Fig Rooting Experiment

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1. Objective

   An experiment was undertaken in October 2008 to quantitatively determine differences in rooting success resulting from different types of rooting stock. Many sources recommend using mature wood, dormant wood or growing tips as stock for propagating figs. Often the information is conflicting and there is not readily available data to justify using one type of stock verse another. Further, many sources recommend a “cooling-off” period for cuttings prior to rooting by utilizing cold storage while others recommend rooting immediately following harvesting the cuttings. My objective with this experiment was to put some of these to the test and determine which sources of stock performed the best.

2. Experimental Design

   2.1. Cultivar

   All cuttings used for the experiment were taken from an ethnic unknown variety of fig named “Bella”. This heirloom fig is a vigorous grower that has been grown since circa 1910 in Brooklyn NY and later Queens NY. It may have originated from the Salerno region of Italy in the towns of Sanza or Teggiano. It was rescued by cuttings in late 2006 before it was destroyed when the home was sold. By best recollection, it bears a dark fig with strawberry to red pulp and is similar to Italian Everbearing. It has been growing in the ground in northern NJ since the summer of 2007 and bore its first crop in the fall of 2008 but did not ripen due to the cool weather.

   2.2. Cutting Stock

   Cuttings were taken of various maturities from the Bella-Unknown cultivar - hard wood cuttings (woody), softwood cuttings (green) and cuttings that were turning woody (partial wood). Other cuttings were taken from the previous season’s growth. Cuttings were taken the first week in October when the season’s growth had nearly stopped. A second batch of cuttings was taken the first week of November when the trees were going dormant, had lost their leaves and had been exposed to several days with temperatures below freezing.

Group	Quantity	Description	Pre-Chill Period	Diameter	Length
A	2	Last year’s wood	None	3/4"	6” - 7”
B	6	Current season’s wood	None	3/8” – 5/8”	6” - 7”
C	2	Last year’s wood	1 week	3/4"	6” - 7”
D	6	Current season’s wood	1 week	3/8” – 5/8”	6” - 7”
E	4	Current season’s green wood	None	1/4" – 3/8”	6” - 7”
F	4	Current season’s green wood	1 week	1/4" – 3/8”	6” - 7”
G	8	Current season’s wood, dormant	1 month	3/8” – 1/2"	6” - 7”
H	8	Current season’s green wood, dormant	1 month	1/8” – 1/4"	6” - 7”
I	8	Current season’s partial wood, dormant	1 month	1/4" – 3/8”	6” - 7”

Figure 1 Experimental cutting Groups.

2.3. Pre-Chill Period

To determine the benefit of using a pre-chill period before starting the rooting process, some cutting groups were put into cold storage. Some cuttings entered the rooting process immediately after harvesting and preparation. Some cuttings were pre-chilled at 38F for one week before beginning the rooting process and others were pre-chilled for approximately 1 month (4 weeks).

3. Methods

3.1. Introduction

There are many ways to root Figs successfully as they readily root when moisture and temperature are controlled properly. The method I used for this experiment is the “traditional rooting-in-a-bag” method employed by many with good results. All measures were taken to try to keep the method constant during the rooting process but inevitably as experience builds results are more favorable. In the following sections I describe in detail the method used recognizing there are slight variations that could be employed.

3.2. Cutting Preparation

Fig branches were chosen of various diameters for the experiment as well as maturity: woody (hardwood) and green (softwood). Using a clean sharp pruner, the branches were cut into lengths of 6 to 7 inches making sure there were at least two or three nodes on each. Any leaves and fruit were removed using the pruner by cutting near their base leaving a slight “stub”. These stubs later fell away naturally.

All cuttings were then rinsed with tap water and cleaned with a sanitizing solution. A mixture of 10% household bleach and 90% tap water was used. The cuttings were allowed to soak in this solution for about 5 minutes and then scrubbed using a toothbrush and the bleach solution. After sanitizing, they were rinsed with tap water and laid out to air dry for 30 to 60 minutes.

Figure 2 - Prepared cuttings prior to beginning the rooting process.

