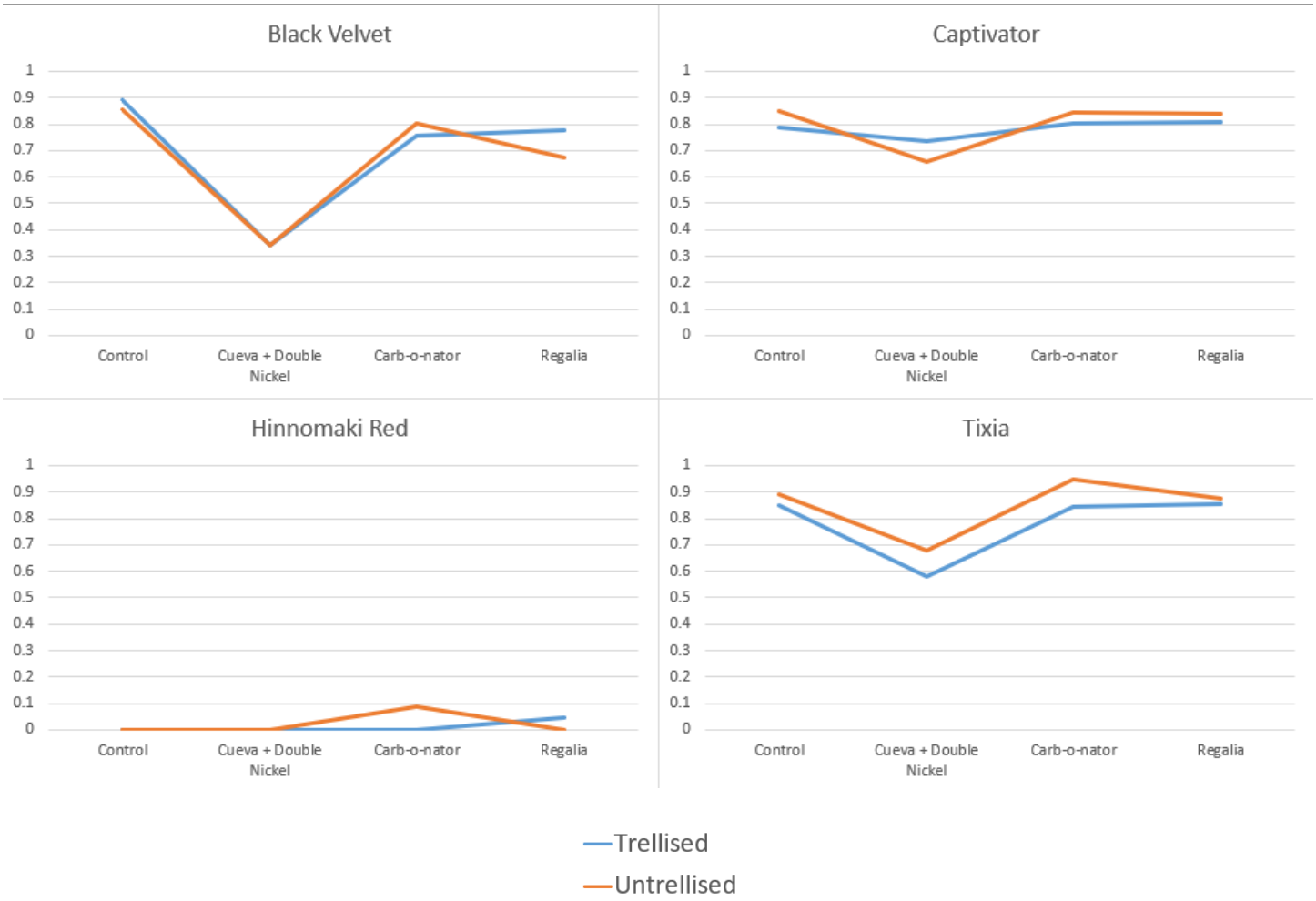
Statistical Significance Codes: *** p<0.001 ** p< 0.01 * p<0.05



