TITLE: **Morris Arboretum Nursery Trial: A Study of Rose Care Treatment**

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ABSTRACT:

The Arboretum's IPM program has been striving to reduce pesticide use in the Rose Garden. In 2010, Justin Jackson, the Rose Garden Section Leader, proposed a sustainable landscape management plan that would incorporate compost tea into the Rose Garden's IPM program. The study of improving the quality of the compost has been on-going.

The intent of this project was to determine the efficacy of three organic fungicides. The project was divided into two phases, the pre-trial phase and trial phase. A treatment plan was applied from the end of spring until the end of fall, 2012. The four treatments for the trial were control (just water), compost tea, CEASE, and Green Cure. CEASE and Green Cure were sprayed onto the leaves once a week as recommended and compost tea was sprayed and drenched once a month.

Black spot and downy mildew were found on almost all of the rose leaves or canes in the entire Rose Garden. As a fungal disease, the intensity of damage caused by black spot and downy mildew tends to be influenced mostly by weather conditions and the disease resistance of the rose varieties. Many hybrid tea, grandiflora, and floribunda roses are susceptible, whereas many of the shrub roses show more resistance. This observation also shows that the resistance level might be variable in different places and conditions. Nine weeks after planting, which includes four weeks of treatment that took place in early June, the rose plots did not have comparable treatment results in growth, vigor, and performance. The black spot or fungal diseases on the leaves had not significantly changed the growth and performance of the plants.

In order to have better study results, continuing treatment and observation is encouraged until the end of October to determine the percentage of fungal disease present or the percentage of defoliation among the treatments and varieties.

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INTRODUCTION

Consumer demand for organic food has risen quickly over the past decade, triggered in part by the development and success of USDA's organic regulatory program and labeling. As consumer demand for organic products has increased, organic retail sales have spread far beyond the "natural products" market niche in urban areas and college towns and into big-box stores across the country (Greene et al., 2009). The increasing demand for "organic products" is one of the results of a growing concern for this health and environmental problem. It has been found that people not only pay attention to the adverse effects of hazardous chemicals in the foods they eat but also to the pollution to the environment in which they live. Public agencies are facing increasing demands from their employees, their clients, and the general public to explain and justify their use of pesticides (Flint et al., 2003). This awareness has been occurring in many public areas and services including public gardens that often use pesticides to control pests and diseases as part of their pest management program.

A public garden is a mission-based institution that maintains collections of plants for purposes of education, research, conservation, and/or public display. Furthermore, it must be open to the public and provide accommodation for access to all people (Rakow et al., 2011). With the mission of promoting an understanding of the relationship between plants, people, and place through programs that integrate science, art, and the humanities, Morris Arboretum as a public garden attracts people to visit, educates and instantly puts them into contact with plants and the environment. We recognize that the general public and staff deserve to be protected from exposure to hazardous chemicals and pesticides. We also recognize that public gardens should be a model of environmentally responsible practices. For these reasons, most public gardens have been practicing Integrated Pest Management (IPM).

Integrated Pest Management (IPM) is a problem-solving approach to landscape management designed to prevent and control undesirable weeds, pests, and diseases. The main goal of IPM is the development of sustainable ways of managing pests to minimize risks to environmental health and the economy (Rakow et al., 2011). The IPM program at Morris Arboretum was established in 1981 by Dr. Ann Rhoads. A monthly monitoring by the plant pathologist, interns, gardeners, and arborists has been financially beneficial, reducing the use of pesticides and minimizing the health risk to people visiting and working in the garden.

The Rose Garden is one of the horticultural treasures of the Arboretum and one of the most visited destinations. The formal Rose Garden emerged in 1924 after it provided fruit, vegetables, and flower to the mansion for 36 years. The monoculture Rose Garden declined over the years since it opened to public in 1933. In 1994, there was a revitalization of the garden including soil conditioning and introducing diversity into the garden to create an updated and more beautiful garden, and at the same time build an ecologically healthier garden. Adding companion plants to the garden encouraged more beneficial insects, increasing its wildlife value and providing built-in controls for pest and disease problems, while being part of the IPM program.

Growing roses with a lot of chemicals and pesticides has been an accepted practice for the general public. In a formal rose garden, spraying pesticide is commonly used to get rid of

pests and diseases and is an easier way to keep roses looking their best. Before 2010, weekly or biweekly preventive chemical spraying had been scheduled to grow quality roses in the Rose Garden. Alternative controls to pesticide sprays, such as milky spore disease and pheromone traps were used for rose care (Bechtol, 1988).