3.3. Rooting Process

Newspaper was used to wrap the cuttings during the rooting phase. A full-size sheet of newspaper (two printed pages) was cut into equal size quarters (half of a printed page). One quarter-size sheet was used to wrap each cutting. The sheets were wet with tap water and all excess water squeezed out so that the paper was damp and not dripping. The sheet was folded so that it matched the length of the cutting and the cutting was loosely rolled in the paper so that air could reach the cutting.

Figure 3 Cuttings wrapped in newspaper prior to placing in bags.

The wrapped cuttings were grouped together in small quantities (four to eight each) and placed inside 1 gallon Ziploc freezer bags and sealed. Some air was blown into the bags prior to sealing. The sealed bags were labeled and moved into the “Nursery” where controlled heat and moisture were used. Some figs for the experiment were prepared in the same manner but stored for varying periods of time at 38F for a pre-chilling period prior to the start of the rooting process.

Figure 4 Cuttings sealed in a bag prior to being placed in the Nursery.

The Nursery was made from a large clear storage tub with a lid and kept out of any direct sunlight. Some water was poured into the tub with a little bleach to keep out mold or algae. A wire rack was placed in the tub and elevated above the water about 1 inch. A seedling heating mat was placed on the rack and controlled with a temp sensor set at 70-75F. The temperature controller has a sensor that was inserted into a rooting container filled with rooting media so that an accurate root zone temperature could be maintained. A temperature and humidity monitor was used to read the Nursery ambient conditions. The ambient temperature was allowed to vary and no supplemental heat was used. The average Nursery ambient temperature ranged from 65-70F. The humidity was kept above 75% by the standing water and periodic misting. Cuttings in the bags were placed against the inside Nursery walls stored vertically with random orientations (cutting ends either facing up or down). Storing horizontally on the mat would result in overheating the cuttings. Cuttings that have already rooted were placed on the mat in rooting media. The lid of the tub was kept open slightly to allow fresh air flow.

Figure 5 The Nursery used for rooting cuttings in bags, rooted cuttings in rooting media and newly potted cuttings.

Under the conditions of controlled temperature and moisture, the cuttings in the nursery started to show root initials in 1-2 weeks. The cuttings were examined every two days during this period to check for initials and for

mold. Allowing fresh air to into the bags and exposing the cuttings to air briefly every other day will help the rooting process and the control of mold. Cuttings that take a long time to root will have a higher occurrence of mold development. Once root initials developed, the cuttings were examined on a daily basis for the emergence of roots. Roots will emerge in 2-6 weeks depending on the variety being rooted. At this stage, both root initials and emerging roots can easily be damaged so care was taken when examining. Once roots developed and were 1/4 to 1/2 inch in length they were moved to rooting media to promote additional root development.

Figure 6 Root initial formed on cutting (white bump at top).

Figure 7 Emergent root prior to planting in rooting media.

For rooting containers, clear plastic 0.5 liter water bottles were used. The bottle tops were cut off and drainage holes were created in the bottom by using a nail heated with a butane torch and melting 1/8-1/4 inch holes. The water bottles provided excellent viewing of developing roots and their compact size allowed for many cuttings to be stored in the nursery because they can be stored closely together. Others have used clear cups of larger size but the bottles met the needs of the experiment well.

When the cuttings were moved from the bags to the rooting media, they were covered as completely as possible leaving only one node exposed above the media. In some cases, more than a node was exposed which is acceptable but can increase the rate at which the cutting looses moisture. For rooting media, equal parts of perlite and vermiculite was used. The media was thoroughly wet with water after planting the cutting and allowed to drain well. After the initial watering, small amounts of water were used (about 1/4 cup) once or twice a week and allowed to drain well. If the Nursery humidity remains high and daily misting is used, watering this way once a week can be adequate. Seeing condensation inside the rooting containers is a good way to verify adequate moisture is present.

