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*In a Nutshell*
Tulare County

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# Walnut Trees in the Nursery Trade: Understanding Terminology, How they are Propagated, Availability and Clonal Rootstock Pest Interactions

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## Helpful Terminology in Understanding Walnut Plant Material

**Cultivar (cultivated variety)** - A named group of plants within a cultivated species that is distinguished by a group of characteristics, e.g. refers to a vegetatively propagated clone, such as 'Chandler' or 'Howard'.

**Genotype** - The genetic constitution of an individual.

**Phenotype** - An individual's observable characteristics or traits, e.g. flower color, or nut size.

**Clone** - Plants (scion or rootstock) reproduced from a single plant by vegetative methods (grafting, cuttings, layering, micropropagation). Plants produced in this manner have the same genotype as the parent. Variation can exist among clones from a given plant due to their interaction with the environment.

**Micropropagation** - Multiplication of plants under sterile *in vitro* conditions in a lab followed by hardening off in a greenhouse. *Most of the clonal rootstock and own-rooted walnut plant material in the trade is micropropagated.*

**Grafted or budded plant** - A plant whose roots are of one genotype and the shoots (scion) are of a different genotype, obtained by grafting or budding a cultivar onto a rootstock.

**Own-rooted (also known as self-rooted) plant** - A plant whose roots are of the same genotype as the shoots. It is obtained by micropropagation or rooting stem cuttings.

**Seedling** - A plant propagated from seed.

**Plantlet** - A plant propagated by vegetative methods e.g. micropropagation.

**Liner** - A young rooted plant used for transplanting into a nursery row or larger container.

**A walnut plant can be purchased as a:**

- **Rootstock** - A seedling or clonally produced tree, to be subsequently field grafted or budded to the desired English variety (cultivar). Until recently, most rootstocks have been seedlings: seedling black, seedling Paradox hybrid (black x English), seedling English (no longer available). Clonal Paradox rootstocks with selected characteristics are now favored by many growers and are available from many nurseries. They are sold as potted plants or bare root trees.
- **Two-year old tree** - A two-year nursery product where the rootstock grows for a year and the cultivar (English variety scion) grows for a year in the nursery. Nurseries can either bud the rootstock in the fall of year one or graft the rootstock in the spring of year two.
- **June-budded tree** - A one-year old tree with the English variety budded onto the rootstock at the nursery in the spring or early summer. The nursery tree will be much smaller than a two-year tree, however, research and experience have shown that the grower's orchard tree at the end of the first growing season can be as large as or larger than a two-year tree. http://walnutresearch.ucdavis.edu/1996/1996_71.pdf.

- **Own-rooted (also known as self-rooted) tree** - An English variety rooted and grown on its own roots until ready for orchard planting. There is no graft or bud union.

**Availability in Nursery Trade**

**Rootstocks (sold as ungrafted or unbudded trees):** Seedling Paradox, seedling black, or clonal Paradox 'Vlach', 'VX211', or 'RX1' (and possibly other clonal rootstocks).

- Clonal rootstocks are sold as potted plants or bare root trees.

**Nursery Grafted or Budded Trees:** Various English varieties on seedling Paradox, seedling black, or clonal Paradox 'Vlach', 'VX211', or 'RX1' (and possibly other clonal rootstocks) sold as bare root trees.

**Own-Rooted English Trees: '**Chandler' available in 2014. 'Howard', 'Tulare', or 'Serr' available by custom order (one year advance notice required for large quantities).

**Characteristics of available clonal Paradox walnut rootstocks based on available data[1]**

| Trait of interest | 'Vlach' | 'VX211' | 'RX1' |
|---|---|---|---|
| **Rootstock Vigor[2]** | Vigorous | Highly vigorous | Moderately vigorous |
| **Resistance to *Phytophthora citricola* (a cause of crown and root rot)** | **LR** | **MR** | **MR-HR** |
| **Resistance to *Phytophthora cinnamomi* (a cause of root and crown rot)** | **LR** | **LR** | **HR** |
| **Resistance to *Agrobacterium tumefaciens* (cause of crown gall)** | **LR** | **LR** | **MR** |
| **LR** = low resistance | **MR** = moderate resistance | **HR**=high resistance | |
| **Root Knot Nematode** | **S-IT** | **S-ST** | |
| **Root Lesion Nematode (*Pratylenchus vulnus*)** | **HS-IT** | **S-ST[3]** | **S-IT** |
| | Nematode's ability to reproduce | **HS** = highly susceptible<br>**S** = susceptible | |
| | Tree response to nematode | **ST** = some tree tolerance to nematode presence<br>**IT** = tree intolerant to nematode presence, i.e. reduced tree vigor/health in presence of nematode | |