The Arboretum's IPM program has been striving to reduce pesticide use in the Rose Garden. The IPM program for roses generally includes choosing resistant varieties, keeping good sanitation in the garden, and following proper cultural practices. These include adding compost, mulching, watering, pruning, weeding, adding companion plants, and controlling pests and diseases with chemicals. The use of chemical pesticide is usually considered a last resort in an effective IPM program. If pesticides are needed to control pests, the safest, least harmful product to humans and the environment should be considered first (Rakow et al, 2011).

Organic Rose Garden

The practice of organic rose gardening has become more and more popular in the last decade. Since 2000 there have been a lot studies using compost tea and organic farming practices conducted in Northwest states (Oregon and Washington). In 2000-2001 there was a rose garden compost tea study at University of Washington, followed by a compost tea trial done by the Cascadia Consulting Group for City of Seattle in the Woodland Park Rose Garden, the Jackson Park Golf Course, and at Pritchard Beach. Woodland Park Rose Garden succeeded transforming a 2.5 acre rose garden to a model of organic practices after two years on a diet of compost tea. Brooklyn Botanical Garden, Atlanta Botanical Garden and Lotus Land Rose Garden in California are some public gardens that use sustainable practices to manage their rose gardens organically. Smithsonian Gardens has been practicing selective spraying in its rose garden to reduce the use of chemical pesticide. The Antique Rose Emporium in Texas is a nursery practicing organic rose growing using careful selection of the rose varieties planted and compost tea.

Morris Arboretum had been spraying a total of 2,000 gallons of synthetic chemicals a year in the Rose Garden. In 2010 Justin Jackson, the Rose Garden Section Leader, introduced compost tea to the Rose Garden after attending Dr. Elaine Ingham's Soil Health Workshop.

After three applications of compost tea, both drenching to the soil and leaf spraying, there were some improvements including reduced water use for irrigation. The vegetation appeared greener than plants in the surrounding area, the presence of beneficial insects in the garden was noted, and black spot was suppressed. Problems that persist are the presence of black spot and fungus in the garden and population levels of beneficial bacteria and fungus in compost tea is lower than expected. Improving the quality of the compost tea has been studied. Removing synthetic chemicals from the Rose Garden is going to be a challenge and it is not going to happen in a year. Justin expects that it will take at least a few years of an organic approach before we start to really see a truly healthy rose garden.

PRE-TRIAL PHASE

The intent of this project is to determine what the best organic fungicides for treating black spot on four varieties of roses The project is divided into two phases: the pre-trial phase and the trial phase. The pre-trial phase, including field observation and plot preparation, was done throughout the fall and winter. The trial phase including planting, maintenance, applying fungicide treatment, observation, and monitoring was done in the spring and summer.

METHODOLOGY

Pre-trial field observation was conducted to study the general condition and diseases in the Rose Garden and collect information that could support the trial methods and materials. The points necessary to study before the trial were the common diseases of the Rose Garden, the resistance of some varieties and type of roses in the field, their availability in the market, and the organic fungicides that could be applied and be effective in the Rose Garden.

To study general conditions and problems in the garden, some interviews with Justin Jackson and photo documentation were done. Some photos of varieties in the garden had been taken in the fall to examine their performance and resistance to black spot. Any supporting information was collected from journals and articles, correspondence, discussion on intern field trips, and meetings with The Philadelphia Rose Society. The nursery area at the farm site was chosen to conduct the trial. The plots were prepared by weeding and digging the soil in October and tilling to loosen the clods in January.

RESULTS & DISCUSSION

1. Disease Incidence

Based on observation, the Rose Garden's main pests and diseases are black spot, downy mildew, rose midge, Japanese beetle, aphids, and rose rosette disease. Black spot is the most important foliar disease of roses and is widespread among all rose species and cultivars. Symptoms are dark brown or black blotches with irregular margins found on the leaves, which often turn yellow and drop as the disease progresses (Davies and Stickland, 2004). Repeated defoliation weakens the plants leading to fewer blooms and greater sensitivity to other stresses.

The fungus, *Diplocarpon rosae* overwinters on diseased canes and fallen leaves. Spores produced on fallen leaves are spread via rain or water splashed on newly emerged leaves and stem tissue in the spring (Wallis and Lewandowski, 2008). The fungus favored warm wet seasons as infection is optimal at 75 ^{o}F when leaves have been wet for 7 hours (Davies and Stickland, 2008).


Figure 1: Black spot presence in Rosa ‘Rheinaupark’ and ‘Golden Celebration’.

