

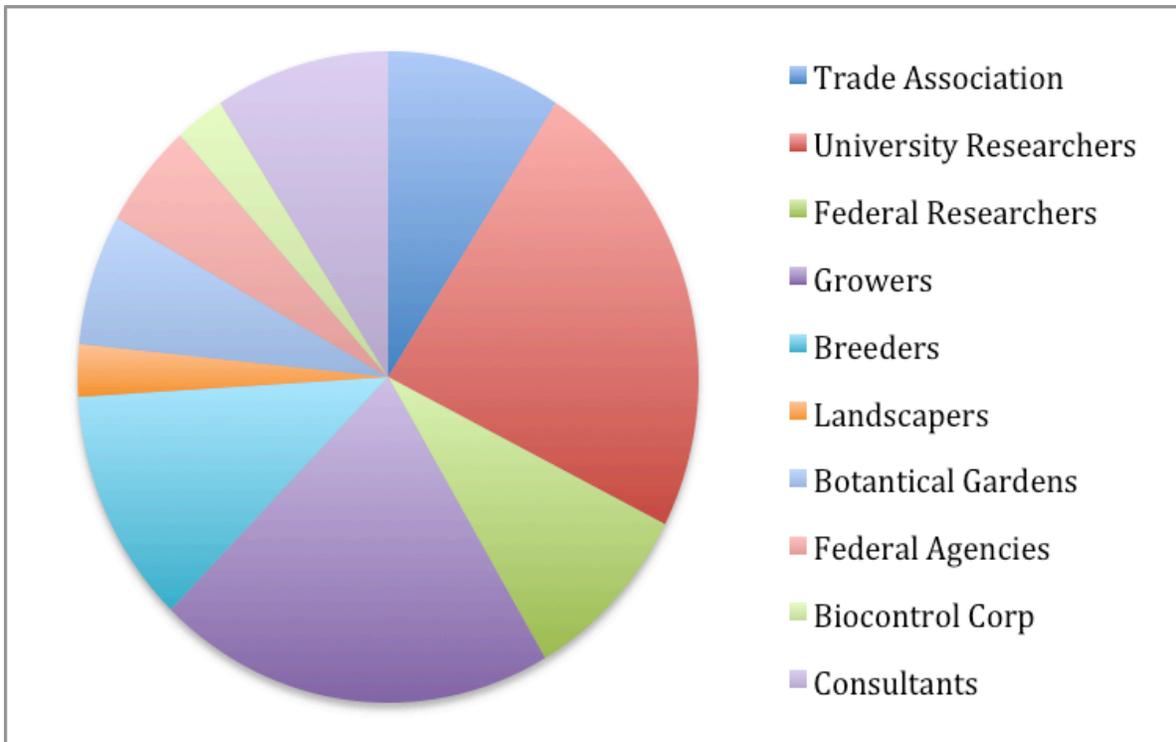
**RRD Summit
April 14-16, 2013
Newark, Delaware**

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Welcome and Summit Overview – Dr. Michael Dobres

Invited participants represent a wide range of stakeholders, each with valuable perspectives on RRD and its current and potential impact on the rose industry. We are looking forward to learning from each other and engaging in robust conversations that will provide direction for continuing work address this important issue.



Our objectives are to explore RRD cause, potential for cure, strategies for prevention, development of resistance, effective early diagnosis

We are going into this summit with three targeted outcomes:

- White Paper on RRD
- Grant Planning
- Consumer & Trade Relations (PR)

Purpose Statement

Manage RRD to eliminate the impact on the rose industry starting today

Prioritized Key Actions

1. Develop best management practices for EVERYTHING. Develop and deliver guidelines
2. Research RRD Virus and Vector Lifecycle
3. Ramp up breeding programs
 - a. Confirm source of resistance
 - b. Robust transformation and regeneration
 - c. Robust molecular marker systems for roses
4. Develop quick, cheap, reliable diagnostic test for RRD to use in lab and field
5. Identify Existing Resistant Varieties
6. Establish “RRD CZAR” to drive effective collaboration via an established structure
7. Create Aggressive Funding program
 - a. State, Federal, Grower Box Tax, University, Extension, Concerned Citizens
 - b. Grant advisor
8. Educate across the three tiers within next two years
 - a. Nurseries
 - b. Wholesale Growers
 - c. Landscape, Maintenance, Homeowners
9. Support a robust information and collaboration web site – multi function
 - i. Educate consumers, retail, nurseries, landscapers
 - b. Share research and experience between lab and field
10. Fight multiflora as an invasive species

Summary of Presentation Discussions

Origin & History of RRD - Dr. James Amrine

General Q&A

Q1. Where did RRD originate? – I believe that it originated on the Rocky Mountain Rosa Woodsii

Q2. How is virus acquired and how long is virus hosted in the mite? – Once acquired from infected plants, the virus is hosted in the mite for life. It is my theory to keep the plants dry so mites may not feed and develop on next the plant... but then the roses would not flower.

