

Ficus religiosa - New Crop Summary & Recommendations

By Colin Doherty

2012

Series: New Floricultural Crops: Formulation of Production Schedules for Wild, Non-domesticated Species

Part of the requirements for
Horticultural Science 5051: Plant Production II
University of Minnesota

Colin Doherty

HORT 5051

24 April, 2012

Everything You Need to Know About
The *Ficus religiosa* and Growing it for Bonsai
New Crop Report

The word “bonsai” brings to mind an image of a small potted tree. In fact, the word bonsai has Chinese origins, “bon” means pot and “sai” translates to “tree.” However, what many do not realize is if these small trees were not “trained” as bonsai for shape with their growth restricted by pruning and the small pots they are potted in, they would most likely become very large trees. The *Ficus religiosa* which is the subject to this report is such a tree. To the purist, bonsai is a horticultural art that manipulates or “trains” a young tree often over a period of many years until it becomes a work of art governed by ancient standards of size, style and design. To others, the word bonsai has a looser interpretation it can be a small, immature specimen of a tree in a small pot or bonsai tray represented as a miniature bonsai. The purpose of this report is to investigate and discuss the feasibility of producing these trees for sale. The report addresses growing the plant as both a simple miniature bonsai or as a more developed starter bonsai tree. The reader will see that although the propagation and initial growth from plug to plant of a miniature tree or as starter bonsai is the same, the grower whose target market is the true bonsai community will need a considerably longer time and a greater

financial commitment as well as a much higher horticultural skill level to bring this plant up to the standards of the bonsai artist.

Taxonomy:

The *ficus religiosa* is a large dry-season deciduous or semi-evergreen tree. It is in the family Moraceae often called mulberry or fig. Moraceae are either monoecious or dioecious flowering trees, shrubs and lianas (vines), comprising of 40 genera and 1,000 species, nearly all with milky sap. A synonym for the *ficus religiosa* is *Urostigma religiosum*. The tree has many common names depending on the language spoken where it is grown. It is called the sacred fig, bo tree, peepal, and bohdi tree.

Geographic distribution:

Ficus religiosa is native to India, Nepal, Chad, Thailand, and Southwest China, and Southeast Asia east to Vietnam. However, the species is believed to have originated in India after which humans introduced the tree to the other Asian areas. The tropic of cancer at 23.5 degrees north cuts India in half and passes through southern Asia. The region just above this latitude is the subtropics, below is the tropics. The tree is found as far north as subtropical Katmandu, Nepal at an elevation almost 5000 feet and as far south as the tropical mountainous area of Kerala on the southwest coast of India. (Orwa et al.2009) The tree most likely entered this country in the early 1900's, when a Buddhist monk brought a sapling to Hawaii, while traveling there to do missionary work. The very tree still lives in the Foster Botanical Garden in Honolulu and is considered the oldest of its species in the United States. The tree continues to be cultivated on the island of Maui as a landscape as well as potted tropical plant. Later, it was introduced for the same uses to Southern California, South Florida, and Puerto Rico and South

Africa. (Orwa et al.2009) In the late 1930's the tree was introduced in Israel. (Galil, 187) With the exception of Israel where the tree has naturalized it has little or no chance of becoming invasive or naturalized in most areas in which it has been introduced. It remains a non-native plant unable to reproduce itself without human help. This is because its seeds are sterile unless they are pollinated by a specific pollinator wasp that not present in most areas to which the tree has been introduced. This will be discussed in greater detail in a later section.

Native habitat

The *ficus religiosa's* native habitat is the monsoonal areas of South and East Asia. In mid July to September the climate is characterized by warm, windy and intense periods of rain causing flooding and lasting for weeks. In March though June the weather is generally cooler, but dry and dusty. During winters in Katmandu, Nepal the tree survives just below freezing winter temperatures. The tree is found in woodland areas in both the subtropical and tropical zones and shares the forests with many other trees and exotic plants such as the banyan Tree and palm tree.