Some cuttings developed leaves before the emergence of roots. Other cuttings developed roots but not leaf buds until much later. It is important that there are roots present before moving to rooting media. In some cases, early leaf development will result in rotting or mold of the leaves before roots emerge. When rotting leafy growth was present, it was promptly removed so as not to risk the health of the cutting. In most cases, new leaves formed from nodes even if earlier leaves had been removed.

In some cases cuttings never produced roots or leaves and succumbed to mold and needed to be discarded.

3.4. Rooted Cuttings

Cuttings that rooted in the bags and were put into rooting containers were monitored for root development daily. When good roots were visible on the walls of the containers, the cuttings were potted. An indication for deciding when to pot the cuttings is when thick white roots were present with at least one-level of root branching. Overall root length is not a good indicator of healthy roots – root branching should be present. In some cases, roots will begin to show signs of browning which is a good indication of the start of root rot (from excessive watering) or overheating. When not caught early enough, this browning will result in deterioration of the cutting by wilting and later desiccation.

Figure 8 Good root development showing root branching prior to potting.

3.5. Potted Cuttings

Removal of the cuttings from the rooting containers was done by cutting down opposite sides using scissors. The container was opened by laying it on its side and opening it like a clamshell. The container was then turned to the side so that the root ball would roll into my hand. Much of the rooting media fell away except that which was kept intact by the roots. Care was taken not to disturb the root ball as much as possible. It is

inevitable that some root damage will occur during this process but with care it can be minimized.

The cutting with intact root ball was transferred to 1 gallon nursery pots and covered with potting media at least as high as it was covered before transplanting. If additional cutting length could be covered in soil it was done to help preserve moisture in the cutting. The soil used was made from equal parts of: pine bark mulch, Shultz Aquatic Soil, sphagnum peat moss and perlite. This mix provides for quick drainage after watering and does not compact like typical potting soil so allows for sufficient air to reach the roots.

After transplanting to potting mix measures must be taken to transition the cutting from high moisture to ambient conditions and from limited light into sunlight. Often if only a few cuttings were potted at a time, they were returned to the nursery for one week to provide the added humidity. When several cuttings were potted at the same time, plastic bags were used to cover the cutting and hold in moisture. Holes were cut into the bags to allow for some fresh air flow and the bags were periodically removed to allow the cutting to dry to prevent mold. Once potted, and acclimated to the change in humidity, they were transitioned into sunlight or under grow lights gradually. Transition into the light is important to establish photosynthesis before the developing plant utilizes all its stored energy reserves. Transitioning into the light too quickly will lead to damage to the leaf tissue and likely cause leaf loss. Fertilization was withheld until new growth was well established after potting. Fertilization was done every two weeks using 50% diluted Miracle Grow plant food.

4. Rooting Results

The length of time for each individual cutting to root was recorded. The time was measured from when the cuttings were first brought into the rooting process (controlled heat and moisture) to when the first roots had emerged. For those groups that were pre-chilled, the period of chilling was not counted in the rooting times. Significant variability was observed amongst the groups in both success rate and duration of rooting times.

4.1. Rooting Results

The green wood (softwood) cuttings rooted more rapidly than the woody (hardwood) cuttings and had a 100% success rate. Group H rooted the fastest followed by Group F then Group E. Among these three groups, a clear trend is visible showing that the dormant condition and pre-chill period benefitted the rooting process. The longer 4 week pre-chill period resulted in shorter rooting times and lower variability of the results within

the group (measured by standard deviation). The roots produced by the green cuttings were very fine and produced less root branching then the woody ones. The finer roots resulted in a higher rate of failure of these cuttings in rooting media and later after potting. The thin roots were more prone to root rot, desiccation and damage during the transplanting steps.

The woody (hardwood) cuttings took longer to root and the success rate varied between these groups. The shortest times were recorded for Group G and had 100% success. The longest times were recorded for Group D and Group B. Here the 4 week pre-chill period and dormant condition also seems to have produced better results and less variability in the groups results. For both the green and woody cuttings it does not appear that the short 1 week pre-chill significantly influenced the results. The roots produced by the woody cuttings were much thicker than the green cuttings (approximately twice as thick) and produced much more root branching. The healthier roots resulted in a higher success rate of the cuttings in the later rooting and potting stages. The thicker and more developed roots were less susceptible to root rot, desiccation and damage during transplanting.