Q3. Where does mite overwinter? – It lives in scales at the base of branches and/or inside partially opened buds; wherever the mites can find living (soft) tissue they will winter inside

Summary of table discussions

TABLE #1 – Mary Ann Hansen

Take-Away:

- Need a standard operating procedure that is reliable to detect this virus. Need to disseminate factual information at all levels of production. re: effective control and general information on disease.

Questions/Key Points:

- How prevalent and widespread is RRD in commercial nurseries in the USA?
- Important to survey native rose species and map potential reservoirs of disease and potential for source of resistance

TABLE #2 – Mike Cunningham

Take-Aways:

- RRD originally thought not to go to Hybrid Teas and shrubs; this was original thought when used as multiflora control
- McCarthy Rose is mite resistant Rosa woodsii, no spread from cane to cane beyond the crown
- 2 other species that are immune (R. palustris & R. setigera)
- Infection occurs in soft meristematic tissue

Questions/Key Points:

- Where are stock plants produced?
- Are they infested in grubs, or infested in greenhouse or field?
- Discussion: introduction of RRD in 1980s, reappeared in 1990s, thought not to go to hybrid tea roses

TABLE #3 – Marjorie Hoy

Take-Away:

- Are mites attracted only to diseased plants? re: dispersing to diseased plants and mites avoiding healthy plants?
- Will pruning control disease?
 - At the base?
 - Only removing symptomatic tissue?
- Can infected roots transmit RRD?

Questions/Key Points:

- Does virus move to roots of own root roses?
- Can cuticle thickness deter mites from infecting plants?
- Do Symbionts of mites allow transmission of RRD?

TABLE #4 – Ann Peck

Take-Aways:

- Woodsii may have been the reservoir for RRD in the Western USA before it spread

Questions/Key Points:

- Which came first, the virus or the rose?

TABLE #5 – Tom Evans

Take-Aways:

- Quality of production is #1 control strategy
- Three systems require three different control strategies
 - Production Roses
 - Landscape
 - Natural environment
- “Resistance” is the answer

Questions/Key Points:

- SAR, Phostrol, etc.
- Even field production has different levels
- RRD infected roses are more attractive to mites

TABLE #6 – David Byrne

Take-Aways:

- Natural predators – biocontrol
 - Thrips – alternate feeding, virus vector?
 - Chalcid wasps– multiflora control
- Depth of seed banks – multiflora
- Tight/Restricted original rose (range?)

Questions:

- Other hosts of RRD: Rosa rugosa along eastern seaboard, Rosa eglantaria (sweet briar), Rosa canina (unique symptoms)
- What is true distribution in California?
- Is it seed transmitted?
- How to incorporate water management in control?

Discovery of the RRD Virus – Dr. Robert Martin

General Q&A:

Q1. Isolated virus from mites? – Virus replicates in mites

Q2. How immunogenic is it? – We don't know.

Q3. Focusing on nature of virus, not detection... Why does this virus have such a high mortality rate? – Coming from another host plant where they have co-evolved, creating a severe reaction.

Q4. Have European studies revealed diversity? - Don't know.

Q5. Does the sequence now known support development for resistance? – Yes.

Q6. Have we purified the virus? – Have not yet purified the virus.

Q7. Is it possible the virus and mite synergize positive environment in host? – Yes.

Q8. Is there terminal sequence diversity that will allow you to detect the virus? – Yes.

Q9. Where do you get your clean mites for study, and how do you ensure they are clean? – Use mites from colony of asymptomatic plants.

Presenter Question to group: Are the population of eriophyid mites increasing now versus 15 years ago in commercial crops?

- 4,800 known species and that is less than 5% of what is out there. Likely 100,000 species in plants worldwide, but Jim Amrine has found fewer mites in canes in the last 10 years but species is unknown.
- Marjorie Hoy suspects the changes to mite species come from toxic chemicals in pesticides, and pesticide resilience is increasing.