Black spot is found on almost all of the rose leaves or canes in the entire Rose Garden. As a fungal disease, the intensity of damage caused by black spot tends to be influenced mostly by weather conditions and disease resistance of the rose varieties. Many roses that were attacked by black spot after wet rainy weather in the fall of 2011showed significant damage in the spring of 2012 particularly some of the hybrid teas. Sometimes symptoms can be seen not only on the leaves but also on petals (red dots, distortion), petioles, fruit, and canes (Wallis and Lewandoski, 2008).

2. Variety Selection

Table 1: Resistance of some roses varieties in the rose garden.

Type	Varieties	AARS Rose	Blackspot / fungal symptoms quantity	Resistance (on the field)
Shrub/Landscape	Care Free Spirit	√	-	Resistant
	Pink Knock Out		-	Resistant
	Rainbow Knock Out	√	-	Resistant
	Winter Sunset		-	Resistant
	Golden Celebration		+	Non-resistant
	Glamis Castle		+	Non-resistant
	Robusta		+ + +	Non-resistant
	Rheinaupark		+	Non-resistant
Floribunda	Rainbow Sorbet	√	-	Resistant
	Julia Child	√	-	Resistant
	Easy Does It	√	+ + +	Non-resistant
	Redwood		+	Non-resistant
	Cinco De Mayo	√	+	Non-resistant
	Mardigras	√	+	Non-resistant
Hybrid Tea	Traviata		+	Non-resistant
	Pink Promise	√	+ +	Non-resistant
Grandiflora	Sunshine Daydream	√	+	Non-resistant
	Wild Blue Yonder	√	+ +	Non-resistant
	Dick Clark	√	+ +	Non-resistant

The table shows that all hybrid tea and grandiflora roses observed had black spot or fungal disease symptoms and were considered non-resistant. Many hybrid tea roses are very susceptible, whereas many of the shrub and rugosa roses show more resistance (Wallis and Lewandowski., 2008). Most of the floribunda roses had some black spot. Hybrid tea, floribunda, and grandiflora roses tend to have low resistance levels because most of their hybridization involves flower performance instead of vigor and hardiness like the shrub-type roses. Even though shrub-type roses are the most resistant in the garden some of them had black spot as well.

Some of the roses that we have are the All-America Rose Selections (AARS) winners that are expected to perform well in the garden. AARS is a nonprofit association started in 1938 and dedicated to the introduction and promotion of exceptional roses. Every year the AARS tests new roses in gardens across the U.S. After two years of testing, they select the best varieties for disease resistance, growth qualities, and overall appeal. In fact, some of them apparently still have a visible incidence of black spot in the garden, so being the winner does not always mean they are not susceptible to black spot.

This observation also shows that the resistance level might be variable in different places and conditions. Some of the varieties that claim to have resistance to black spot performed surprisingly different in the garden. A knowledgeable member of Philadelphia Rose Society mentioned that there was no such thing as a 100% resistant rose. Every rose is susceptible to black spot but their vigor in handling black spot makes them different. Some varieties like 'Knock Out' are very vigorous against the defoliation of black spot. Though they look resistant, it is still possible to find black spot infection on their leaves and canes.

Considerations for selecting four varieties for the trial were rose type, resistance, popularity, and availability in the market. They are 'Robusta' (Shrub type), 'Easy Does It' (Floribunda type), 'Chrysler Imperial' (Hybrid tea type), and 'Sunshine Daydream' (Grandiflora type). They were considered as non-resistant based on observation in the Rose Garden. Three of them are AARS winners and all of them are available in the marketplace.

The varieties selected are the same varieties that we have in the Rose Garden. Their performance and resistance in the garden were expected to also happen in the trial. Non-resistant varieties were selected intentionally to easily attract black spot for comparative measurement and efficacy treatments in the trial. AARS winner varieties are prioritized in the selection since they are popular purchases made by the public.

Figure 2: Rosa ‘Robusta’: black spot and downy mildew presence in the fall

‘Robusta’ (*Rosa* ‘KORgosa’) is a modern rugosa rose hybrid that has crimson red single flowers. It was bred by Reimer Kordes in Germany in 1979. Robusta tends to be a big shrub rose. It is very thorny and extremely vigorous, but some mentioned it is also susceptible to black spot. In fact, they are susceptible to black spot in the garden. Most of the leaves were covered with black spot and downy mildew in the fall.

Figure 3: Rosa ‘Easy Does It’: black spot and downy mildew presence in the fall

‘Easy Does It’ (*Rosa* ‘HARpageant’) is a 2010 AARS winner. It is claimed to be excellent in all kinds of climate, a combination of apricot and peach in color, and disease resistant. In the garden, the leaves apparently did not perform really well particularly in the fall. Even though they are still blooming in the fall, most of the plants were badly defoliated by black spot and downy mildew.