Description	Average (days)	Std. Dev. (days)	Percent Rooted	1	2	3	4	5	6	7	8
A - Last year's wood (no chilling)	13	NA	50%	13	X						
B - Current season's wood (no chilling)	60.5	13.5	33%	X	47	X	X	74	X		
C - Last year's wood (1 week chilling)	NA	NA	0%	X	X						
D - Current season's wood (1 week chilling)	66.0	13.0	100%	42	62	67	69	70	86		
E - Current season's green wood (no chilling)	25.8	5.8	100%	19	21	31	32				
F - Current season's green wood (1 week chilling)	22.5	2.1	100%	19	23	24	24				
G - Current season's wood, dormant (4 weeks chilling)	29.8	3.7	100%	27	27	27	29	29	29	31	39
H - Current season's green wood, dormant (4 weeks chilling)	17.1	1.8	100%	15	16	16	16	17	17	20	20
I - Current season's partial wood, dormant (4 weeks chilling)	50.8	9.4	50%	X	X	35	X	54	54	60	X

Figure 9 Rooting Time Results

It is difficult to interpret the results from Group I that were partially woody. The group suffered from significant mold issues that reduced the sample size that actually rooted. From the sample that did survive to produce roots, the results were shorter than the woody groups but longer than the green groups. The results later in the process were lower than the woody groups and more characteristic of the green groups.

It is also difficult to interpret the results from the small sample size of the previous season's woody cuttings (Groups A and C). It was observed that the only surviving cutting from these groups produced the most vigorous grower and the shortest rooting time.

Overall, taking into account rooting times, extent of root branching, yield after transplanting and later growth vigor, the best results were obtained from woody cuttings that were pre-chilled 4 weeks and entering dormancy when harvested.

4.2. Comparison Data

For comparison purposes, data is included for other cultivars that were rooted by the same method. These cultivars were not part of the experiment; the data are approximate times and included only to demonstrate the variability in rooting times between different cultivars. The conditions prior to the start of the rooting process were not as controlled as in the experiment.

Variety Name [source]	Average (days)	Percent Rooted	1	2	3	4	5	6	7	8	9	10
King [KF]	35	50%	35	35	X	X						
Martin's - Unknown [MD]	16	100%	14	16	16	17						
Sal's – EL [MD]	61	100%	45	76								
Armenian [GM]	40	90%	28	30	32	36	38	42	48	48	55	X
Osborne Prolific [JR]	30	83%	28	30	30	31	31	X				
Gillette [RF]	5	100%	5									
Smith [RF]	16	100%	13	18								
Atreano [RF]	13	100%	13									
Ventura [RF]	14	100%	14									
Paradiso (Gene's) [RF]	26	100%	26									

Figure 10 Collected data on other cultivars included to show variability between varieties.

5. Survival Rates for Rooted Cuttings

As noted earlier, the type of cutting stock and rooting behavior influenced the overall success rate of propagation. Data was collected on each group that successfully completed a stage in propagation: root emergence, root development and potting. The conditions and methods were less controlled in the later stages as various techniques were employed in trying to sustain the rooted cuttings. The purpose of this information is to capture some lessons learned and identify what did or did not work and where some potential problems can arise.

5.1. Yield

Although the green (softwood) cuttings rooted with 100% success rate, they failed at a very high rate at later stages. As was previously described, the roots of green cuttings are thin and fragile with less root branching than woody ones. The roots of green cuttings were easily damaged and prone to rot from overwatering when in rooting media. The amount and frequency of watering was varied to adjust for results. It was found that reduced watering supplemented by daily misting was adequate for sustaining these cuttings in rooting media. It was also observed that when roots reached the outer walls of the rooting containers, they could quickly dry out from the ambient warmth or the contact heat from the heating mat. Later in the experiment, a temperature controller with a probe was employed and improved results. Likewise, when potted these cuttings also suffered from more frequent damage.

