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YLR Manual

Propagating Plants for Restoration

Introduction

Successful propagation of native plants is essential to restoration projects. This chapter will cover the basics of propagation, with considerations to native California plants, especially those used for restoration on the main UCSC campus and at Younger Lagoon Reserve (YLR). Most of the information from this chapter was compiled from: personal interviews and conversation with Jim Velzy (UCSC Greenhouse Director), Beth Howard (YLR Reserve Director), and Tim Brown (YLR Restoration Field Manager), *Plant Propagation Principles and Practices* 4th edition (Hartmann and Kester 1983), *Growing California Native Plants* (Schmidt 1980), and *Seed Propagation of Native California Plants* (Emery 1988).

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Seed Anatomy

A seed is a baby plant surrounded by a protective covering in a suspended state of growth, *dormancy*, and has three basic parts: the embryo, food storage tissues, and the seed covering tissues. *The Embryo* is the result of the union of female and male gametes. Its basic structure consists of an embryo axis, where the shoot (the *plumule*) and roots (the *radicle*) grow from either end. The embryo of dicotyledons also includes a *hypocotyl*, or basic stem of the emerging plant.

The Cotyledon is a food storage tissue that also functions as the growing plant's first leaves. Plants are classified by how many cotyledons their seeds contain; plants whose seeds contain one cotyledon are called *monocots*, likewise, seeds with two cotyledons are called *dicots*. Other plants may have even more cotyledons, for example, gymnosperms like pines and ginkos, may have up to 15. These plants are classified as multicotyledonous

The Endosperm is a triploid food storage tissue that mainly supplies the embryo with starch, though it may also contain fats and proteins. In some plants, the endosperm is largest and is the main food source for the seed, whereas in others, the cotyledon is the dominant part of the seed and provides the main food source to the seed.

Seed coverings, like the seed coat, provide mechanical protection for the embryo and allow the seed to survive for long periods of time without injury. Seed coats of some species may be impermeable to water or require certain abiotic and biotic weathering processes before water can penetrate the seed. Seed coat characteristics vary by species and certain traits can often be traced to certain plant families.

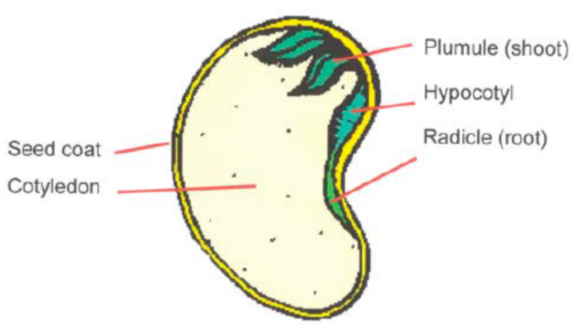

Figure 1: The anatomy of a dicotyledonous seed (CSU Extension, 2010)

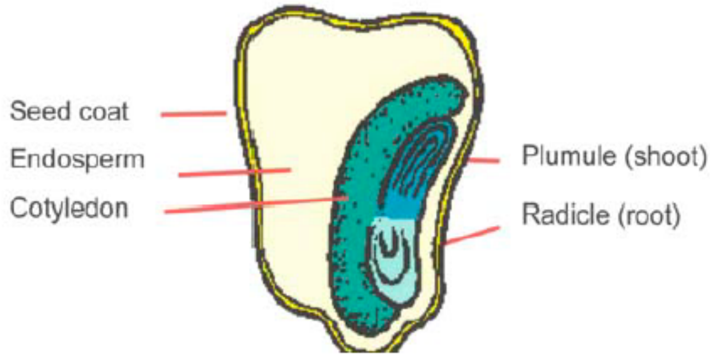

Figure 2: The anatomy of a monocotyledonous seed (CSU Extension, 2010)

<u>Breaking Dormancy</u>

Once the dormancy of a seed is broken, it begins to germinate and grow into a full sized plant. However, many species in California have complex dormancy mechanisms. The seed coat of a species may be impermeable to water and prevent germination, called external germination. Likewise, the embryo may need to be subjected to certain physical conditions such as warm or cold temperatures before it becomes activated, called internal germination.