**[1]Based on data from ongoing UC and USDA-ARS trials.**
**[2]In field trials with grafted trees, the vigor of the rootstock isn't necessarily reflected in the vigor of the scion, e.g. sometimes grafted trees on RX1 and Vlach are more vigorous than on VX211.**
**[3] Nematode tolerance due to a post-infection resistance mechanism.**

*Revised February 25, 2014*

## Thousand cankers disease outbreak in Italy places the disease on European Plant Protection Organization Alert List.

*Elizabeth Fichtner, UCCE Tulare County*

In September 2013, thousand cankers disease manifest in the international arena with its report on black walnut (*Juglans nigra*) in both a garden and a timber plantation in northeastern Italy (Figure 1). The disease complex, a combination of a fungal pathogen and insect vector, has proven aggressive on *J. nigra* in the western United States, and affects a range of *Juglans* spp. including commercial English walnut in California (*J. regia*). Based on the observed risk of the disease to *Juglans* sp. in the United States, the finding in Italy incited the addition of both the pathogen and vector to the European Plant Protection Association (EPPO) Alert List. In the EPPO region, *J. regia* (English or Persian walnut) is the most widely grown of the *Juglans* species. In California, the disease is widespread in commercial *J. regia* orchards and survey data illustrating the geographic distribution of the disease in California orchards is forthcoming. The recent finding of the disease complex in Italy clearly indicates that long distance, and even intercontinental movement of these organisms is possible.

Figure 1. In 2013, thousand cankers disease was found in Italy on black walnut. Cankers associated with beetle entry (arrow) are similar to symptoms of the disease in California. This is the first report of the disease in the European Union. (Photos: Lucio Montecchi, University of Padova.

## Thousand cankers disease continues to advance into the native range of *Juglans nigra* in the eastern United States and is associated with a new insect

*Elizabeth Fichtner, UCCE Tulare County*

The thousand cankers disease complex on walnut is thought to originate from the southwestern United States where the walnut twig beetle vector, *Pityophthorus juglandis*, is considered native. The known distribution and epidemiology of the complex continues to evolve as the pathogen, *Geosmithia morbida*, and vector emerge in new geographic areas. Over the past 20 years, the disease has spread in western U.S. states causing extensive morbidity and mortality of eastern black walnut, *Juglans nigra*, planted outside of its native range. In 2009 the disease was observed in commercial English walnut,

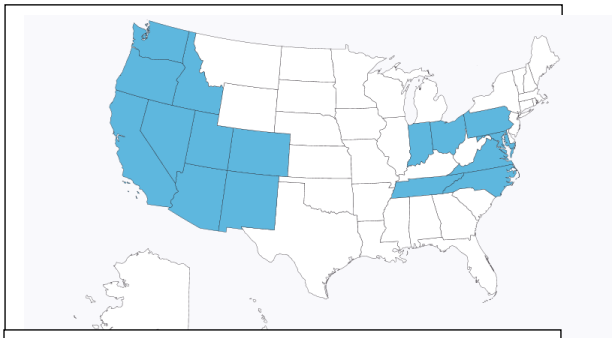


Figure 1. Thousand cankers disease continues to spread in both the western and eastern United States. Blue-shaded states indicate presence of thousand cankers.

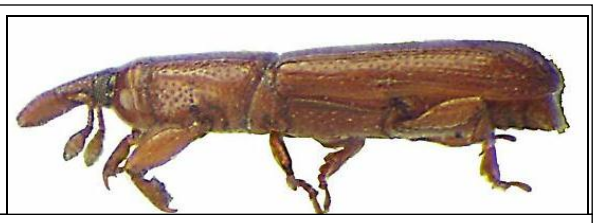


Figure 2. In Indiana, the pathogen was found on small weevils. (Photo: S. Seybold).

*J. regia*, orchards in California and has since been documented in orchards throughout the state. In 2010 the disease was discovered within the native range of *J. nigra*, posing a threat to natural ecosystems and plantations of the high value timber species. Between 2010 and 2014, either the insect or the pathogen for thousand cankers disease has been detected in seven eastern states: Tennessee (2010), Virginia (2011), Pennsylvania (2011), Ohio (2012), North Carolina (2013), Maryland (2014), and Indiana (2014). Figure 1 illustrates the current distribution of thousand cankers disease in the United States.