The green cuttings were observed to be prone to desiccation and/or root rot after potting. The desiccation was likely the result of root damage and not loss of moisture by the cutting. The latter was tested by using “WiltStop” which contains beta-pinene polymer that forms a pliable protective layer to help in moisture retention. Some of the cuttings were sprayed with WiltStop after putting in rooting media and later when put into potting media. No observable improvement resulted from these treatments.

The woody (hardwood) cuttings had a better success rate after root emergence. As earlier described, the thicker roots were more robust and had more levels of root branching then the green cuttings. The woody cutting roots were less likely to be damaged during the transplanting steps because they were more extensive and held a root ball more intact. The roots tolerated more variation in watering and tolerated the contact with the rooting container wall better. The temperature control benefitted these results as well. No differences were observed between cuttings treated with WiltStop and those left untreated.

As can be seen in the table of cutting survival rates, as the techniques were improved the results were better. Later groups G and H are more representative of the yields that can be expected than earlier groups. The contrast between groups G and H demonstrates the differences noted for robustness of the woody cuttings.

Description	Total Qty.	Qty. Rooted	Qty. Potted	Comments
A - Last year's wood (no chilling)	2	1	1	One rooted, potted & thriving. Second lost to mold during rooting.
B - Current season's wood (no chilling)	6	2	1	One failed in rooting media. One potted and thriving.
C - Last year's wood (1 week chilling)	2	0	0	All were lost during rooting.
D - Current season's wood (1 week chilling)	6	6	1	One potted & thriving. Five were lost in rooting media due to rot / lack of root growth.
E - Current season's green wood (no chilling)	4	4	2	2 failed in rooting media. One lost to transplant shock. One thriving.
F - Current season's green wood (1 week chilling)	4	4	4	3 failed after potting. 1 growing well.
G - Current season's wood, dormant (1 month chilling)	8	8	8	All potted and thriving under grow lights.
H - Current season's green wood, dormant (1 month chilling)	8	8	6	2 failed in rooting media, 6 discarded due to transplant shock / root rot.
I - Current season's partial wood, dormant (1 week chilling)	8	4	2	4 lost to mold during rooting. 2 failed in rooting media. 2 potted but likely to fail.
Totals	**48**	**37**	**25**	

Figure 11 Survival Rates at various stages of propagation. Rooted = Cutting produced roots and moved to rooting media; Potted = Roots well developed and transplanted to potting media.

6. Growth Rates

Growth rates were compared for the more successful later groups G and H. Measurements were taken 30 days after average group rooting time. The Group H cuttings were still in rooting media at the time of measurement and the group G cuttings were already potted when measured. It can be seen that the woody cuttings (G) were much more developed then the green ones (H) at 30 days with more branches, leaves and greater overall height. You can also see that leaf development (as measured by overall size) was further along for the G cuttings. The branches that developed were also about twice as thick as the H cuttings. This trend can also be seen in the few surviving individual cuttings from earlier groups and the difference continues beyond 60 and 90 days.

Description	Average	1	2	3	4	5	6	7	8
Group G: Number of Branches	2.1	3	2	2	1	2	2	2	3
Group G: Number of Leaves	8.6	10	11	9	5	10	6	10	8
Group G: Height (in.)	6.7	6	7	7.5	5	9	6	6	7
Group G: Max. Branch Diameter (in.)	0.23	0.24	0.25	0.24	0.24	0.24	0.22	0.24	0.20
Group G: Largest Leaf Length (in.)	2.8	3.1	2.5	1.7	3.4	3.0	3.3	2.4	2.7
Group G: Largest Leaf Width (in.)	3.0	3.1	2.7	2.2	3.6	3.3	3.9	2.7	2.4
Group H: Number of Branches	1.3	2	1	2	1	0*	2	0*	2
Group H: Number of Leaves	2.6	5	3	5	2	0*	1	0*	5
Group H: Height (in.)	2.3	3.0	1.9	2.6	3.0		2.1		1.1
Group H: Max. Branch Diameter (in.)	0.14	0.14	0.14	0.14	0.10		0.12		0.20
Group H: Largest Leaf Length (in.)	1.4	1.3	1.8	1.2	1.3		1.0		1.6
Group H: Largest Leaf Width (in.)	1.5	1.3	1.9	1.3	1.5		1.1		1.9

Figure 12 Comparison of growth rates of woody cuttings (G) and green cuttings (H). * = roots present but no leaf development.