In order to sow dormant seeds in a greenhouse setting, many species must be exposed to simulated conditions that mimic the condition with which species have evolved such as temperature or scarification from fire or other means. Many California plants have evolved dormancy methods to respond to disturbances like fire, low rainfall, and passage through an animals gut. A few processes to combat external dormancy that are particularly important in California systems are outlined here:

Hot Water: A simple treatment that is widely used with generous success for small and medium sized seeds is exposure to 12-24 hours of hot water to soften the seeds. Seeds are submersed in hot water and remain there as the water cools. The time that seeds are soaked depends on the species. Seeds should be sowed immediately after this treatment.

Scarification: Many seeds have tough impermeable seed coats, which in nature, are worn down over time before the seed can germinate. This can be simulated in a greenhouse by mechanically scratching or damaging the seed coat to let water permeate in. This is done with sandpaper, files, knives, or other tools. Care should be taken not to damage the embryo within, however.

Fire: The seeds of species that are adapted to a native fire regime may need to be exposed to temperature and or smoke in order to germinate. In the greenhouse, seeds can be subjected to the heat of a fire by being placed in a moist medium, covered with 10 to 15 centimeters of pine needles, and lighted. After burning, seeds should be sowed, but not all species will germinate immediately. Manzanita requires another two months after burning to germinate; likewise other species must be subjected to periods of hot and cold after burning.

Charate: Charate, burnt woody material, can neutralize germination inhibitors for certain species. Woody material that has been burnt or baked can be crushed and added to the germination medium to activate a dormant seed. Keely & Fotheringham (1998) found that oxidizing gases in smoke and acids found in charate play an important role in the germination of chaparral species.

Mulch: Over the course of several months, microbial processes that occur naturally in mulch can help soften seed coats of seeds planted in it and this often happens in nature. Seeds should be planted in trays with a mix of composted and fresh material without and added fungicide, as fungicide can kill the beneficial microbes in the mulch. Mulching increase germination in above-ground beds, as well as direct seeding in the field.

Acid: Sulfuric acid may be used to breakdown a tough seed coat, which mimics a seed's passing through the digestive system of an animal. Length of exposure is dependent on species, and seeds should be removed before the entire seed coat is penetrated to avoid damage to the embryo. After exposure, seed should be washed so that none of the acidic solution remains, which could harm the emerging seedling.

Warm or Cold Stratification: Sometimes seeds need to be exposed to long periods of warm or cold temperatures which can imitate a cold winter period and can help with seed ripening process, or warm temperatures can promote further ripening of the seed getting it to a stage where germination can be initiated. These processes are methods to break internal dormancy. In both cases, seeds should be placed into a moist medium for the treatment. Length of treatment depends on the species, and either may be used in combination with another treatment method to break external dormancy such as acid exposure or scarification. Warm and cold stratification might also be used together, for example, a warm period to ripen the seed followed by a prolonged cold period to imitate a winter.

Table 1: Listed here is a table of particular treatments for plants propagated for YLR. Scientific names and common names of various plant species are listed, followed by treatments recommended by Emery (1988). Blank boxes in the treatment section indicate no data.

Scientific Name	**Common Name**	**Seed Treatment**
Baccharis pilularis	Coyote brush	No Treatment
Baccharis douglasii	Salt march baccharis	No Treatment
Rubus ursinus	California blackberry	No Treatment
Elymus triticoides	Beardless wild rye	No Treatment
Epilobium ciliatum	Fringed willowherb	No Treatment
Juncus effusus	Soft rush	No Treatment
Danthonia californica	California oatgrass	No Treatment
Stipa pulchra	Purple needle grass	No Treatment
Deschampsia cespitosa	Tufted Hair-grass	No Treatment
Hordeum brachyantherum	Meadow barley	No Treatment
Artemisia californica	California sagebrush	No Treatment
Lupinus arboreus	Yellow bush lupine	Boiling Water
Eriophyllum staechadifolium	Seaside wooly sunflower	No Treatment
Erigeron glaucus	Seaside daisy	No Treatment
Achillea millefolium	Comon yarrow	No Treatment
Rhamnus californica	Coffeeberry	Fresh seeds: No Treatment Stored seeds: 3 months stratification
Sambucus	Elderberry	Stratification
Myrica californica	California wax myrtle	2-3 months of stratification
Ribes	Gooseberry	Stratification
Rosaceae	Roses	Several months stratification
Fragaria spp.	Strawberries	No Treatment. Germination may be hastened by 2-3 months of stratification
Satureja douglasii	Yerba buena	No Treatment
Scrophularia californica	Bee plant	No Treatment
Sisyrinchium bellum	Blue-eyed grass	2-3 months of stratification
Prunella vulgaris	Self-heal	No Treatment
Plantago maritime	Sea plantain	No Treatment
Mimulus aurianticus	Sticky monkey plant	No Treatment
Grindelia stricta	Gumplant	No Treatment
Lotus scoparius	Deerweed	Boiling Water
Eschscholzia californica	California poppy	No Treatment
Eriogonum latifolium	Coast buckwheat	No Treatment