The Indiana case reported in June 2014 marks the first time that the pathogen has been associated with an insect other than the walnut twig beetle. In fact, the walnut twig beetle has not been found in either Indiana or North Carolina. In Indiana, the pathogen was found on small weevils, *Stenomimus pallidus* (Figure 2), that had emerged from black walnut trees grown in a plantation in Yellowwood State Forest in Brown County.

Even before the advance of the disease to the eastern United States, many states had initiated quarantine regulations to prevent the introduction of wood from infested areas. Recent information on quarantine status can be found at the following website: www.thousandcankers.com

## Pistachio Bushy Top Syndrome

**Randall Laboratory, New Mexico State University**

*Dr. Jennifer Randall 06/30/14*

Good morning from the Land of Enchantment where the high temperature today is a balmy 109°F, but thankfully it is a 'dry' heat.

A summary of the results from my laboratory along with my colleagues on the progress made in regards to the association of *Rhodococcus* sp. with Pistachio Bushy Top Syndrome may be useful as I know many people are confused by some of the reports.

**First, what is Pistachio Bushy Top Syndrome?**

In the last three years, a large number of clonally-propagated 'UCB-1' pistachio rootstocks planted in California and Arizona orchards exhibited symptoms that included shortened internodes, stunted growth, swollen lateral buds, bushy/bunchy growth pattern, and twisted roots with virtually no lateral branching. In California, many of these trees also had stem galls. These stem galls are characterized by having multiple buds arising from the gall. The percentage of abnormal rootstocks within affected orchards varied from 8% to 80% with approximately 30% budding success in the field. Within one to two years of t-budding, many trees exhibited unusual bark cracking around the bud-union. We have termed 'Pistachio Bushy Top Syndrome' (PBTS) for describing the suite of symptoms exhibited by these trees.

**What is the cause of Pistachio Bushy Top Syndrome (PBTS)?**
**The cause of Pistachio Bushy Top Syndrome is at the moment unknown**.

Research efforts by our laboratory at New Mexico State University have found an association of *Rhodococcus* spp. with symptomatic Pistachio Bushy Top trees. However, an association does not mean *Rhodococcus* sp. is the cause of the symptoms. We are currently conducting tests to determine if the *Rhodococcus* sp. is responsible for these symptoms.

**What testing has been accomplished in New Mexico?**

Our laboratory in New Mexico has tested around 300 trees that include field trees from affected and non-affected orchards in California, Arizona, and four independent nurseries. Our testing included DNA analyses from pistachio trees, bacteria isolation and DNA analyses of these bacteria, microscopy analysis including light microscopy, confocal microscopy, and transmission electron microscopy. We found an association of *Rhodococcus* sp. with trees exhibiting PBTS in affected orchards. We are currently testing to determine if these bacterial isolates can cause PBTS symptoms on pistachio trees and other woody tree species.

**What is *Rhodococcus* sp.?**

*Rhodococcus* is a genus of bacteria that contains many related but distinct species. These species are gram positive and their genome has a high GC content. For us scientists, DNA with high GC content means that it is a little more 'tricky' to work with when performing some of our DNA tests and sequencing. Several of these *Rhodococcus* species are environmentally advantageous as they have been utilized for biodegradation of harmful products. However, there are also known pathogens from this genus. These include *Rhodococcus equi*, which affects horses and humans and *Rhodococcus fascians* a known plant pathogen with a broad host range. *R. fascians* was previously known as *Corynebacterium fascians*. Symptoms from this bacterium are often confused with those caused by phytoplasmas, viruses, *Agrobacterium tumefaciens*, and latent hormone effects in nursery settings (Putnam and Miller, 2007). *R. fascians* can be present on plants as an asymptomatic epiphyte (a bacteria living on the outside of the plant that does not cause symptoms) or may gain entry into the plant where it modulates hormone activity, resulting in stunted growth, shortened internodes, bushy or bunchy top appearance, leaf galls, and modified root development. Genetic analyses from our laboratory indicate that we have identified a species of Rhodococcus that is 99% similar to *R. fascians* and another species that is also similar to *R. fascians*. We are performing in-depth genetic analyses of both of these *Rhodococcus* spp.

**What have other laboratories found in regards to this association?**

Dr. Maher Al Rwahnih from Foundation Plant Sciences at UC Davis reported on June 9th that their laboratory had also found *Rhodococcus sp.* on samples from the nursery and from field samples (12 out of 31 trees from the field). His results indicate that the chromosomal virulence gene vicA that he amplified and sequenced was 98-99% similar to *R. fascians*. This matched the results from NMSU.

Melodie Putnam, Oregon State University, reported on June 27th that her laboratory also found the presence of *Rhodococcus fascians*, and *Rhodococcus* sp. from nursery plants. She was unable to isolate *Rhodococcus* from the field samples that were sent to her. They also reported that their results were **negative** when testing for the **plasmid** associated genes that carry the ability to cause disease on herbaceous plants in nursery settings.