Figure 4: Rosa ‘Chrysler Imperial’

‘Chrysler Imperial’ (*Rosa* ‘Chrysler Imperial’) is a strongly fragrant, dark red hybrid tea rose cultivar. It has been a around since the 1950’s and is still very popular. It was bred in California in 1952. It was the 1951 Portland Gold Medal winner and the 1953 AARS winner. It is noticeably susceptible to mildew and black spot. It performed reasonably well in the Rose Garden, but like most hybrid tea roses, it was experiencing some black spot. This variety was not included in pre-trial observation, but was proposed by Justin Jackson as a popular hybrid tea rose.

Figure 5: Rosa ‘Sunshine Daydream’ and black spot presence in the fall

‘Sunshine Daydream’ (*Rosa* ‘Meikanaro’) is the latest 2012 AARS winner. It is a grandiflora rose with prolific clusters of light yellow, cuplike flowers that fade to creamy yellow. It has excellent disease resistance, including resistance to black spot and thrived during two years of testing in 21 gardens nationwide. It performs well in the Rose Garden, but had a little black spot in the fall.

3. Treatment Selection

The general recommendations for black spot management are proper watering of the soil, not the foliage, good sanitation, resistant variety selection, and fungicide application (Wallis and Lewandowski, 2008). The treatment includes organic fungicide treatments or the use of non-synthetic chemicals to suppress black spot. The information was gathered from discussion during field trips and also from The Philadelphia Rose Society. By choosing different treatments, they were expected to be able to show comparative results and effectiveness particularly in our area and climate.

Compost tea was chosen as a treatment. It is a represents the treatment program that has been implemented in the Rose Garden during the past two years. Compost tea has been sprayed once a month during the growing season (late spring and summer) in the Rose Garden. For the trial, the compost tea recipe referred to the current recipe for the Rose Garden and was applied once a month. The result of compost tea trials in the Woodland Park Rose in 2011showed that both the compost tea and conventionally treated beds looked comparable relative to black spot and powdery mildew and the bloom quality and quantity were comparable.

CEASE® is contact biological fungicide that currently has been used in the Rose Garden of the Brooklyn Botanical Garden in New York. It is one of the largest rose collections in North America with over a thousand kinds of roses. In 2010-2011 NYBG's Cranford Rose Garden was renovated because of rosette disease (RRD). They introduced a bright mix of annuals and perennials into the rose beds to provide habitat for beneficial insect that reduce the need for chemical treatment in the garden (Owens, 2011).

Green Cure is a potassium bicarbonate-based (KNO_3) fungicide that has been tested and endorsed by The American Rose Society. It is recommended by Dr. Suni and Rafiq Bolar, members of both The Philadelphia and West Jersey Rose Society. They sprayed Green Cure in the fall to their roses. It worked well on powdery mildew and was somewhat affective against black spot. Another benefit of using Green Cure is that it brought the acidity of soil down, since they had acidic soil.

The four treatments for the trial are control (just water), compost tea, CEASE and Green Cure. CEASE and Green Cure will be sprayed to the leaves once a week as recommended, and compost tea will be sprayed and drenched once a month.

TRIAL PHASE

The Trial Phase was conducted in spring and summer, included ordering the plants, planting, maintaining, applying fungicide treatment, observation, and monitoring.

METHODOLOGY

Four beds (23 x 5 feet, with 8.5 foot spacing) were prepared at the nursery at Bloomfield Farm. Four rose varieties were used: 'Robusta' (V1), 'Easy Does It' (V2), 'Chrysler Imperial' (V3) and 'Sunshine Daydream' (V4). The second factor was fungicide treatment that consisted of four treatments: control (N0), compost tea (N1), CEASE (N3) and Green Cure (N4). Each variety was planted in all beds with five repetitions randomly arranged. There were 20 plants in a plot 3 feet apart, so there were 80 plants in total. One bed got one treatment.

General tilling and turning the soil was done in the fall and winter. No particular treatment was given to the plot before planting. Weeding and mowing the grass were done as needed.

'Robusta' was planted from bare root plants and the others were transplanted from pots in the first week of April. The plots were mulched after planting; watering was done frequently in the first three weeks and continued as needed. Soaking leaves in watering methods referred to sprinklers in the Rose Garden that somehow can attract black spot to the leaves easily.