Dudleya caespitosa	Dudleya	No Treatment
Chlorogalum pomeridianum	Soap plant	2-3 months of stratification
Aster chilensis	California aster	No Treatment
Armeria maritime	Sea thrift	No Treatment
Bromus carinatus	California brome	No Treatment

Biology of Germination:

Activation:

The first step in seed germination is the activation of the dormant embryo. This process begins with the *imbibition* of water. Imbibition is the physical process of water absorption by a dry seed that happens regardless of whether the seed is alive or dead. Water absorption may cause the softening of the seed coat and swelling of the internal tissues, which can cause the seed to coat to burst. The seed coats of some species are impermeable to water and need to be preceded by specific treatments before imbibition can occur, as described above.

Several plant hormones that have been detected in seeds play important roles in activating and inhibiting germination. Abscisic acid has been found to produce dormancy in species like cereals and is often used to induce seed dormancy to store seeds for long periods of time. On the other hand, the hormone cytokinin has the opposite effect of abscisic acid and helps to stimulate germination by allowing giberellic acid to function. After a seed is imbibed, giberellic acid causes enzyme activity and begins the conversion of the starch in the endosperm into sugar (Koornneef et al. 2002). Similarly, ethylene has also been shown to promote germination in some kinds of seeds. These hormones are commercially available from producers and can be used in a nursery to induce or inhibit germination.

The emergence of the radicle is the first visible sign of germination, aside from swelling of the seed with imbibition that may be visible in some species. Depending on the species, radicle emergence can occur from between a few hours to a few days after imbibition. Radicle extension can involve cell elongation, cell division, or both. Radicle extension through the surrounding media typically marks the end of the germination period and the beginning of seedling growth.

<u>Seedling Growth:</u>

Seedling growth is marked by a steady increase in cell division along the embryo axis and expansion of seedling structures. The root system expands and the cotyledon(s) emerge from the soil and begin to photosynthesize, later on true leaves develop and the seedling becomes self-sufficient. Metabolic rate readily increases as the amount of fresh tissue weight increases and the amount of dry storage tissue decreases. Eventually, energy storage tissues no longer participate in the metabolism of the seedling, and the emerging plant is capable of increasingly capable of photosynthesis and water absorption.

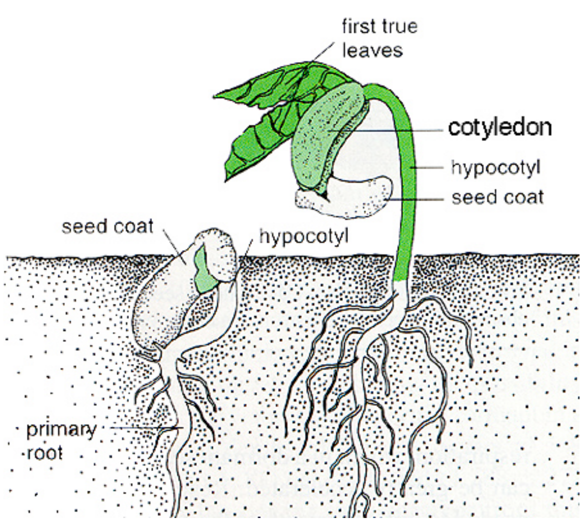

Figure 3: A diagram of early plant growth (CSU Extension, 2010).

Vegetative Propagation:

Various vegetative methods of propagation can be used when seeds are not readily available or if the particular species is easily propagated by vegetative methods.

Cuttings:

Cuttings are widely used commercial greenhouse method of propagating shrubs which involves taking a portion of stem, leaves, root, or leaves and placing it in favorable conditions that induce it to develop a root system. This method is sometimes used to propagate shrub species like lupine and manzanita, though lupine is also propagated by seeding. Some species from YLR that are propagated from cuttings are *Sambucus, Rhamnus californica, Myrica californica, Ribes spp., Satureja douglasii, Rosa californica* and *Fragaria spp.*.