Mean Percent Defoliation, Low Shoots, August 2022

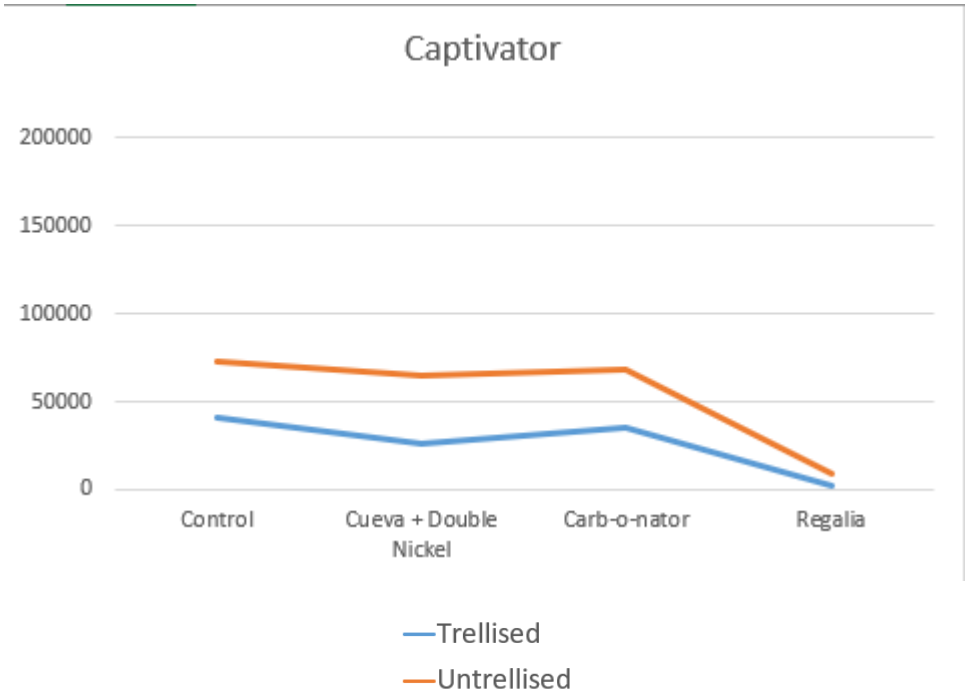
Independent Variable	Statistical Significance of Effect	Description of Effect
Block		
Variety	***	Hinnomaki Red suffered much less defoliation than Black Velvet, Captivator, and Tixia.
Trellis		
Spray Treatment	***	Cueva + Double Nickel reduced defoliation
Variety x Trellising Method		
Variety x Spray Treatment	***	Cueva + Double Nickel reduced defoliation in Black Velvet and Tixia more than in the other varieties
Trellising Method x Spray Treatment		
Variety x Trellising Method x Spray Treatment		

Statistical Significance Codes: *** p<0.001 ** p< 0.01 * p<0.05



Yield, 2021

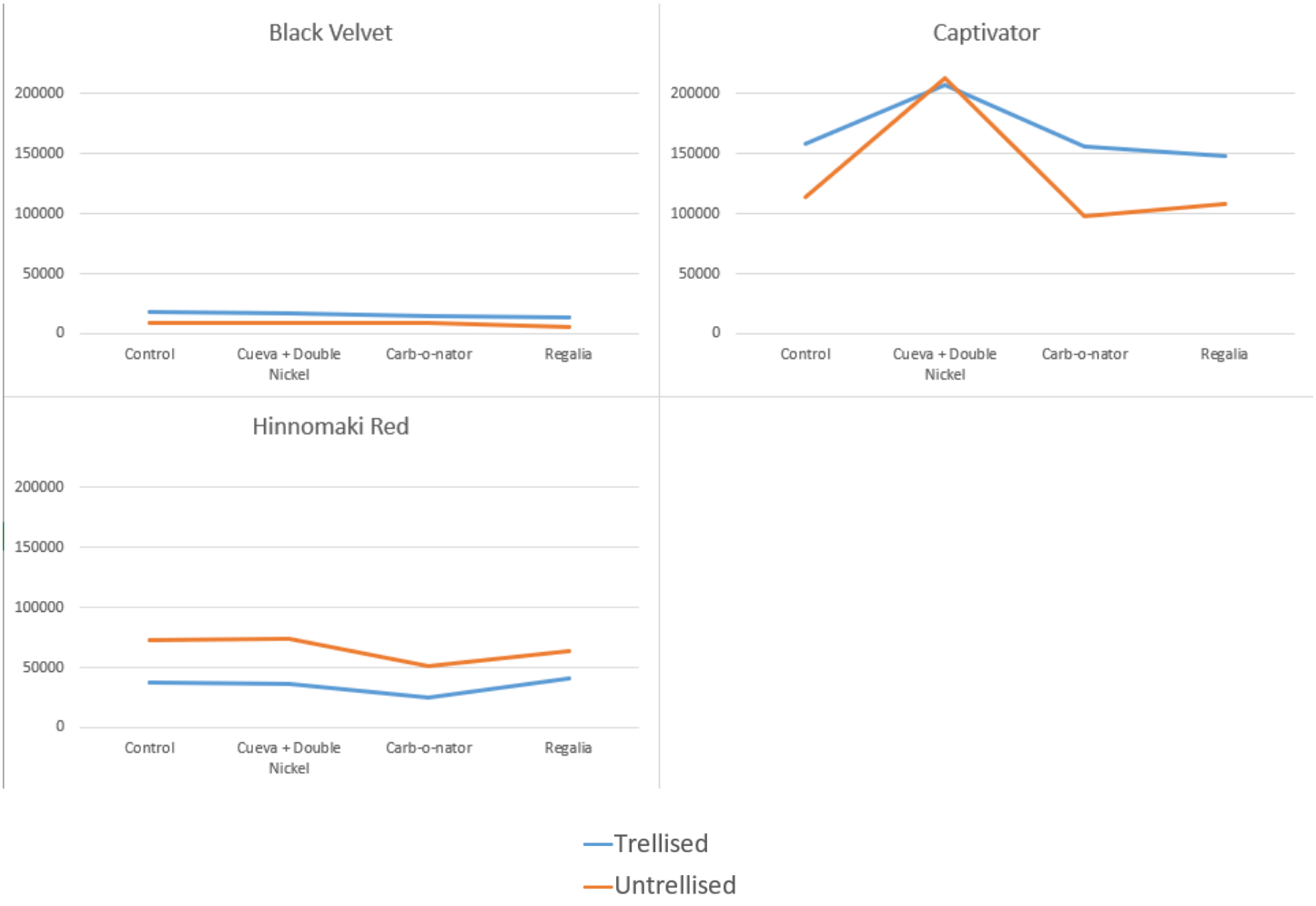
No statistical analysis was performed on 2021 yield data. However, there were clear trends that trellising reduced yield and that Regalia spray treatments reduced yield (probably because of the defoliation due to spray oil phytotoxicity in spring).