Taxonomic Description:

Ficus religiosa is a large tree and can grow 65-70 feet tall and 5-6 feet dbh. It has an irregularly shaped habit, with wide-spreading branches. The trunk is regularly shaped, and thick, often with large low shallow buttressed roots, which grow out from the base of the trunk. This is an adaptation to growing in soil that is very poor, with nutrients available mostly at the surface level. These extended roots increase the area over which nutrients can be absorbed from the soil. Unlike most of its fig relatives, the *ficus religiosa* does not generally form aerial or adventitious roots from its branches. The bark of the plant is smooth and gray with brownish

specks, exfoliating in irregular rounded flakes. The leaves are alternate, spirally arranged, broadly ovate, glossy, leathery, and dark green when mature. They are 6-7 inches long by 3-4 inches wide, with unusual tail-like tips. The leaves are pink when they first emerge. They are base-cordate or heart shaped attaching to the petiole at a notch in the base. The petioles are slender and 3-4 inches long. The fig is a “false fruit” in which the flowers and fruit grow together to form a single mass. This mass, the fig or syconia is rolled inward like a shell with many small flowers arranged on the inner surface. The actual flowers of the fig look like fleshy threads each bearing a single seed and cannot be seen unless the fig is cut open. The fruit or fig develops in pairs, begin green and ripen to purple and are about a half inch in diameter. (Shiell, 1993, pg 98)



A mature tree, leaves and fruit

The plant often begins life as an epiphyte, its seeds germinating and growing on a host tree or in some cases in cracks in walls. However, it can also germinate and grow in ground soil. When seeds are dropped on other trees, most often by birds and other wild life the plant will

grow relying on the host only for anchorage. The *ficus religiosa* does not at first parasitize its host, and gets its nutrition from the air and rainfall. However, this epiphyte plant can exhibit some interesting behaviors in terms of root development that will eventually parasitize the host tree. In its natural monsoonal habitat, the plant most often attempts to send its roots into the stem of its host. This sometimes splits the trunk of the host. While it is rare that it succeeds in getting its roots all the way to the ground, this is most likely an evolutionary adaptation that protects its roots from the hot dry season. When epiphytic germination occurs in less hostile habitats such as Israel, the roots do not need protection and the plant will send its roots in circles around the outside of its host. (Galil, 1983)



A epiphyte *Ficus religiosa* with its roots wrapped around a palm tree

The *ficus religiosa* has several medicinal uses by indigenous people. Its leaves are known to treat dysentery, its seeds urinary ailments, its bark is said to have antibiotic properties against staph and e-coli bacteria while its sap is used to remove warts and its roots to heal gum

disease. Its bark is also used in tanning leather and its wood is consumed for firewood. Finally, its leaves are used for fodder for animals as they have 10-14% crude protein. (Orwa et al 2009)

One of the interesting facts about the plant is that although it is monoecious plant, it cannot fertilize itself. Pollination and fertilization of its seeds is accomplished through a mutual relationship that has evolved over millions of years with a tiny, short lived female fig wasp species of the Agaonidae family, the *blastophaga quadraticeps*. Amazingly, it is this one species of over 650 described species of fig wasps that is sole pollinator of this species of fig. Pollination does not occur passively or by the wasp carrying pollen she picks up on her extremities. The fig wasp actively collects pollen in specialized pouches and deposits it on another tree's flowers seemingly by choice when they lay their eggs. The wasps, in turn have a place inside the fruit to lay their eggs and nourish and support their larvae until they emerge as adults. The female wasps however sacrifice themselves to enter the fig. The wasp loses her wings and antennae as she forces her body into the small narrow passage. Jander and Herre report on a study to determine what happens if a non-pollinating wasp enters a fig flower. In some, but not all cases the tree will react and “punish” these wasps by dropping that particular fruit. While all species of ficus studied did this to some degree, the *ficus religiosa* was less apt to do this. The result of this tolerance for non-pollinating wasps directly affects the amount of viable seeds produced by the tree. (Jander and Herre, 2010) In most areas of the world where the tree has been introduced, the tree cannot propagate itself because its pollinator wasp is not present. However, in Israel, as *Blastophaga quadraticeps*, has successfully invaded and established itself, the tree has naturalized, producing seedlings near irrigated areas that have become exceptionally moist microhabitats for several decades. (Galil and Eisikowitch, 1968)