Summary of Table Discussions

TABLE #1 - David Zlesak

Take-Aways:

- How many RNAs – 8 of them
- How much variability for each of them in sequence is not totally known, so a very conserved region is not known. Number of strains is unknown; look for symptom variations to help identify strains
- Sequence PCR product when starting the protocol in the lab to check accuracy

Questions/Key Points:

- What is the diversity of the virus to develop resistant CVS?
- Can we make antibodies, and who would develop them?
- Can pruning clean an infected plant?
- Can we identify what all the RNAs are responsible for so we can develop a genetic control approach?

TABLE #2 – Ruth Welliver

Take-Aways:

- Need to attack at all levels – breeding, virology, entomology, ecology – so much to do, so little time!
- Virus variability/diversity is important to our understanding of management/control
- Molecular techniques have taken us very far – but cannot use in isolation, or get misinterpretation in results. Identifying that there IS a specific virus is a relief! – now need to understand it, need solid PCR, and a second diagnostic test.

Questions/Key Points:

- We do have a thrips survey right now, in cut flowers.
- Do commercial farming practices result in eriophyid management change?
- In commercial production, are there infected and/or tolerant rose species being traded or moved?

TABLE #3 - ??

Take-Aways:

- Collect isolates from throughout the country and compare with collection from Woodsii
- Even without knowing diversity start plant breeding
- Replication in mites

Questions/Key Points:

- Data on sensitivity of PCR for the virus
- How fast does the virus move from top into the roots?
- Does virus move through progeny from one generation to next?

TABLE #4 – Tyler Francis

Take-Aways and Questions/Key Points:

- At the molecular level, are we looking at the right thing?
- Obvious concerns about asymptomatic plants being introduced to the general public
- History should be important, was the virus introduced to the US?

TABLE #5 - Ann Chase

Take-Aways:

- Basic virus work needed – older methods needed to nail this down.
- ELISA antibody for widespread work. 1 or more antibodies needed

- Disease pressure changes – epidemiology

Questions:

- Is there a secondary host?
- What has changed?

TABLE #6 - Deborah Golino

Take-Aways:

- Not seeing is not always believing. Failure to detect virus does not mean that it is not there.
- Virus population is diverse – we need much more information
- Key to find source of origin – might get handle on diversity

Questions/Key points:

- What is happening with Rose Woodsii?
 - Is this a source of tolerance/resistance?
- Sorbus (Genus in Rosacea) – what is its role as alternate host? Some indication it has an important role.
- Have farming/environmental practices in the last 20 years exacerbated the RRV population?

Distribution of RRD in the United States – Nancy Gregory

Participant Survey

Participant answers to Dr. Gregory's survey of 30 representatives across the U.S.

1. Area of US work?
 - a. NorthEastern 19
 - b. Mid-Atlantic 25
 - c. Central 7
 - d. West 4
 - e. South 7
2. Have you seen Symptoms of RRD in your state?
 - a. YES 25 54%
 - b. NO 20 43%
 - c. Not Applicable 2 4%
3. Have you Seen Symptoms of cultivated rose in your state?
 - a. YES 22 54%
 - b. NO 17 41%
 - c. Not applicable 2 5%
4. Have you confirmed RRD by methods other than visual confirmation?
 - a. 21
 - b. 55
 - c. 11
5. Occurrence of RRD
 - a. Symptoms 18, 42%

- b. Occurrence of the specific mite vector 3, 7%
 - c. PCR 5, 11%
 - d. Grafting 2, 5%
 - e. Not App 7%
6. Have you microscopically identified your *Phyllocoptes fructophillus*
 - a. YES 8, 17%
 - b. NO 46%
 - c. Not App 37%
 7. Do you believe RRD has increased in 5 years in your region?
 - a. YES 23, 57%
 - b. NO 10%
 - c. Not App 33%
 8. If you have seen RRD, which period did you see it
 - a. 2010-2013 6, 22%
 - b. 2005-2009 6, 22%
 - c. 2000-2004 6, 22%
 - d. 1990-1999 6, 22%
 - e. Prior to 1990 3, 11%
 9. Would map data for non-native rose species hold promise in identifying material for resistance breeding?
 - a. YES 19, 54%
 - b. NO 10, 29%
 - c. Not app 4, 11%

General Q&A

Q1. Research/Communication mapping helpful for Research community:

- Wide spread in commercial nurseries
- Acres figures from size of industry from commercial to demonstrate urgency
- Researchers to connect expertise, locations to work
- Full collaboration w/ extension
- Cost benefit analysis is over time
- Protect quarantine system; fear that the rose, national flower, might disappear

Q2. Voids in information

- Data not consistent across regions, better communications
- Disconnect between extension research labs and rose society
 - No obligation for recording unless it is a regulation issue
- CAP Survey – Cooperative A. P.
- Need an Economist to document economic impact on RRD's effect on Rose industry
- Problem with risk analysis – potential economic harm and loss without current action. Quantify know current loss and known future loss.