Cuttings should be taken from a large number of healthy vigorous plants to ensure genetic diversity. The size of samples can vary depending on the propagation methods and the planting conditions. It is important to leave the plants you take cuttings from in good shape. You can take cuttings from branches that are over-reaching the average plant canopy, that open up the inside of the plant to better sunlight, that are in the rearch of herbivores, or shape the plant in other beneficial ways. The impact from taking cuttings from a plant should not be detrimental to the life of the plant.

Divisions:

Divisions are a method of vegetative propagation that simply involves splitting a plant with more than one rooted crown at the base. This must be done at the right time of year, which varies by species, but often occurs in winter or spring. Divisions are done in the winter at YLR, and for two rhizomatous species: spreading rush (*Juncus patens*) and alkali rye grass (*Elymus triticoides)*, both for which seed germination has been poor. It is important to leave a sufficient amount of plant material in the area you take from. It may be necessary to leave a small division in place of the area you take from.

Runners:

Runners are thin stems that originate from a leaf axil and that grow down from the parent plant to form a new plant at the tip. Strawberries (*fragaria*) are an example of these. Runners can simply be removed from parent and placed into a growing medium, after which they will root themselves. It is usually best to leave any rooted starts in place and only take plants that are not rooted into the native soil.

Seeding vs. Vegetative propagation:

There are many factors that must be considered before choosing which propagation method to use. The appropriate method for a given species depends on the biology of the species, cost effectiveness, genetic diversity requirements, resources available and time it takes to produce plants ready to be planted in the field. For example, divisions are a cost-effective method of propagating rhizomatous species like *juncus*, while lupine is easily propagated by seeding or cuttings.

Seeding:

Propagating plants from seed is a cost-effective strategy that is often the most successful in terms of plant yield. It also results in the most amount of genetic diversity compared to other vegetative propagation methods due to the combination of two genomes and recombination during meiosis. Seeds often develop into healthier mature plants than cuttings because they do not begin with the same spectrum of parasite and pathogen loads as cuttings taken from mature plants do. Seeds are separated from the chaff to reduce pests and diseases. Seeds can also be frozen, dried, or dipped in 10% bleach to kill pests and pathogens. Seeds are often sowed and cared for in a nursery or greenhouse before being outplanted into the field. This is a more costly process than direct seeding into habitat plots but ensures higher germination and survival rates. Seeds sowed directly into the soil may fall victim to competition, predation, and infection from parasites and pathogens, whereas seeds sowed in greenhouses are started in sterile and mild conditions which results in much higher survival of recently germinated seedlings.

Native plant seeds of some species can be purchased from a few growers; however, it is better to use seeds that were harvested locally because they contain genes from plants that are adapted to the local conditions and some species are not commercially available. If local seeds are not available, some native seed banks in California include: Rancho Santa Ana, Santa Barbara Botanical Gardens, California Native Plant Society, and the UCSC Arboretum. Purchasing commercial seeds is cheaper and easier if there resources, such as student interns and volunteers, are not available. When collecting seed in the wild it is important to collect no more than 10% of what is out there. You will need to assess what is in the area you are collecting when you begin to harvest. Additionally, proper permits must be obtained in order to collect local seeds, and planting projects take careful preparation to plan for seed collection. Vegetative propagation can be a good alternative for certain species for which seeds are sparse, or for herbaceous species which can be grown in the greenhouse to maturity, seed can then be collected from these greenhouse grown plants and can be used to 'bulk up' (e.g. increase the total amount) of seed.

Seeds used for YLR projects are collected on site at YLR and are propagated and prepared for transplantation on campus by Brett Hall at the UCSC Arboretum and Jim Velzy at the UCSC Greenhouse along with their staff of volunteers and interns. Brett and Jim also propagate plants for other restoration projects around campus and for various gardens around campus.

Vegetative propagation:

Vegetative propagation can be a good alternative to seeding when seeds are not available in large quantities or when getting seeds to germinate is difficult. Many cuttings or runners can be taken from a single plant, although genetic diversity then becomes a concern. Genetic diversity should be maximized throughout plots to maximize ecological resilience to environmental change.