Another interesting fact and more important in terms of a horticultural niche for the plant as bonsai-like or authentic bonsai tree is its religious significance to two of the world's most predominant religions, Hinduism and Buddhism. More than 2500 years ago, Siddhartha is said to have attained the Supreme Enlightenment, or became Buddha, while sitting under the Bodhi in Bodh Gaya, India. The tree is one of the earliest Buddhist symbols and objects of reverence. According to the Buddhist scriptures, people asked the Buddha whom should they pay respect to when he was absent and he told them that they should pay respect to a Bodhi tree. While the original tree called the *Maha bodhi* no longer is alive, its prodigies and their descendants have been propagated by cuttings and saplings to become temple trees all over the India. In 288 B.C., a sapling from the first tree was brought to Sri Lanka, becoming the Sri *Maha bohdi* tree. It is still living and is the oldest living human-planted tree in the world. One of its saplings was returned to the site of the original tree over 120 years ago and is now growing where its sacred ancestor once stood and is pictured below.



The Hindus also worship and the *Ficus religiosa* which they call the peepal tree. There are several references to this in Hinduism. Some say that when the demons defeated the gods, Lord Vishnu hid himself in the peepal tree. The tree is a symbol of Vishnu, the supreme god of Hinduism. While another belief is that the tree represents the Timturi, or the Hindu trinity of

the cosmic forces of creation, maintenance and destruction. The roots of the tree are Brahma, the trunk Vishnu and the leaves Shiva. Still another belief is that Goddess Lakshmi also inhabited the tree. Because she is among other things, the goddess of fertility, women worship the tree to bless them with a son tying red thread or red cloth around its trunk or on its branches (<http://www.religiousportal.com/index.html>)

Name and Description of Varieties/Cultivars on the Market:

It is not known if there are any cultivars or varieties on the market. It is very unlikely that any exist.

Propagation Methods:

Ficus religiosa is most often propagated from cuttings. Air layering and tissue culture techniques are also used. However, seed propagation was the subject of this experiment. There are several anecdotal online references on to how to germinate and grow a *ficus religiosa* from seed. Mostly on gardening blogs, however there is really not much horticultural information available. There was however a common thread, these are very difficult to germinate due to all the factors that affect the seed viability; fertilization, storage method in terms of temperature and moisture retention and age of seeds. B-and-t-world-seeds.com listed these seeds as a “short viability seed” indicating a very short window of 6 months for availability and as the seeds would come from India; the time from order to delivery would be lengthy. (B&T World Seeds, Personal communication, 3/15/2012) The seeds would take anywhere from 2 weeks to 30 even 90 days to germinate if at all. Seeds with such short viability most likely do not have dormancy issues. It is obvious why cuttings are by far the most common way to propagate this tree, this propagation method would be the best way to achieve a

planned production schedule as compared to the erratic and inconsistent germination of its seeds and extremely slow growth of seedlings.

Crop Ideotype:

The ideal phenotype for the *ficus religiosa* for starter bonsai is approximately 12-24 inches tall with contained, strong established rooting and branching. The tree to be sold as a simple miniature bonsai could begin to be sold as small as 6-8 inches.



Miniature “bonsai style” tropical plant potted in bonsai style tray



The above pictures are two starter bonsai *ficus religiosa* plants grown from seed, 3-4 years old and 12-16 inches tall. These trees are kept in small pots to keep them small for training as a bonsai and have developed a strong trunk and buttressed roots. Acceptable starter trees have already been pruned to have some bonsai attributes.



In this picture a large *ficus religiosa* in Thailand. It has been trained in a “formal upright” style. The style has a straight trunk that mimic how the tree grows in nature. The men in the picture give an indication of the size to which this 25-30 year old tree has been contained through restricting the size of the container in which it is grown.

Market Niche:

To determine if there was a niche for this plant, I researched existing sources and possible competitors in the market place for these plants. I interviewed a representative from an online source for the plant, www.rareplants.com (personal communication, April 2, 1012) that had the plant listed on their site, but it indicated that they were not ready for sale yet. He told me that the plant has had a sudden increase in popularity and their sources have not been reliable. They were getting most of their stock as cuttings from growers in India. Due to the lack

of supply, they were propagating their own through cuttings that will be ready in about 6 months. He told me that they are used as an indoor tropical plant and confirmed people are buying them for bonsai. The tree he told me has limited potential as a bonsai due to its larger leaves, but it can be designed and trained into a larger shaped bonsai around 2 feet. Primarily, people want them because of the religious symbol the tree is for both Buddhists and Hindus.