Figure 6: Planting process

Treatments

Compost tea was brewed every month beginning on May 8. A 250-gallon GEOTEA brewer was used to brew tea for the Rose Garden and the trial every month. The tea was brewed with the following proportion of ingredients: 225 gallons of water, 12 quarts fresh, local compost, 1 quart seaweed extract and 1 bag (5.5 lbs) GeoTea starter. GeoTea starter is a balanced and diverse food resource to encourage the proliferation of naturally occurring microbes present in high quality compost, with an emphasis of fungal development. A tea sample was taken and checked under the microscope to study the microorganism population. Compost tea was sprayed to the leaves and drenched in the soil.

CEASE and Green Cure were sprayed as a solution to the leaves every week. The dosage and timing were recommended in the manufacturer's direction. Both CEASE and Green Cure were diluted in ¼ gallon (32 oz.) of water. CEASE was diluted with Therm X^{TM} 70, a

recommended spreader/sticker. The control bed was sprayed with just water every week to create the same condition as in the other treatments. This was applied also to the compost tea bed in the weeks that it did not get the treatment.

Photo Documentation

The trial plot was photographed every week to document the general growth and performance of the roses beginning in early April after planting and continuing throughout the study period. Pictures of each bed will be taken every week beginning in May (after treatment application). Pictures of sample leaves with fungal disease present were taken to see growth performance and presence of black spot and other pests and disease symptoms. By the end of the study, the photos are expected to have significant change and comparable result.

Site Monitoring

The plots were monitored every month through visual evaluation. Justin Jackson, the Rose Garden Section Leader, and I conducted a visual evaluation of the roses in the plots. Scouting was done at the same time to control any pest or insect interfered.

RESULTS AND DISCUSSION

General Growth and Performance

After nine weeks from planting and four weeks in treatment, the rose plot did not appear to be in comparable growth, vigor, and performance. Most roses grow rapidly after the fourth week and get continuously bushier up to the eighth week. While the leaf growth slowed down, it started to bloom abundantly in the eighth and ninth weeks. Four varieties have been continuously blooming after the ninth week, but not as much as the eighth and ninth weeks as the first blooming.

Figure 7: Rose growth in beginning and in the 2nd,4th, 6th, 8th, and 9th weeks

There were two ‘Robusta’ roses that failed to establish and died. It was expected that bare root roses are more difficult to establish when transplanted compared with roses in pots. There was one sample of ‘Easy Does It’ in the control bed that was determined to be a different variety with purple flower color.