Divisions and runners are easy to propagate compared to cuttings but still require many times more work than propagation by seed. Cuttings must be processed and planted into propagation media within 24 hours of harvesting and require special care during their beginning stages of development. As an alternative to seeding, they grow into a finished plant faster and some species are very fairly easy to propagate with by cuttings. However, cuttings are fragile and must be kept under a mist bed to provide enough moisture until their roots develop. Not all facilities have mist beds, so cuttings are limited to project with enough resources to make them cost efficient.

One problem encountered with cuttings is the presence of parasites and pathogens from the adult plant from which they were harvested. Seeds are sorted and cleaned before sowing which reduces parasite load and cuttings must be dealt with appropriately to reduce these concerns. Cuttings will be carrying pests and disease that are attaching mature tissue, which need to be dealt with immediately as compared to seed that can dried or frozen to reduce pest and disease loads.

California Native Plants:

Restoration projects must be careful to consider a wide suite of factors when designing a project including the local habitats and community of plants native to those conditions, as well as propagation methods required for the species included in the planting pallet. For example; California plants are well adapted to low nutrient conditions, drought conditions, and a fire regime (An Introduction to California Plant Life).

Several seed species, including manzanitas, are adapted to only germinate once a fire has occurred. This adaptation may have arisen because the ground is quite bare after a fire, which ensures less competition for a young plant. Likewise, as mentioned above, the presence of charate in the soil can be a factor that stimulates germination.

Plant Propagation Process:

Seed Propagation:

Seed propagation for UCSC restoration projects begins in the greenhouse in late summer or early fall, timed so that seedlings will be ready to outplant in the winter during the rainy season. Propagation typically takes around three months to complete so propagation projects should be timed around this limitation. If plants are outplanted too early, the seedlings are at risk of being too immature and fragile to survive in the field, and survival rates may drop. On the other hand, seedlings kept too long in nursery conditions way outgrow their holding containers and become rootbound. These problems add cost to a propagation project and should be avoided with proper planning.

Some problems encountered at this stage are poor germination rates and sowing seeds too densely. Poor germination rates can sometimes be avoided by using proper sterilization methods (discussed later), or by choosing the proper seeds to use. It is important to use ripe, mature, undamaged, and cleaned sterile seeds in this process. Failing to do so may lead to losses from poor germination failure. Proper seed handling and cleaning techniques are described in another chapter. When seeds are sowed too dense, the resulting seedlings may end up smaller and weaker than more sparsely sowed seeds because of intraspecific competition. These plants must be transplanted sooner and transplantation may also be more difficult because they are weak.

Planting Medium:

Choosing the right planting medium is an important part of the propagation process. The medium must be dense enough to hold the seed or cutting in place throughout propagation, but not too dense so that roots cannot easily penetrate through it or that it is insufficiently aerated. The planting medium should also be able to hold a constant volume whether moist or dry. Likewise, it should hold water for long enough to so that watering does not have to occur too frequently. Finally, the medium should contain enough nutrients to nurture a growing seedling and be pest-free.

At the UCSC greenhouse, Jim uses a sterile soilless mixture of 75% peat moss and 25% perlite with added fertilizers for all stages of propagation. Peat moss can hold 300 times its weight in water and has a high cation exchange capacity (CEC), while perlite offers good drainage and aeration. The cation (positively charged ion) exchange capacity of soil refers to its ability to hold and release soil nutrients. The benefit of using a soilless mixture is to minimize pathogens or parasites in the medium, which can affect the final plant yield.

Other materials often used are sand, vermiculite, pumice, and compost. There are many generic mixtures of these materials that work for most plants, however, the medium should be chosen based on the needs of a plant. The medium can easily be customized to the needs particular plants, and considerations about soil drainage, soil pH, and nutrient levels for certain plants should be taken into account.

Sowing seeds

Seeds are generally sowed en mass in large plastic seed flats. At the UCSC greenhouse, seed flats measure 25.4cm x 25.4cm (10”x10”), with a soil depth of 1.5cm (about ½ inch). Seeds are covered with an amount of soil to a depth of 1.5× the width of the seed. All flats are labeled with the plant genus, species, collection location and date, and date sowed.