The plants being grown in their Ohio greenhouses I was told require supplemental as well as longer days of natural lighting and would have a growth spurt soon as the days get longer. In six months, the cuttings would be 8-10 inch plants. (Personal communication, April 8, 2012) This is an indication of the timing for a crop schedule based on propagation by cuttings. I also spoke with a second representative from another web source for the plant www.bohdinursery.com. He was very “secretive” about their production, evidently not wanting to help any “competition”. He did tell me he thought he was the only source in the U.S. for this plant which they propagated from seed, which I determined not to be the case. However, he was not willing to give me his seed source. He did say that they have a 30-40% germination rate and that the seeds must be very fresh to be at all viable. There are many “tricks” to germinating and growing, however he was not going to share them. He did confirm that they start out very slow and in 8-10 months are ready for sale in 4” pots at about 6 inches in height. (Personal communication, April 5, 2012) His reaction to my questions gave me more evidence that there may be a potential horticultural niche for these plants.

I believe there is a possibly developing market niche for the *ficus religiosa*. The tree can be grown year round in controlled greenhouses, so production during any season is not an issue. While consumers and growers of tropical plants are very familiar with its relative, the

ficus benjamina and will readily identify the *religiosa* as species of ficus, most will not be familiar with this species. It is apparent that the plant has much competition especially for use as a bonsai. It must compete with other species of ficus as well as a myriad of other trees used for this art. To be sure, the western bonsai community will need some convincing. However, *Bonsai & Stone Appreciation Magazine* (2010) reported that it is often used for bonsai by Indian bonsai artists. Perhaps one of the reasons it is not more widely used is the limited supply in the west. There is definitely a limited amount of suppliers and there is the indication they have no problems with demand. I do however, believe that the primary market would be for the plant grown as a simple indoor plant in a bonsai container and secondly as a starter plant for the bonsai artist. Due to the length of time and hands-on painstaking care and expense it takes to grow into a 12-16 inch tree, prune it to encourage bonsai attributes and allow it to develop a thick trunk and buttressed roots to be ready to sell as a starter bonsai, a grower most likely could reap some financial benefits from growing some of these plants for simple indoor plants ready for market in 8-10 months while keeping the best and highest quality plants for the 3-4 years necessary to reach the size and maturity for use as a starter bonsai. The picture below is an example of how this plant could be marketed. It is 8-10 months old. While bonsai enthusiasts may say this is not a true bonsai, but the style is representative of an early or immature upright informal style of bonsai which in which the tree is allowed to grow free for a number of years to develop a thick trunk, after which movement of the trunk and branches are created by training techniques. (Gustafson, 30) However, to the average consumer, this plant in the bonsai tray and rock accessories creates a bonsai look at what will be a reasonable cost of

under \$25 as compared to an authentic bonsai often priced at hundreds of dollars.



The plant would appeal to several different target markets. The story of the tree is quite remarkable and compelling. The Buddhists see it as a poignant reminder “of the dependence of our lives and achievements on nature and to be kind to all living beings.” Naturally, it would appeal to Buddhists, Hindus and people who have an interest in living plants held sacred by religions. There may be some demand for the tree as Buddhists celebrate the birthday of the historical Buddha. While it is celebrated on different dates by various schools of Buddhism, it is primarily observed on the first full moon date of the fourth month in the Chinese lunar calendar (typically May). To consumers with environmental interests, the tree would be of interest due to its story of adaption to survive for thousands of years.

In researching the potential use of the *ficus religiosa* for bonsai, I accessed a website www.bonzihunk.com. The author Jerry Meislik teaches bonsai at a college in Montana and is a world renowned bonsai lecturer, teacher and writer. The website contained much information about the art of bonsai as well as instructions for the various techniques. However, since the site contained no references to this species of ficus, I decided to contact the author, Jerry