Q3. Separation of Incidence

- Roundup applications along roadsides look like RRD
- Using Diagnostics
- Herbicides increase bugs
- Need commercial lab with RRD testing service
- Shrub vs. non-knockout/non-shrub vs. documenting size of beds where mites and RRD is spreading
- Host data – by cultivar, not by grower. – Look at density of growth.

Summary: Need Positive Education and Communication

- From Producer, Manufacturer, Wholesaler to Consumers at home

Eriophyoid Mites, Their Biology and Dispersal – Jim Amrine **Biological Control of Eriophyid Mites- Vectors of Rose Rosette** **Disease – Dr. Marjorie Hoy**

General Q&A

Q1. What will it take to start testing?

Q2. Are any companies working on this?

Summary of Table Discussions

TABLE #1 – Brent Pemberton

Take-Aways:

- No silver bullets, no one tactic
- Many biologics haven't been tested
- Protocols may be demanding for end consumers

Questions:

- Can seed chalcids be used for biological control of multiflora rose?
- Can specific thrips be identified for biological control that wouldn't harm roses or other crops?
- Can we translate grower experiences into information for researchers and IR4 for increasing labeled uses?
- Need to determine efficiency of transmission.

TABLE #2 – Karen Rane

Take-Aways:

- Integrated approach is important
- More testing of biocontrols needed on the RRD mite.
- Approach is different for commercial growers versus landscape.

Questions:

- What is efficacy of landscape?
- Would biological control be useful when it is not 100% kill? – Yes, even if suppression is the goal.

- Need more research on biological control organisms (identification) look for them in areas where mites are located.

TABLE #3 – ?

Take-Aways:

- Origin of mites? Endemic or Introduced?

Questions:

- Which predatory mites can be used in greenhouse and nursery? Test soft materials, oils, soaps.

TABLE #4 – Nancy Gregory

Take-Aways:

- Very few researches are looking at eriophyid mite's predators – such as one that feeds on eriophyid as preferred food
- Bacterial or fungal – Grandive – bacterial extract
- Biocontrol as part of overall strategy - cultural

Questions:

- Systemic acaricides – very little known of timing and efficiency
- Native v. Non-native v. introduced
 - Synonymy – muddies the water

TABLE #5 – Tom Evans

Take-Aways/Questions:

- Efficacy data is needed for all materials used for this mite.
- The returns on investment/acceptance for biocontrol management of this mite will be very low for a long time. Likely never with the consumer.

TABLE #6 – David Byrne

Take-Aways:

- Microbes need to be found/tested as biological control
- Predators need to be found/tested as biological control. (woodsii)
- Use of soft chemicals – may be useful
- Host plant resistance/genetic engineering.
- The best microbes predators will be found on Rosa woodsii.

Questions:

- Are phytoseiids good egg predators?

Lessons from Viral Disease of Berry Crops – Dr. Robert Martin

Lessons from Plum Pox Virus – Ruth Welliver

General Q&A

Q1. Funding for PPV clearing? 50 million from grant so over 100 million total investment from outside sources.

Summary of Table Discussions

TABLE #1 – Dave Clement

Take-Aways:

- Don't have to control all viruses to zero however RRD is lethal
- Cross protection with another virus? Transgenic roses? Customer acceptance?
- Can't wipe out RRD; Regulatory will not help with native diseases.

Questions:

- Document or catalog the cultivars that RRD attacks
- Test root stocks for resistance to RRD. Transgenic root stock? Most are on their own roots.
- Thicker cuticle? To prevent penetration by mite.

TABLE #2 – Mike Cunningham

Take-Aways:

- Cooperation – nurseries, researchers, regulators down to individual growers
- Complex problems take creative solutions

Questions:

- Cooperation among neighbors starting by protecting already free areas
- Are there infected multiflora plants that just aren't showing symptoms?
- No fast way of testing multiflora for RRD at this time!
- Possibility of roses in the West as carriers

TABLE #3 – John Hammond

Take-Aways:

- Nurseries vs. Landscape – nursery production easier to control
 - Controls in landscape?
 - Nurseries use other rootstocks – not multiflora rose
- Treat landscape as temporary rather than permanent?
 - Replacement cost...
- Acceptability of transgenic roses

Questions:

- Need commitment to clean stock program – and need cheap, effective test that can be used to implement.