7. Observations

7.1. Mold & Treatment Methods

During the course of the experiment several types of mold or fungus were observed on the rooting cuttings. The first is a fine white "fluffy" mold resembling sparse cotton balls. Generally this mold is easily controlled using a diluted peroxide spray (50% peroxide, 50% water). The peroxide treatment usually eliminates this mold and prevents its reoccurrence.

Figure 13 White Fluffy Mold at Calluses.

The second more aggressive type of mold is green and forms on cuttings usually beginning at nodes or buds. Peroxide treatment is not effective on this type of mold and must be combined with mechanical cleaning. This method must be repeated often as it only staves off this mold for a day or two. Treatment with a diluted bleach solution does a better job of

controlling the green mold but even this only prevents return for a few days. When green mold takes hold on the cutting it is likely near time to discard it.

Figure 14 Green Mold at Nodes.

Thick white mold resembling white paint was also observed. This is a persistent mold but slow growing and is easy to confuse with latex seeping from the cutting. Peroxide treatments are ineffective in removing or controlling this mold. Spot treatment with diluted bleach and mechanical scrubbing are required to remove this mold and slow its return.

Figure 15 Thick White Mold at Nodes.

Finally there is black mold. This usually forms when the cutting is beyond saving and has significant rot. If black mold is present, the cutting should be discarded.

Figure 16 Black Mold forming.

7.2. Other Mold Treatments

Other methods of controlling mold were tried during the experiment with varying degrees of success. The use of ethyl alcohol based "hand sanitizer" for combating mold was tried. The ethyl alcohol damaged the surface of the cuttings causing local desiccation of the cutting. This later led to necrosis and black mold growth. The less aggressive isopropyl alcohol was also tried with some success and this same problem was not observed. Definitive results could not be determined because of the prior use of ethyl alcohol.

A solution made from cornmeal was also tried and performed as well or better than peroxide in controlling mold. Cornmeal has natural anti-fungal properties. Cornmeal was soaked in water for 12 hours and then the liquid was decanted and used as a spray. Cuttings that were treated with the cornmeal spray had infrequent reoccurrences of the “fluffy” white mold and no observance of green mold. Further study using this method is needed to firmly establish its effectiveness but shows some promise.

7.3. Starchy Structures

During the course of the experiment another phenomenon was observed during the rooting stage. When root initials are formed they appear as a small raised bump with a round footprint against the cutting. These are firm vegetative growth when felt. What was observed was a different “starchy structure” appearing very early in the rooting process and then periodically throughout the pre-root emergent stage.