**What is a plasmid?**

A plasmid is a piece of DNA that is not part of the bacterial chromosome. Plasmids can replicate on their own, independent of the bacterial chromosome and can be transferred between bacteria. Plasmids can carry important information for the bacteria. For example, the pathogen that causes crown gall, *Agrobacterium tumefaciens*, has a plasmid that is required for pathogenicity. The most commonly studied strain of *R. fascians* (D188), has a plasmid that is recognized to be responsible for pathogenicity in herbaceous plant species. This plasmid has been the focus of study by many groups since the 1970's. The plasmid contains genes that produce cytokinins, plant hormones, that are responsible for shoot proliferation. The presence of the plasmid in *R. fascians* indicates the bacteria may be pathogenic (meaning that it can cause disease and disease symptoms) when it is associated with herbaceous plant species. Plasmids can be unstable and due to different conditions during growth may not be transferred to the next generation of bacteria. Also, in regards to *R. fascians*, studies have shown that leaves can have different populations of *R. fascians* with and without the plasmid. Does the absence of the plasmid mean that it is not pathogenic or virulent on pistachio? Not necessarily. Data shared by private

communication with Melodie Putnam indicates that there are *Rhodococcus fascians* isolates that either lack the plasmid or have major re-arrangements of the plasmid and are still virulent on herbaceous plant species. In addition, the presence of a plasmid is no indication that the bacterium is pathogenic, since non-pathogenic strains may carry a plasmid, and yet lack the genes necessary to cause disease. The *Rhodococcus sp.* we have isolated may be genetically different from the *R. fascians* that infects herbaceous plants. We do not yet have enough information to know whether or not these *Rhodococcus* sp. isolated from these PBTS trees are pathogenic or virulent. We are currently performing in-depth genetic analyses on these *Rhodococcus* spp. The bacterial isolates are currently being tested both at New Mexico State University and Oregon State University to determine if they can cause symptoms on healthy pistachio trees.

We fully understand that many groups and individuals associated with the issue of PBTS are eager for results from the scientific community. We are too! However, it would be both irresponsible and unprofessional to draw conclusions (either positive or negative) on the research prior to completing the experiments, which is why simple precautionary measures such as disinfecting pruning and propagating tools should be suggested to growers during the investigative process until a pathogen can be confirmed or absolutely refuted. Because we are investigating something new, no one knows exactly how long is required or what the results will show. The experiments in progress may take weeks or months to complete and must be performed rigorously and accurately.

UCDAVIS FRUIT & NUT RESEARCH & INFORMATION

University of California Agriculture and Natural Resources

## Advances in Pistachio Production course
## November 18-20, 2014

University of California Cooperative Extension and the Fruit and Nut Research and Information Center are offering the three day extension course, **Advances in Pistachio Production**, November 18th – 20th, 2014. This extension course sets the standard for UC extension courses with a wide array of farm advisor, specialist and faculty instructors representing decades of experience in California pistachio production. Course topics span the full range of pistachio production including tree biology, orchard establishment, pruning, irrigation, nutrition, pest management, harvest and postharvest.

In addition to lectures covering the essentials of California pistachio production, four new lectures have been added this year to address 'hot topics' in pistachio production:

- University of California experts will combine a discussion of pistachio biology, with data from new research projects, to present the latest production recommendations for irrigation under saline conditions. Although pistachio is more tolerant of salinity than most tree crops, excess salinity does affect pistachio tree biology and production.
- Everyone knows the feeling of walking into an orchard, or getting last season's grade sheets, and realizing that *something is wrong*. This is inevitably followed by the question, "How do I fix it?" UC Farm Advisors will provide a new, unique lecture outlining the diagnostic process they use to determine the cause of poor production or tree health.
- Grade sheets are an important tool to measure yield, and understand potential problems in an orchard. UC specialists will review the components of grade sheets in detail, and connect this important postharvest information to future orchard management decisions.

- The success of a pistachio orchard in California is ultimately determined by international markets and exports, even if all other aspects of production are optimal. At the end of the conference, experts will present an updated analysis of international markets, and look into the future for pistachio production.

Participants in this updated course will have exclusive access to the 6th Edition of the Pistachio Production Manual, the first update in seven years, well before it is available for public purchase. In addition to the production manual, participants will receive a bound copy of all lecture slides, the recently published Nutrient Deficiency in Pistachio booklet, and exclusive electronic resources.