Meislik by email to see if he could offer any insight or advice. This contact began a series of questions and answers via several emails. Meislik took an immediate interest in my project and was very helpful and has given me permission to cite our email communications as well as share his pictures in this write up. Our emails and his book *Ficus, the Exotic Bonzai* provided valuable primary resources for this project and report. According to Meislik there is a feeling in the bonsai community that the *ficus religiosa* is not the best ficus species for use in bonsai. The leaves are too big, the branches too dense and the tree does not naturally produce desired aerial roots as most of the other species of ficus. These traits limit the styles of bonsai that could be achieved with this species. (Meislik, personal communication April, 12 1012) However, there are however, bonsai techniques to overcome these issues. Briefly, bonsai artists use a technique called “defoliating” which is the partial or complete removal of the leaves. (Meislik, 98) The replacement leaves will come in smaller and better scale to the tree. To create aerial roots, the artist can graft a seedling to the mother plant where an air root is desired. (Meislik, 67) Bonsai artists also use a technique they call “clip and grow” to prune away excess branching a characteristic of the *religiosa*. To successfully market this species of ficus to the bonsai artist, its characteristics need to be presented as unique and challenging not limiting.

Anticipated cultural requirements:

The *ficus religiosa* is winter hardy to USDA zones 10-12 (http://www.ahs.org/publications/usda_hardiness_zone_map.htm) and heat drought tolerant to USDA Heat Zones 11-12 where there are more than 180 days of temperatures over 30° C. (http://www.ahs.org/publications/heat_zone_map.htm) Outside of these zones, the tree will need to be cultivated in a climate controlled greenhouse.

There was little information available regarding the cultivation of this species of fig. However, there was much information regarding the cultivation of the *figus benjamina*, or weeping fig which most likely will work well for the *religiosa*. The *figus benjamina* is also native to Southeast Asia and grows naturally under similar conditions. Initially for seed germination, use plugs and 4" pots for cuttings. These should be kept in germination chambers where the soil is lightly misted several times per day and in which the soil temperature is maintained at 26-29°C. Light is also necessary for germination. Once true leaves are present they must be transplanted into a peat-based potting soil with up to 20% sand for drainage and moved to the greenhouse for finishing. Ideal greenhouse conditions are daytime temperatures of 23°C. or above with slightly cooler nights at 18-21°C. Plant needs long days for optimal growth, bright yet indirect light (3000-6000 f.c.) Too much light will cause yellowing of the leaves. Supplemental lighting will be necessary to provide 16-18 hours per day. (Ball Redbook, 387) To prepare plants for sale, they should be exposed to shade levels of 70% or more (less than 3000 f.c) for 2-6 months to acclimatize. Plants that are not acclimated this way will experience excessive defoliation when moved to an indoor space. The plant grows very slowly especially at first and no growth regulators are warranted. Keep humidity high by use of misting system. Mist daily. Fertilize once a month with a balanced organic fertilizer such as 8-8-8. Once plant has established, feed only during spring and summer and stop feeding in the fall and winter allowing the plant to go through its natural growth cycle. *Ficus religiosa* cultivated for miniatures or starter bonsai should be kept in small containers up to 6" to contain the root structure to fit a bonsai pot or tray. Watch for scale, mealy bugs and thrips, fungus gnats, white flies, and spider mites. Figs are also susceptible to borer beetles and fungus. (Meislik, 54) Use

systemic treatment to control these insects. In early stages, watch for fungus; apply broad spectrum fungicide if necessary. Also, the grower should plan for the recommended shipping temperatures of 13-16°C. to avoid injury to the plant. (Hamrick, 195)

Production Schedule:

A crop schedule for these plants is difficult due to the extremely wide germination window of (2 weeks to 90 days) and the unpredictable rate of growth after germination; it was only possible to guess. Hopefully, they would germinate within a few weeks and I would at least have a few small but thriving plants to show for my efforts by week 19. A target sales date for my plants would depend on a wide and inconsistent range of germination and seedling growth. However, I would expect that small immature yet established plants may be ready in about 10-12 months. While these would not be ready to be sold as starter bonsai for 3-4 years, they could be sold as small tropical plants.

