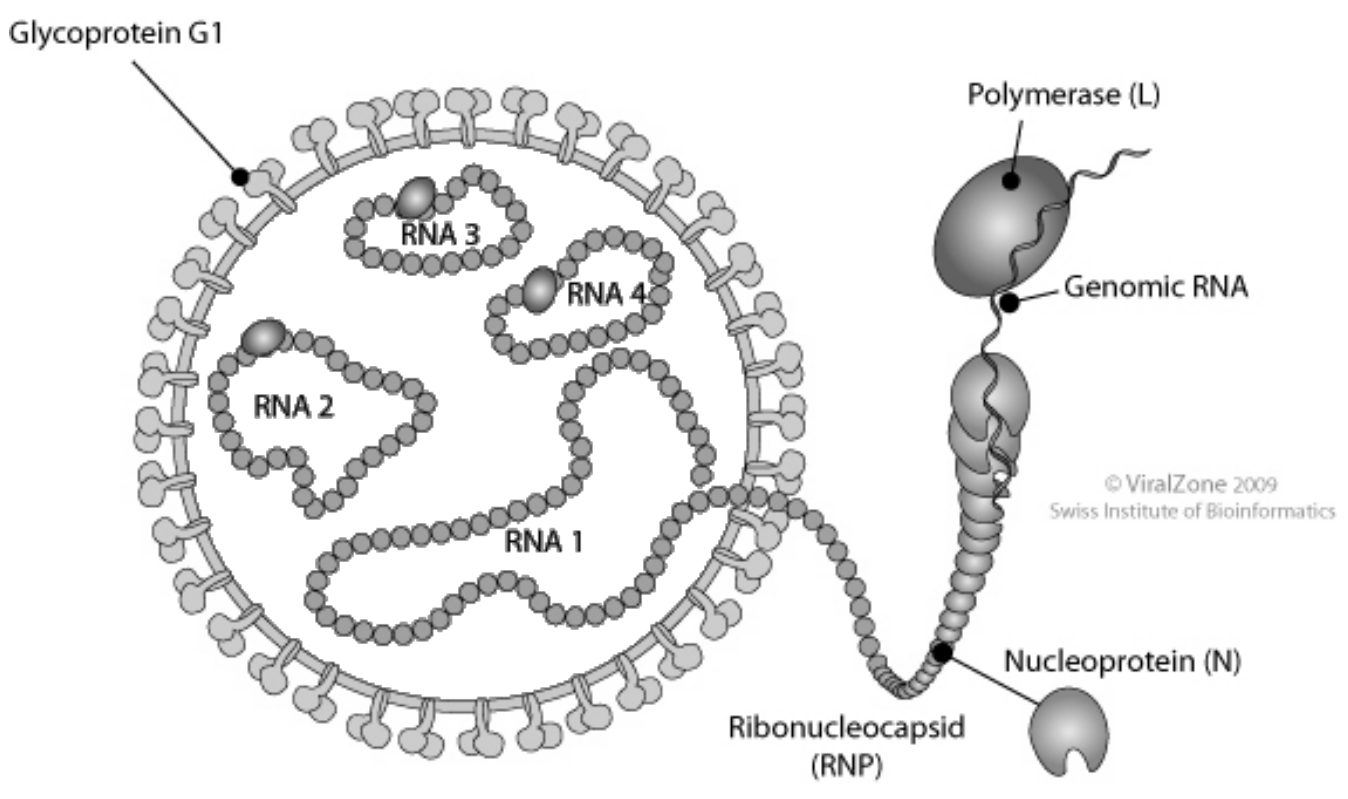


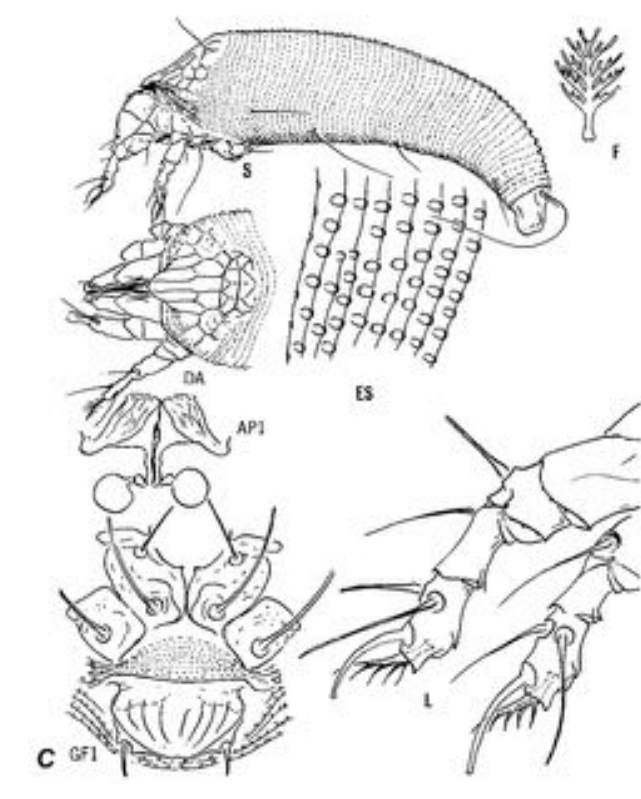


EVALUATION OF ROSE GERMPLASM FOR RESISTANCE TO ROSE ROSETTE DISEASE

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Rose rosette disease (RRD) is a lethal disease of rose caused by *rose rosette emaravirus*. The virion (left) consists of a double membrane-bound body containing 7 negative-sense RNAs. Other members of the emaravirus genus include high plains virus and pigeonpea sterility mosaic virus.



Rose rosette emaravirus is vectored by the eriophyid mite *Phyllocoptes fructiphilus* (Acari: Eriophyidae). This mite is 140–170 microns in length, travels long distances on air currents, and hides in the leaf axils and buds of roses. It can acquire the virus in less than 5 days and retransmit within an hour of feeding.



Roses (*Rosa spp.*) are the only known hosts of RRD. *Rosa multiflora*, a noxious weed and invasive plant in most of the U.S., serves as a reservoir for the virus and its vector. Eradication efforts for *R. multiflora* have had little effect, resulting in the spread of RRD across much of North America.

INTRODUCTION

Rose rosette disease (RRD) is a systemic, incurable, and lethal viral disease of roses. Symptoms may appear within a month of infection and most symptomatic plants die within 1–3 years. RRD has become more prevalent over the last few decades due to the spread of the invasive weed, *Rosa multiflora*, which serves as a reservoir for the pathogen and vector.

Known resistance

There is no known resistance among commercial rose cultivars and the few rose species that have demonstrated resistance are not ideal candidates for introgression of resistance genes into commercially viable cultivars. These species include *R. californica*, *R. carolina*, *R. palustris*, *R. setigera*, and *R. spinosissima*.

Economic impact

Landscape roses are a high-value ornamental with a North American retail market approaching \$1 billion in value (Vineland Research and Innovation Centre).

Symptoms of rose rosette disease

- Abnormal reddening
- Witches' broom
- Leaf and bud distortion
- Thorn proliferation
- Extreme succulence
- Blossom blight
- Shoot elongation
- Stunting
- Dieback
- Plant death

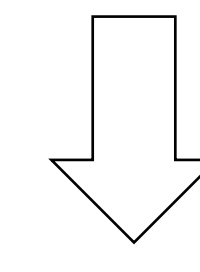


OBJECTIVE

The objective of this study is to identify rose genotypes that merit consideration as candidates in a breeding scheme for resistance to RRD. Additional evaluations of rose germplasm are being conducted at Oklahoma State University, University of Tennessee, and Texas A&M University. Data from all of these studies will inform marker-assisted and conventional rose breeding programs.