Figure 8: Control plot in treatment period

Figure 9: Compost tea plot in treatment period

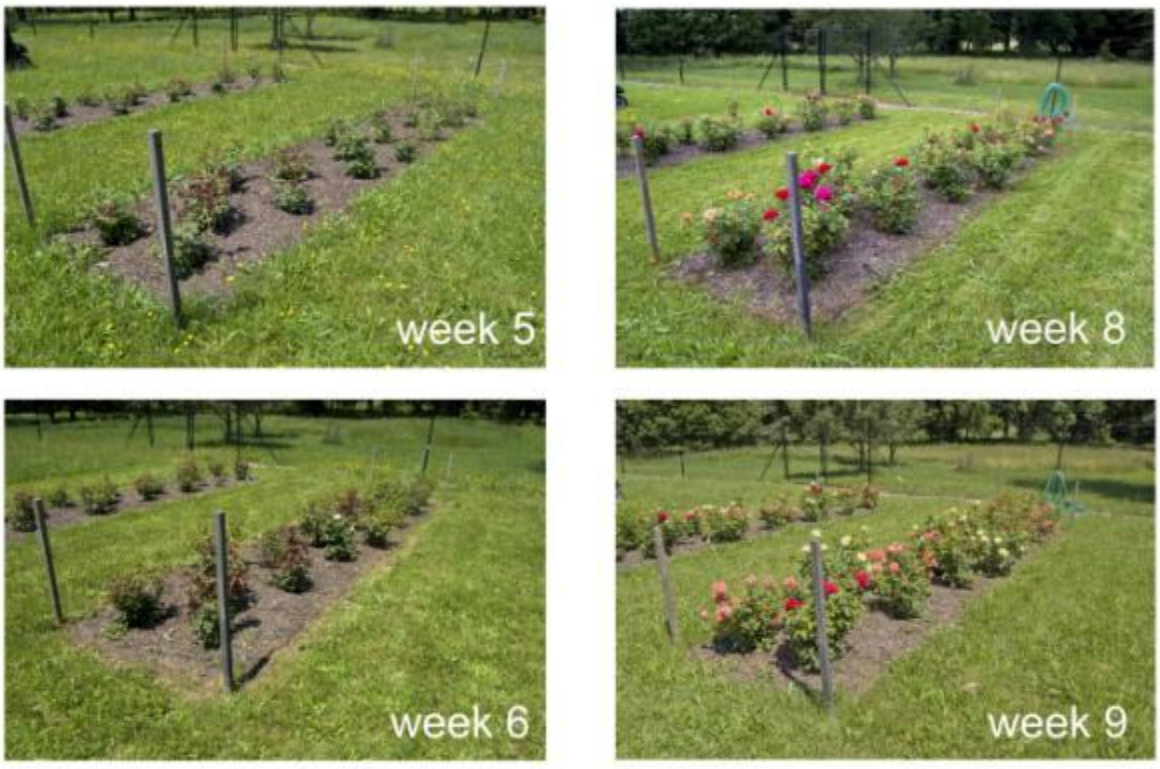

Figure 10: CEASE plot in treatment period

There was no significant difference in either growth or blooming among treatments up to the 9th week. Among the four treatments the compost tea treatments were expected to contribute to the better growth and performance since compost tea mainly acted as source of nutrition and added good microorganisms to the soil.

Until the 9th week the presence of black spot or fungal diseases on the leaves had not significantly changed the growth and performance of the plants. A fourth week of treatments did not affect the growth and performance of the plot.

Foliage Disease

Black spot is one of the most common rose diseases and was monitored during the study. Black spot is easy to identify because of the clearly visible black patches on mature foliage and the premature foliage senescence (Cascadia Consulting Group, 2001). In the plot there were three fungal diseases present on the leaves: black spot, downy mildew, and anthracnose.

During observation until the 9th week downy mildew and anthracnose were more commonly found on the leaves than black spot. This might be because the weather conditions were more ideal for developing both diseases. Anthracnose develops during cool, moist conditions in spring (Mouchett, 2003), and downy mildew appears on garden roses only when these ideal, or at least very favorable, conditions are present: humidity over 85% and temperatures under 80° F (Wyckoff, 2009). Both diseases require similar ideal conditions to

develop, while black spot becomes active during warm (70-80° F), wet weather and requires water on the leaves for 7 hours at 75° F to germinate (Mouchett, 2003).

There was no significant difference in black spot or fungal disease percentages among treatments up to the 9th week. The percentage of black spot or fungal disease for all treatments was less than 5% based on visual evaluation and there was no significant defoliation to the plant. It was understandable that at the end of spring and early summer fungal diseases start developing and showing the symptoms but seldom result in defoliation. Usually fungal disease becomes more aggressive during the month of August when plants experience some drought stress brought on by high temperatures and no natural precipitation (Cascadia Consulting Group, 2001).

The fungal disease that first infected the plot was downy mildew on 'Easy Does It' leaves in 8th week. Each variety had different fungal diseases that primarily infected them. The 'Robusta' rose experienced black spot and anthracnose. The Chrysler Imperial had anthracnose symptoms that were slightly different from the symptoms on the 'Robusta', while the symptoms on 'Robusta' spread more like small black dots, the anthracnose symptoms on Chrysler Imperial were bigger, fuzzy spots. The 'Easy Does It' rose experienced downy mildew, which was concentrated on the center-bottom leaves, while 'Sunshine Day Dream,' which had one or two dots or almost none of black spot or downy mildew symptoms on the leaves showed the least percentage of fungal diseases on the leaves.

Figure 11: Anthracnose and black spot on ‘Robusta’ rose

Figure 12: Downy mildew on ‘Easy Does It’ rose

Figure 13: Anthracnose on ‘Chrysler Imperial’ rose

Figure 14: Anthracnose and black spot on ‘Sunshine Daydream’ rose

There were pest problems in the trial plots during the study. There were some young buds eaten by deer in the first week. This was caused by loose gates in the nursery fence. The problem was solved by putting plastic chain on the gates to make sure they would not open easily. There were aphids and midges attacking in about the 5th week. A high population of aphids on the plants attracted lady bugs and praying mantis as biological pest controls. Both of them are beneficial insects that can suppress aphids, mites, and other arthropods. Encouraging beneficial insects by providing suitable living conditions is a pest control strategy often used in organic farming, organic gardening, or IPM. In the 9th week there was a minor rose slug attack. We did not spray any insecticide to the plots since the damage or the pest population was still at a reasonable level.

Figure 15: Deer (left) and rose slug damage (right)

Figure 16: Symptoms of aphid attacks.

Figure 17: Beneficial insects— praying mantis and lady bug.