I sowed at least 100 seeds in week 6 into a seed starter mix. Since I read that the seeds require light to germinate I pushed the tiny seeds (not much larger than a grain of salt) lightly into the soil, covered the plug trays with a transparent cover in which I had poked holes and placed them in the mist house. Each day I checked on my plugs to make sure they were staying moist. After 2 weeks of no signs of any germination I wondered if maybe my seeds were not viable and since my assignment was to propagate these plants from seeds, I decided to try more seeds. I discarded the original and found two sources of these seeds online that could ship immediately. I ordered 300 from each supplier. In week 7, I sowed about 100 of them in of them in a mix I made with equal parts of sand and black soil then I mixed in equal parts of vermiculite and perlite. I used this mix for its organic components as well as good drainage and

porosity. Then I sowed 100 in sphagnum peat moss. I used this moss because in its natural habitat, the ficus often germinates and propagates itself in the moss of neighboring trees. Sphagnum moss also has high porosity and good moisture retentive properties. These would be my control groups. To determine if the seed coats had some kind of germination inhibitors that might lead to the long to germination time, I soaked half of my remaining seeds in water for 24 hours and the last seeds in a solution 1000 ppm GA3 in water. GA3 is a plant hormone known to break down a seeds natural inhibitors to germination. After the 24 hours it was apparent that both sets of soaked seeds had imbibed the liquid and it appeared that their seed coats had split revealing very thin coats. I sowed about 100 of the gibberellins (GA3) treated seeds in the moss and about 100 in the soil mix and did the same for the water only soaked seeds. I now had 6 separate groups. Then, because it was not certain that the mist house temperatures were not high enough to bring on germination, I used a heat mat to ensure the soil was kept at a consistent 27-29°C. I covered them with a translucent cover with holes and placed them in the mist house. By week 8, some of the potential problems with my set up came to light. First, covering the trays even with holes in the tops did not sufficiently keep the soil moist. This was exacerbated by the fact that I was heating the soil. Second, the electric heat mat was getting water soaked by the misting. Although they are technically waterproof, the pooling of the water was a concern.

I decided to discuss my issues and concerns with Jerry Meislik to see if he would give me any advice on coaxing the seeds to germinate. He advised me that my seeds would require an extreme amount of attention to germinate and several weeks as seedlings thereafter. He told me to remove the covers and hand mist the plugs several times a day and keep the soil moist

and warm, but not wet. One of the problems he told me was if I was able to germinate any of the seeds, the new seedlings would immediately be in danger of developing a fungus problem and quickly damp off. (Meislik, personal conversation, March 6, 2012) Logistically, this presented a bit of a problem that they were in the University's greenhouse and although I was on campus most days, it was hard to mist several times a day outside of the mist house. My seeds however stood little chance of germinating if I discontinued heating the soil. I decided to bring the plug trays home where I set up a simple germination system consisting of grow lights providing 1000 f.c. of light around the clock and a self watering capillary mat tray that sat on the heat mat. A moist 27-29°C. soil was consistently maintained.

In week 12, five weeks after sowing the first two seedlings appeared in the sphagnum moss. These were the control seeds which had no soaking or treatment prior to sowing. Although one of the seedlings was not very vigorous and fell over. Perhaps it damped off as I had been warned. The second one is still very tiny, but a bit more vigorous. I continued to keep the top of the soil moist through the cap mats and several mistings per day and kept them under the grow light. While I was not sure my seedling died due to damping off. I did not want to take the chance and gave my remaining seedling a dose of a broad spectrum fungicide as recommended by Meislik. (Meislik, personal conversation, March 6, 2012)

In week 13, six weeks after sowing, two seedlings from seeds treated with the 1000 ppm GA3 in water appeared in the mixed soil. My first seedling is still growing but continues to be very tiny still it stands about 3/8 inch tall and no evidence of true leaves. Although my original crop schedule was to wait for true leave before transplanting, I decided to transplant this seedling into its own 4" pot of potting soil and began to fertilize with 50 ppm of a balanced

organic fertilizer (8-8-8) CLF as recommended by Meislik and again gave them an application of fungicide by spray. I increased the light levels by moving the pot and the two successful plugs into a sunroom with many windows on the south as east as well as a skylight. Light meter measurements were in a range from 1500 to 6000 f.c. at various times during the day. I also continued supplemental light under the grow lights to equal 18 hours per day.

In week 14 my 3 seedlings were still alive and growing. I expect I will have no further germinations; however I am keeping the top of the plug soil moist as well as continuing to heat the soil. This week, the first seedling is showing tiny true leaves. The other two remain in the plugs and continue to grow as the first one did very slowly.