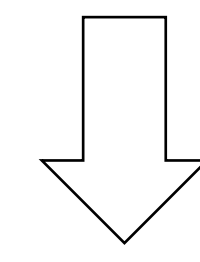
METHODS

151 rose genotypes (3 replicates) planted in a randomized block design in Newark, DE in May 2015



All roses augmented 5 times between May 2015 and October 2016

Augmentation = introduce viruliferous vector mites to field by twist-tying symptomatic shoots of RRD-infected *Rosa multiflora* to actively growing shoot tips of target roses



Symptomatic roses confirmed for RRD with endpoint RT-PCR

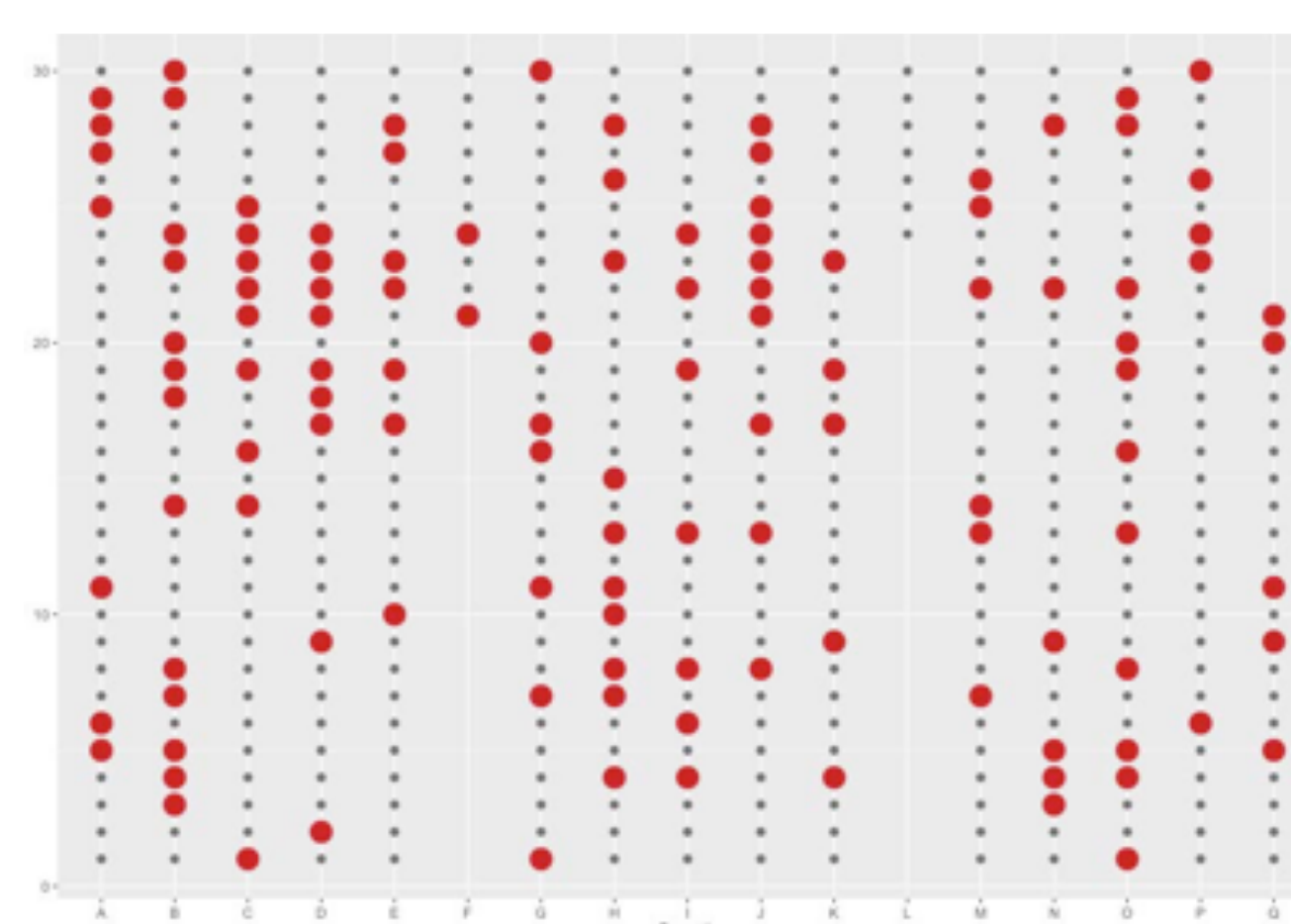


Top left: Aerial photograph of rose plot taken in August 2016. Overlay shows the three replicates of the randomized block design.