Yield, 2022

Independent Variable	Statistical Significance of Effect	Description of Effect
Block		
Variety	***	Yields of Captivator were much higher (approximately 120,000 half-pints per acre) than Hinnomaki Red (40,000 half-pints per acre), which was in turn higher than Black Velvet (approximately 12,000 half-pints per acre).
Trellis		
Spray Treatment	***	Cueva + Double Nickel increased yield
Variety x Trellising Method	***	Trellising increased yield in Captivator, but decreased it in Hinnomaki Red
Variety x Spray Treatment	***	Cueva + Double Nickel increased yield in Captivator but not in other varieties
Trellising Method x Spray Treatment		
Variety x Trellising Method x Spray Treatment		

Statistical Significance Codes: *** p<0.001 ** p< 0.01 * p<0.05



Recommendations

This study did not reveal any methods of Anthracnose Leaf Spot control which were completely effective at eliminating the disease. Anthracnose symptoms occurred in all experimental treatments. However, we found clear and consistent evidence that variety selection, trellising, and organic sprays can all provide some control of Anthracnose.

Varieties differ enormously in their susceptibility to Anthracnose. Hinnomaki Red stood out in this study for its exceptional resistance, and Tixia was notable for extreme susceptibility. It would be worthwhile to test additional varieties for their resistance and susceptibility. However, commercial growers need to consider other factors such as yield and flavor in their variety selection. For example, growers may prefer Captivator to Hinnomaki Red, because Captivator is much higher yielding, despite its greater disease susceptibility.

Trellising slightly decreases disease severity. However, we have found that trellising is very expensive in materials and labor: trellised plantings incur about $15,000 per acre in additional costs during establishment for trellis materials and plants, and roughly 200 hours per acre in additional labor in the first two years of the planting for trellis construction, planting, and training plants (see www.twoonionfarm.com/research/). Therefore we expect that few growers would adopt trellising for disease control alone, but that other possible benefits of trellising such as improved fruit quality and/or faster harvest would drive this decision.

Sprays of Cueva and Double Nickel reduced Anthracnose Leaf Spot, decreased defoliation, and also increased yield of Captivator in 2022. It would be interesting to know whether Cueva or Double Nickel sprayed alone would also control Anthracnose. Cueva is a copper-based product and many growers have reservations about spraying copper because of possible environmental and health impacts. Regalia is a more environmentally benign alternative; Regalia sprays decreased early season disease but did not affect late season defoliation. Carb-o-nator probably absolutely no control of Anthracnose in this experiment.

I thank Leslie Holland, UW-Madison Department of Plant Pathology, for her extensive help with experimental design and statistical analysis. This product was developed with support from the Sustainable Agriculture Research and Education (SARE) Program, which is funded by the U.S. Department of Agriculture – National Institute of Food and Agriculture (USDA-NIFA). Any opinions, findings, conclusions, or recommendations expressed within do not necessarily reflect the view of the SARE program or the U.S. Department of Agriculture. USDA is an equal opportunity provider and employer.