CONCLUSION AND RECOMMENDATIONS

Black spot and downy mildew were two common fungal diseases found in the Rose Garden and were the main cause of defoliation for most of the roses regardless of the type (shrub, hybrid tea, floribunda, and grandiflora). Every rose responded differently to the development of fungal disease infection. Some of them, mostly shrub roses were quite tough and resistant, and mostly hybrid tea, floribunda and grandiflora including AARS winners were not resistant. The resistance level might be variable in different places and under different conditions. Some of the varieties that claim to have resistance to black spot or fungal disease performed otherwise condition in the garden.

There are some organic fungicides in the market that can be used for organic rose gardening. Compost tea as the current treatment in the Rose Garden is still facing a challenging future and further study is needed to achieve better results. CEASE and Green Cure are two organic fungicides that were recommended by Brooklyn Botanical Garden and the Philadelphia Rose Society.

After 9 weeks of study there was no significant difference in growth and performance among the treatments. There was also no difference in fungal disease percentage or defoliation among the treatments since the fungal disease just started to develop by the end of study. Based on the visual evaluation, 'Sunshine Daydream' was the most resistant variety among other three varieties showing the least fungal disease present on the leaves.

Since the study will achieve better results by the end of growing season in October, continuing treatment and observation is encouraged until the end of October to determine the percentage of fungal disease present or the percentage of defoliation among the treatments and varieties. Furthermore, a cost analysis and biological soil test could be done to add more input or recommendations to the IPM program in the garden.

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APPENDIX A : TREATMENTS DETAIL

Compost Tea

Compost tea is a solution created by extracting microorganisms and nutrients from compost. Compost tea is produced by mixing compost with water and culturing it for a defined period, either actively aerating (aerated compost tea, ACT) or not (non-aerated compost tea, NCT) with or without an additive that is intended to increase microbial population densities during production (NOSB, 2004). In the last ten years methods for making aerated compost teas have been determined and it has grown in popularity in the United States, with global interest also increasing (Ingham, 2005). Compost tea has been demonstrated to be an effective source of beneficial organisms and can help restore the natural function of healthy soil, increase available water to plant roots, and protect roots and other plant tissue from pathogens and diseases (Cascadia Consulting Group, 2001).