In week 15, the tiny seedlings are growing but very slowly, no new germinations.

In week 16, 9 weeks after sowing, I was surprised to see a new germination also in the 1000 ppm GA3 treated group in the mixed soil as well as seed leaves appearing on one of my later seedlings. I transplanted them as I had my first seedling. Now there are four. This may be indication that indeed the seeds might have some germination inhibitors in their seed coats. However, it might be truer that the seeds were old and less viable, perhaps the seeds did not have enough energy in reserve to break through their coats and the chemical breakdown of the coat was enough to bring on germination.

In week 17, the final week to report, all the seedlings have true leaves. The first is growing a second set. The heart shape of the leaves is beginning to be recognizable. Still my "champion" who I have affectionately named "Sid" (after Siddhartha) is still less than $\frac{3}{4}$ inch tall and is pictured below. From the penny it is clear it is still very small at five weeks past germination. (Note the heart-shaped leaves beginning to be apparent.)



Overall, I had 5 germinations from over 600 seeds sowed, 2 in the sphagnum moss with no treatment and 3 in the mixed soil treated with the 1000 ppm GA3 in water. This provided no significant data about what was the best method to achieve germination. It did however; confirm fact that propagation from seed is an erratic and difficult undertaking. If a grower desires to grow from seeds, the most critical factor must be the seed supplier. Only fresh young seeds that have been handled and stored to retain moisture should be purchased. It is very apparent why these plants are generally propagated from cuttings. While using cuttings, a grower initially would have to be acquired from other growers, most likely from India, however these plants can be ready to market as immature yet established plants within 8-9 months, while growing from seed may take up to 2 years to achieve a saleable plant. Once the grower has a substantial stock of plants, it will no longer be necessary to import cuttings.

Needs Assessment for Genetic Improvement:

The seeds of *ficus religiosa* are to be sure, difficult to germinate. However, this difficulty does not come from a genetic trait that can be bred out of them. The factors that lead to seed viability, fertilization by the right fig wasp, followed by timely harvesting and finally a very short

storage that continuously maintains the seeds moisture and temperature are the keys. Therefore, genetic improvement of seeds to enhance germination rates is not necessary. It is even most likely, not possible.

References

- Bonsai & Stone Appreciation Magazine*; "Ficus Queen of India" Oct-Dec2010, Vol. 49 Issue 4, p52-53, (no author given) Wiley Library Online Accessed 3/8/2012
- GALIL, J. (1984), "*Ficus religiosa* L.–the tree-splitter". *Botanical Journal of the Linnean Society*, 88: 185–203. doi: 10.1111/j.1095-8339.1984.tb01570.x Wiley Library Online accessed 3/6/2012
- Galil J. and Eisilowitch D (1971), "Studies on the mutualistic symbiosis between syconia and sycophilous wasps in monoecious figs". *New Phytologist*, 70: 773–787. doi: 10.1111/j.1469-8137.1971.tb02578.x Wiley Library Online accessed 3/6/2012
- Gustafson, H.L. *The Bonsai Workshop*. (1994) New York. The Sterling Publishing Company
- Hamrick, D (Ed.) (2003) *Ball Redbook*. 17th Edition. Batavia Illinois. Ball Publishing
- Jander, K., & Herre, E. (2010). "Host sanctions and pollinator cheating in the fig tree-fig wasp mutualism" *Proceedings of the Royal Society B: Biological Sciences* DOI: [10.1098/rspb.2009.2157](https://doi.org/10.1098/rspb.2009.2157) accessed from Wiley Library Online accessed 3/6/2012
- Meislik, J. (2007). *Ficus the Exotic Bonsai*. Devonshire gardens LTD. Whitefish MT.
- Orwa C, Mutua A , Kindt R , Jamnadass R, Simons A. 2009. Agroforestry Database: a tree reference and selection guide version 4.0 (<http://www.worldagroforestry.org/af/treedb/>) accessed 3/20/2012
- Samson, I. and Samson R. (2000). *The Creative Art of Bonsai*. London. Octopus Publishing Group LTD
- Shiell, Richard "Ficus Religiosa" *American Nurseryman*; 7/15/93, Vol. 178 Issue 2, p98