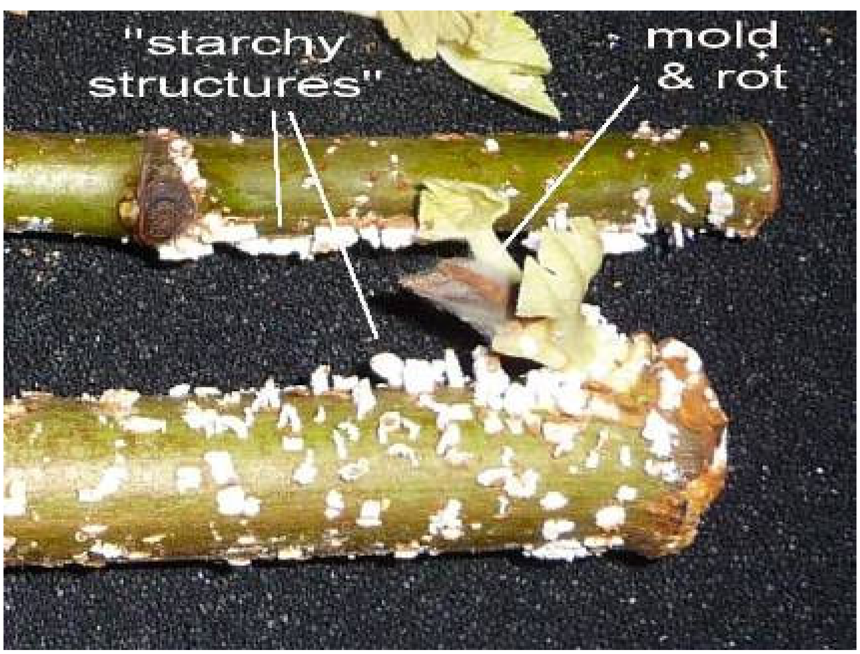

Figure 17 Starchy Structures observed on rooting cuttings.

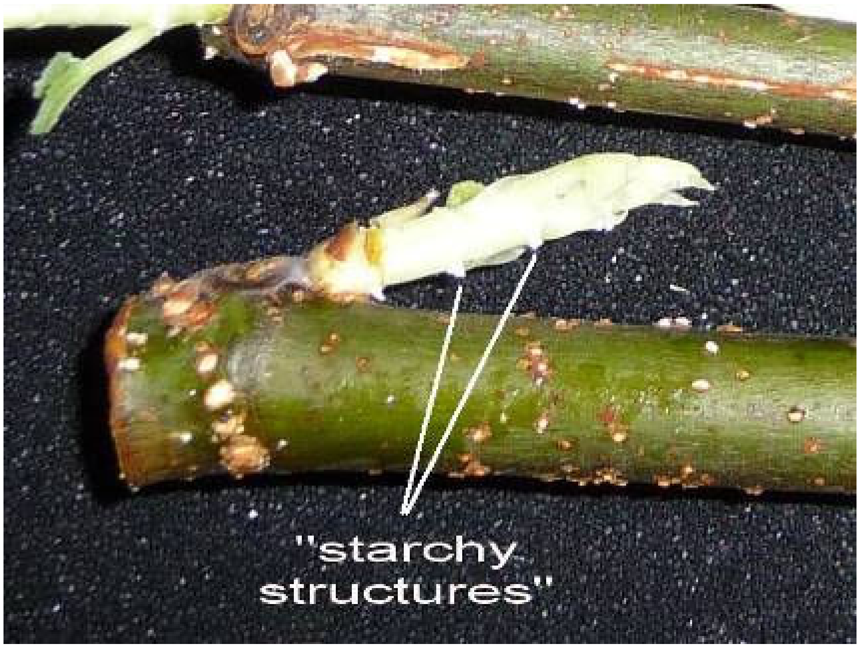

Figure 18 Starchy Structures observed on the new growth of rooting cuttings.

The starchy structures are easily mistaken for root initials when they first appear. As they grow in size, they take on irregular shapes and can flake-off the cutting on their own or when gently disturbed. When closely examined they are found to be soft and almost powdery. They are bright white when they first appear and then later turn brown. These are definitely not roots forming but are some other phenomenon. Some of these structures extend about 1/8” from the cutting but remain flaky and spongy in texture and they begin browning after about a week and stop increasing in size. After cleaning and rinsing it was noticed that they leave behind "scars" on the cuttings. These are hard and brown and are not easily removed. They resemble the callus that forms on the ends of the cuttings. The scars are reminiscent of the "bumps" often seen on growing branches when closely inspected. These starchy structures were also observed forming on the new leaf growth of rooting cuttings.

Figure 19 The scars left behind after cleaning away the unknown starchy structures can be seen along the node and the cutting.

This phenomenon is extensively observed on the Bella cuttings but only infrequently observed and not prominent on other cultivars rooted by this method. Therefore, I conclude that they are not an artifact of the process itself but maybe an excretion of some sort from the cutting.