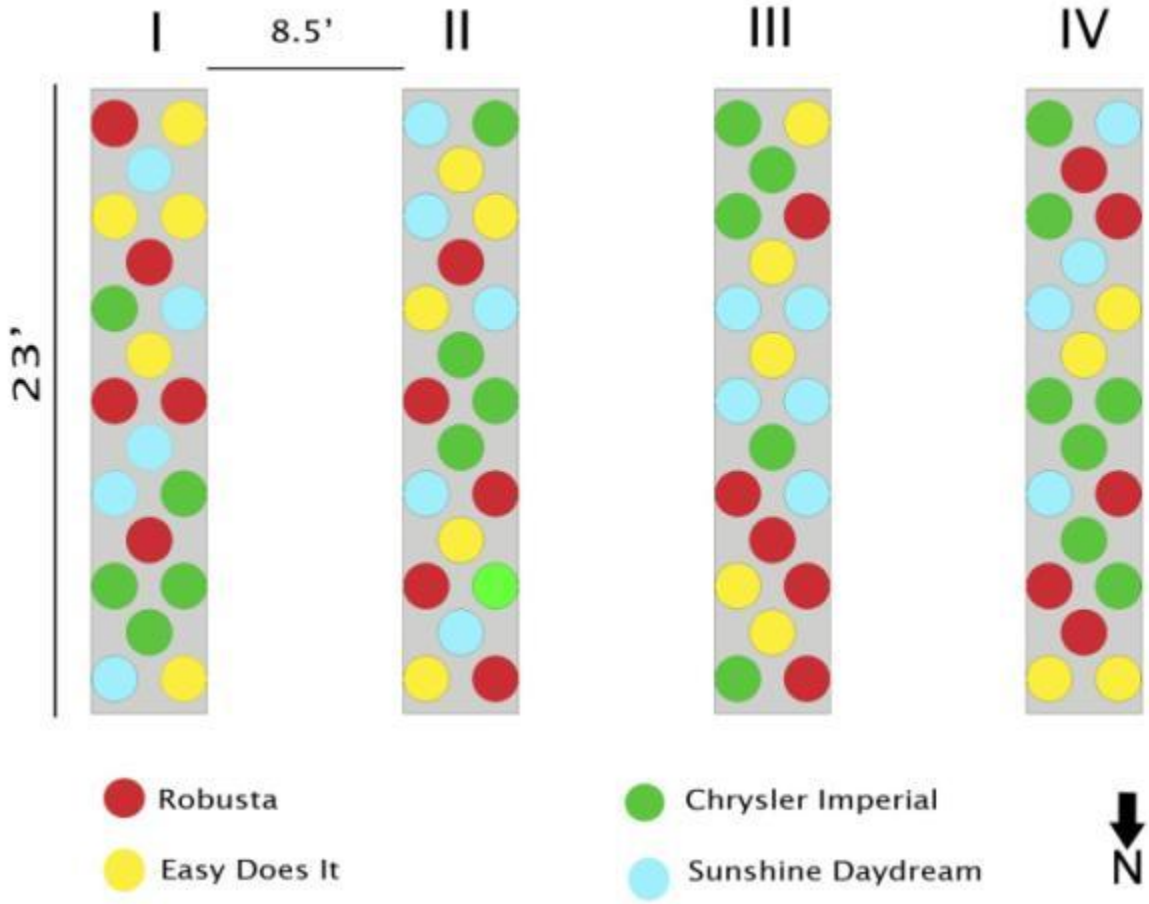
CEASE ®

CEASE is a contact biological fungicide that contains a patented bacterium, *Bacillus subtilis* and is approved by the National Organic Program (NOP) for organic production. It controls common fungal and bacterial diseases on foliage and soil. The bacterial spores occupy space on the plant surface and compete with the pathogens, then active compounds called lipopeptides produced by each bacterium, disrupt the germination and growth of invading pathogens. The benefit of CEASE is its safety. It is exempt from the residue tolerances in food crops, has a 0 day Pre-Harvest Interval, and a four hour Restricted Entry Interval (REI). CEASE can be affected by rain or overhead irrigation, therefore applying it with a spreader sticker (such Therm X^{TM}70) might be needed. It is recommended to spray once a week for prevention when conditions are optimum for disease. The most commonly used rate is 4 quarts per gallon per acre.

Green Cure ®

Green Cure is a potassium bicarbonate-based fungicide that has been proven for 12 years to cure and prevent powdery mildew, black spot downy mildew, blight, mold, and other plant diseases. Potassium bicarbonate is a naturally occurring compound that is widely used in food and is 25 to 35 percent more effective that sodium bicarbonate (baking soda). It is registered for organic production by NOP and provides up to two weeks of preventive protection. It is applicable for indoor plants and has an hour pre-harvest interval. It can be used as a good preventive control for powdery mildew by applying one tablespoon per gallon of water every one to two weeks when environmental conditions are ideal for the disease. One gallon of solution is sufficient to treat approximately 450 square feet.

APPENDIX B : Plot Layout



Plot Treatments

I : Compost Tea

II : Control

III : CEASE

IV : Green Cure

APPENDIX C : Trial Schedule

The schedule was designed for one study period, beginning in April until October 2012. This report covers the observations from beginning up to first week of June 2012.

Month	Week	Control	Compost Tea	CEASE	Green Cure	Documentation	Observation
April	I	PLANTING				√	
	II						
	III					√	
	IV					√	
May	I	√	√	√	√	√	√
	II	√		√	√	√	
	III	√		√	√	√	
	IV	√		√	√	√	
	V	√		√	√	√	
June	I	√	√	√	√	√	√
	II	√		√	√	√	
	III	√		√	√	√	
	IV	√		√	√	√	
July	I	√	√	√	√	√	√
	II	√		√	√	√	
	III	√		√	√	√	
	IV	√		√	√	√	
Aug	I	√	√	√	√	√	√
	II	√		√	√	√	
	III	√		√	√	√	
	IV	√		√	√	√	
	V	√		√	√	√	
Sept	I	√	√	√	√	√	√
	II	√		√	√	√	
	III	√		√	√	√	
	IV	√		√	√	√	
Oct	I	√	√	√	√	√	√
	II	√		√	√	√	
	III	√		√	√	√	
	IV	√		√	√	√	
	V	√		√	√	√	√

APPENDIX D : Measuring Scale of Black Spot

The measuring scale below is modification of black spot measuring of Conard Pyle Company (Star Roses).

<20% susceptible to black spot	0-19% of the foliage is showing symptoms of black spot or has already defoliated
40% susceptible to black spot	lower 40% of foliage is showing symptoms of black spot or has already defoliated
60% susceptible to black spot	lower 60% of foliage is showing symptoms of black spot or has already defoliated
80% susceptible to black spot	80% of the foliage is showing symptoms of black spot or has already defoliated
100% susceptible to black spot	no foliage