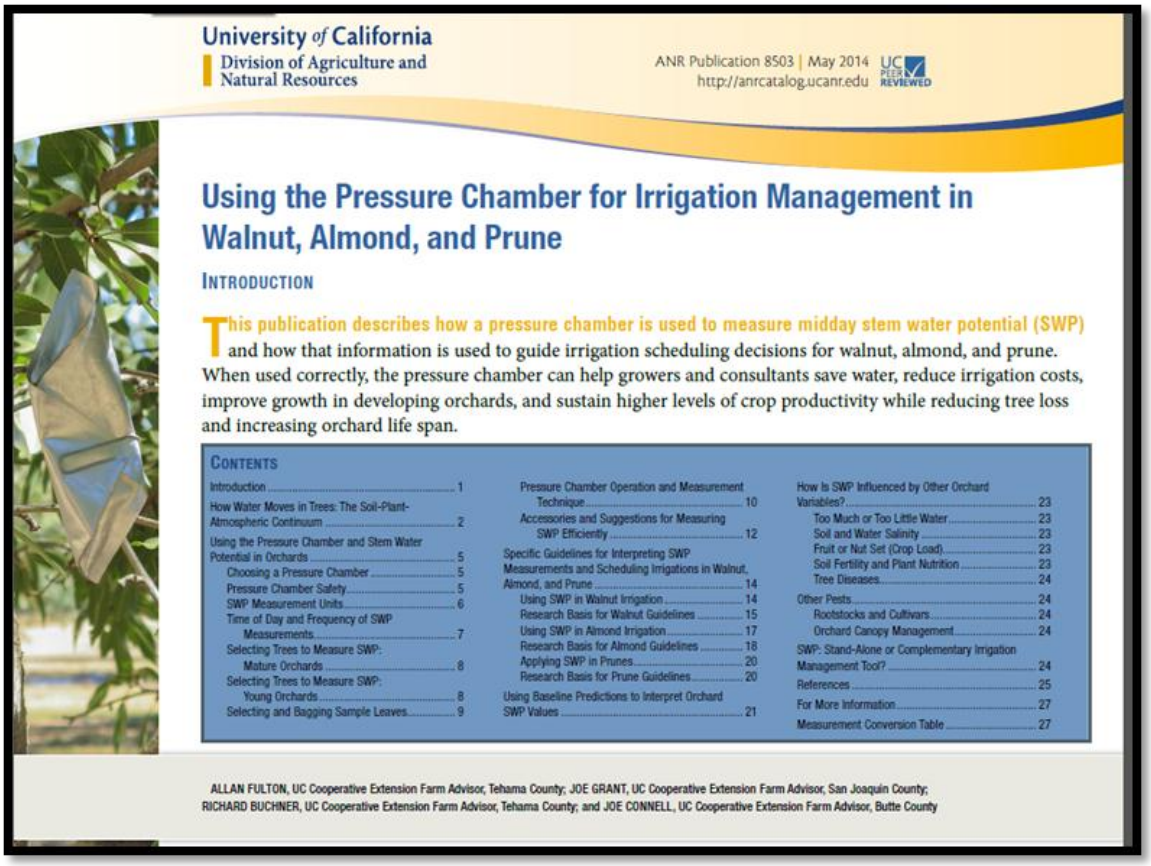
Advances in Pistachio Production will be held at the Visalia Convention Center on November 18th – 20th, 2014.

Enroll now using our online registration survey:
http://ucanr.edu/survey/survey.cfm?surveynumber=13178

## Improving your irrigation management with the use of a pressure chamber

ANR has recently published a peer-reviewed, online-accessible document describing how to use a pressure chamber to measure midday stem water potential. The publication, collaboratively composed by four UCCE Farm Advisors, addresses the selection of equipment, methodology, and application to walnut, prune and almond. It also offers guidelines for interpreting stem water potential measurements and scheduling irrigations within the context of the growth and development of each crop.

To download your free copy of this publication, visit: http://anrcatalog.ucanr.edu



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ANR Publication 8503 | May 2014
http://anrcatalog.ucanr.edu
UC PEER REVIEWED

### Using the Pressure Chamber for Irrigation Management in Walnut, Almond, and Prune

INTRODUCTION

This publication describes how a pressure chamber is used to measure midday stem water potential (SWP) and how that information is used to guide irrigation scheduling decisions for walnut, almond, and prune. When used correctly, the pressure chamber can help growers and consultants save water, reduce irrigation costs, improve growth in developing orchards, and sustain higher levels of crop productivity while reducing tree loss and increasing orchard life span.

CONTENTS




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# In-A-Nutshell

## July 2014

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