TABLE #4 – Francesca P.

Take-Aways:

- Need to develop a testing tool for RRD (possibly inexpensive)
- Educating people to identify the disease properly (fact sheets)
- We are dealing with a combination of wild populations of rose and cultivated rose, so the approach is much more complicated for eradication versus PPV.

TABLE #5 – Tom Evans

Take-Aways:

- RRD, unlike Plum Pox and Berry viruses. This is a mite problem and a home owner problem.
- Not feasible to implement area-wide monitoring of mites at this time – to what end?
- Let's just eradicate multiflora and educate the public

TABLE #6 – David Byrne

Take-Aways:

- Eradicated PPV but in a small area,
- Multiflora can be regulated by each state
- Be strategic in control protocols
- Should do a survey (PCR) on other species

Questions:

- What would it take to federally regulate multiflora
- Is RRD seed transmitted in multiflora
- Is multiflora a better platform for disease and mite?
- Is hybrid rose a good platform for virus/vector?

Prospects for Breeding Viral Resistance in Roses – David Byrne

General Q&A

Q1. Mechanical Inoculation for screening

- Simple tests have worked
- Some are responsive viruses limited to specific tissue – usually by viral groups
- In tender growth, mite transmission occurs in 17 Days

Q2. How much root grafting of roses? - None.

Q3. Threat to historical roses? - Protect them.

Catalog of roses known to be susceptible to RRD

Purpose Statement Development Notes

Participants developed a unified purpose that they would subscribe to in moving from the Summit into Action. Summary of discussion leading to development of purpose statement:

- Eliminate is more aggressive than reduce; minimize; manage; or control
- Impact covers:
 - Biology
 - Market
 - Consumers
- A multi-level approach is essential
- Reliable, inexpensive, consistent, easy-to-use diagnostics are essential
- Three tiers
 - Wholesale growers
 - Nurseries
 - Landscape, Maintenance, Homeowners
- Urgency: We must target solutions that we can effect in two years. “We do not have 10 years; otherwise we, the growers, are dead in the water.” Bill (grower)

Identificaiton of Key Action Steps:

Researcher Recommendations

1. Develop best managements practices for ALL, including nursery growers
 - a. Need to be written down and developed
2. Breeding Programs
 - a. Confirm sources and levels of resistance
 - b. Robust transformation and regeneration
 - c. Get a robust molecular marker system established for roses
3. Focus outreach in areas of major impact
 - a. Start with most affected areas
 - b. Focus where problems are worst
 - c. Website with support of ALNA
4. Additional research in life cycle of vector and virus; lifecycle
5. Clean Rosa collection for national benefit
 - a. Includes species, germ plasm, as well as commercial cultivars
 - i. In safe area of country
6. Parallel and distinct strategies for current issues (management) and future development (new products)
7. Raise funding from multiple sources

- a. State, Federal, Grower Box Tax, University, Extension
- b. PRIVATE INDIVIDUALS, endowments, gifts
- 8. Engage chemical industry in our fight
 - a. Commercial Diagnostic Labs – those not represented in this conference
 - b. Economists for Risk & Loss analysis
 - c. Entomologist following in Dr. Jim Amrine's path

Diagnostics and Research and Extension Recommendations

- 1. Develop a quick and reliable diagnostic test to be used in lab
- 2. Fast, Easy, Cheap to be used in the field, also
- 3. Develop a SOP for mite collection
- 4. Reliable IPM programs for growers, middle men, and landowners (see Table 1 Researchers)
- 5. New entomologist in an infested area for IPM
 - a. With various kinds of chemical control
 - i. Soft products for homeowners and larger commercial use
- 6. Website to collaborate research, not duplicate
- 7. Education and Outreach
 - a. To homeowners on mite control
- 8. Research on biocontrol of mites in an infested area

Researchers and Regulators Recommendations

- 1. Prepare for War – multilevel approach
 - Education
 - Quick management solutions
 - Knowing the basics
 - Longer term research
 - Political and funding
- 2. Focus on Process and Milestones
- 3. Third Party Certification for clean stock

Growers Recommendations

- 1. Identifying resistance varieties that already exist
 - a. Focus on heavily infected areas
- 2. Grass Roots
 - a. Communication to public
 - b. Set the Record Straight
 - c. Claim official source of info and guidance
- 3. Assure collaboration with an established structure
 - a. "RRD CZAR"
- 4. Strategies to Fight Invasive Plant Species – i.e. multiflora