8. Lessons Learned

8.1. Rooting Stock Condition – the condition of wood chosen for cuttings directly affects the results. If the wood is damaged by cuts or scratches there will be a higher instance of mold and rot during rooting. Likewise, if there are a lot of buds or branching at the nodes there is a higher likelihood of later mold development

8.2. Wrapping Cuttings - Using newspaper to wrap the cuttings during rooting resulted in lower occurrence of mold when compared to using paper towels. Only dampen newspaper and wrap the cuttings loosely to allow air to reach cuttings.

8.3. Removing Figlets – Sometimes small figs will develop when a rooting cutting begins to leaf-out or when it is very young. It is best to remove these figs to conserve energy for the growing cutting.

8.4. Mold Reduction – For cuttings that take a longer time to root, periodically replacing the newspaper and bag can help reduce the occurrence of

mold. Periodically letting some fresh air into the bag and/or letting the cuttings dry a while will also help.

8.5. Removal of Leaves During Rooting – A rooting cutting will sometimes leaf-out before roots develop. This is normally ok but after sometime the leaves are likely to begin rotting. Remove any rotting leaves and return the cutting to the rooting process. Acceleration of the rooting process by leaf removal was not observed.

8.6. Presence of Root Initials – The presence of root initials should not prompt one to transfer the cutting to rooting media. The success rate is improved when waiting for true roots to develop at least 1/4" before transferring.

8.7. Root Damage After Root Emergence – Emerging roots are very delicate and will not regenerate after damage. Care should be taken when examining cuttings during rooting and when moving to rooting media and potting media. If emergent roots are damaged, wait until new roots are formed elsewhere on the cutting.

8.8. Planting in Rooting Media – It is best to cover as much of the cutting as possible when transferring to rooting media to preserve moisture in the cutting. It is good practice to leave at least one node above the soil line but this is not necessary if moisture is controlled well.

8.9. Watering in Rooting Media – Good drainage is needed when cuttings are in rooting media. Excessive water will promote root rot. Limiting water is good practice and often daily misting and once-a-week drizzling with water should be adequate.

8.10. Good Root Development – Once good roots are seen in the rooting container, and at least the first level of root branching is apparent it is a good time to transplant to potting media. Healthy roots are bright white and sometimes translucent. Any browning of roots is a sign of the beginning of root rot. When browning is observed, immediately move to potting media and restrict water until new growth is established. When root rot starts, the cutting will rapidly deteriorate and is not likely to recover.

8.11. The Presence of Leaves Before Potting – Although it is desirable for leaves to be present when transplanting to potting media it is not necessary. Good root development is more important than leaf development at this stage.

8.12. Retention of Root Ball When Potting – It is best to retain as much of the root ball as possible when transplanting from rooting media to potting media. This will reduce the extent of root damage incurred during this

process. Any loose rooting media not containing roots should be allowed to fall away if possible without risking damage.

8.13. Promoting Root Development – After roots are present, reducing the temperature of the root zone by removal from bottom heat will aid in promoting root development. Humidity control and introduction to light should be the focus at this stage.

8.14. Controlling Humidity After Transplanting – After a cutting is moved from the humid environment of the nursery to ambient conditions, the use of a humidity “dome” is helpful until new growth is established. A humidity dome can be easily made from an inverted clear plastic bottle or plastic bag. It is important to cut some holes in the dome to allow in fresh air to combat mold. Periodically removing the dome for short periods of time is also helpful.

8.15. Introduction to Light – It is important to gradually introduce new cuttings to light slowly. Even direct sunlight in a window can result in damage to young cuttings. It is important that the transition into sunlight (or grow light) is done as early as possible. Photosynthesis must be established in the plant to sustain it before the stored energy in the cutting is consumed.

8.16. Hardwood Cuttings Produce Better Results - I found that the thinner green cuttings produce poorer results. I suspect than the thinner cuttings have three major disadvantages when compared to the woody ones: (1) the roots are finer and more prone to root rot; (2) there is less stored energy to support the cutting's growth until photosynthesis can be established by introducing to light; and (3) the thinner cuttings are more prone to moisture loss and desiccation.

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