Top right: Planting roses in the field in May 2015.

Bottom left: Augmenting a rose by twist-tying a symptomatic shoot of *R. multiflora* (inoculum) to a target rose in the resistance trial.

Bottom right: A rose, 'Mermaid', showing symptoms of RRD.



Left: Depiction of rose field from overhead showing all individuals that have become symptomatic since the start of the trial. Within 18 months of planting 31% were infected with RRD.

• Infected
• Not infected

RESULTS

262-97-4	Francis Meilland	Oso Easy Mango Salsa
89-1	GNIS	Oso Easy Paprika
Abbaye de Cluny	Golden Fairy Tale	Oso Easy Pink Cupcake
Adobe Sunrise	Gypsy	Oso Happy Candy Oh
Amber gem	Hot Cocoa	Oso Happy Petite Pink
Belinda's Dream	I03-4-5	Oso Happy Smoothie
Bonica	Iceberg	Poseidon
Carefree Beauty	Intrigue	Queen Elizabeth
Carefree Celebration	J06-20-14-3	Red Drift
Carefree Delight	Joseph's Coat	Rosa odorata
Carefree Sunshine	Julia Child	Rosa roxburghii
Champlain	Korsteimm	Rosa soulieana
Champneys Pink Noisette	La Marne	Rosa wichuraiana var. poterifolia
Charisma	Laev 17-10	Rosarium Uetersen
CK25	Limoncello	Sally Holmes
Coral Drift	Linda Campbell	Sevillana
Dee-lish	Marmalade Skies	Stormy Weather
Desmond Tutu	Mermaid	Strawberry Hill
Dr. Huey	Miracle on the Hudson	Tahitian Treasure
Dream Come True	MORSoucrest	Teasing Georgia
Ducher	Nearly Wild	Tequila
E02-17-3	ORA 050.07	The Knock Out Rose
Easy Elegance Calypso	ORA 295.08	Tournament of Roses
Easy Elegance Kashmir	Oso Easy Double Red	Westerland
Easy Elegance My Girl	Oso Easy Fragrant Spreader	Windermere
Elle	Oso Easy Honey Bun	Winner's Circle
Eyeconic Melon Lemonade	Oso Easy Italian Ice	Zephirine Drouhin
Fire Meidiland	Oso Easy Lemon Zest	
Fortuniana	Oso Easy Mango Cream	
195-95	G02-2-1	Peter Mayle
2-30-07	J. P. Connell	Purple Pavement
201-98-A	John Cabot	Raspberry Kiss
4-48-07	John Davis	Rosa arkansana
6-91-9	Kordes Perfecta	Rosa bracteata
66-84-18	Lady of Shalott	Rosa carolina
90-1C	Lafter	Rosa foliolosa
90-82	Little Buckaroo	Rosa palustris
American Pillar	Love	Rosa rugosa
Basye's Blueberry	M4-4	Rosa rugosa alba
Basye's Purple	Manetti	Rosa setigera
Brite Eyes	Mevrouw Nathalie Nypels	Rosa virginiana
Caldwell Pink	Michelangelo	Rosa wichuraiana
Carefree Wonder	Moore's Striped Rugosa	Rosa woodsii
Cherry Parfait	Morden Blush	Sir Thomas Lipton
Chuckles	Morden Centennial	Skylark
De La Grifferaie	Morden Fireglow	Sophy's Rose
E02-15-4	Mr. Lincoln	Sorcerer
Electron	Nicole Carol Miller	Star Delight
Fair Molly	Old Blush	The Endeavor
Frau Dagmar Hartopp	Oso Easy Cherry Pie	Therese Bugnet
Fuzzy Wuzzy Red	Papa Hemeray	Winnipeg Parks

85 confirmed susceptible

66 without symptoms (so far)

CONCLUSIONS

Of the 151 genotypes evaluated, 85 were confirmed susceptible to RRD. Many of the remaining 66 will likely develop symptoms as the study continues through 2018. Any roses remaining symptom-free will be assayed to confirm the absence of viral replication. Further research is needed to determine if susceptibility is affected by different RRV isolates or by co-infection with other viruses.