Germination rates can be very unpredictable depending on the batch or species of seeds. Jim Velzy estimates that the average germination rate for native plants he cultures is around 60%. At the UCSC greenhouse, Jim typically sows 500 seeds or more in each seed flat. A general rule of thumb is to oversow seeds at this step of the propagation process because of the unpredictability of seedling yield. If fewer seedlings germinate than expected, resowing to get more plants may set back a schedule by several weeks, and miss the deadline for the peak-planting season. Seed flats should be kept inside a shaded greenhouse to protect the seedlings from stressful environmental conditions. Seedlings should also be provided with adequate water.

Transplantation to Conetainers:

Once seedlings have developed their first few leaves, they are ready to be transplanted to conetainers. Conetainers are a widely used pot type because of they require less greenhouse space than regular pots, are easy to transport and can be outplanted very quickly and efficiently with precise custom tools and machinery. Other pot sizes may be used for different species and restoration goals. Individual seedlings are transplanted from the seed flat into a conetainer; conetainers are placed in racks that are easily moved around the greenhouse and transported between sites. After transplanting to containers, seedlings should be regularly watered and fertilized according to a specific regime. At the UCSC greenhouse, plants are fertilized every six weeks with a solution of 300ppm NPK (Nitrogen, Phosphorus, Potassium) liquid feed.

Cuttings and Divisions:

For both cuttings and division, it is important to collect them at the correct time of year. Specimens used for cuttings must include a terminal or lateral node close to the base of the sample; this node is what is induced to grow into a root. Cuttings are dipped into root-tone, a hormone that induces root growth, and placed into a seed flat from which they will eventually be transplanted into conetatiners. Cuttings are planted into a mixture of 75% perlite and 25% screened peatmoss. It is important when propagating cuttings to plant them with the proper orientation (buds facing up). Upside down plants, a common mistake at the UCSC greenhouse, will not develop. Likewise, it is important to make sure one node is completely covered by the soil and another is exposed to air and sun. This ensures that both a root system and leaf system develop.

In general, bottom heating will encourage and root growth. Cuttings should be kept out of direct sunlight and harsh conditions because of the risk of moisture loss from transpiration. They should be kept in moist conditions, as there is no initial root system, and water must be absorbed through the leaf tissue. To help keep optimal conditions for cutting establishment the UCSC greenhouses employ a misting system that is set to mist the cuttings every half hour for 15 seconds during the day.

Hardening-off:

Once plants have grown in the conetainers for several weeks, they begin a regimen of *hardening-off* to transition them from mild greenhouse conditions to the more stressful natural conditions in the field. Plants recently transplanted into conetainers should be stored in the same conditions as seed flats for the first few weeks of their lives – shaded and with mist. As they grow in size, they may slowly be transitioned into a sunny part of the greenhouse, into a shaded outdoor spot, and finally outdoors in the full sun. Direct sunlight and wind increase transpiration, and are particularly drying; plants will also have to adapt to a wider range in temperature change. The watering regimen is also reduced to mimic conditions in the field. This is particularly important for California plants, as a long dry season is characteristic of California ecosystems. Hardening off allows plants to develop tougher leaves before outplanting into the field.

Pest Management and Sterilization:

Parasites and pathogens can cause major loses in final plant yields, especially in the warm humid conditions of a greenhouse. It is important that the physical propagation facility (greenhouse or nursery), propagation materials (such as seed flats, soil media, planting tools, and containers), and plant materials are clean. Some large-scale nurseries and producers have extensive pest management systems to control parasites; regardless of the scale, it is very important to keep these three basic components clean.

Greenhouses should be light, humid but not damp, and cleaned at the end of each day. Damp, low-light environments favor fungi and pathogens that may hinder plant growth or be otherwise harmful. There should not be pools of standing water that could foster pathogens such as water molds (Pythium). Likewise, surfaces used for planting, transplanting, etc should be kept clean.

Seed trays, conetainers, and all other planting media should be kept clean. To maintain sterile planting media we always move in one direction such that residual media should never go back into a soil bucket. Old media should not be resused for propogation but can be used for larger potted plants. Recycled soil from plants that don't grow can be used in gardens or compost. If planting media is reused it should be properly treated to eliminate pathogens. At the UCSC greenhouse, all planting containers are cleaned several times with soapy water to remove pathogens. Soapy water disrupts the lipid membrane of cells and is an effective and cost-efficient way of eliminating pathogens like fungus, viruses, and bacteria. Likewise, a dilute solution of soapy water will also kill pests such as aphids, mites, whitefly, fungus, gnats, and thirps; which are common greenhouse parasites.

Plant material should be kept as clean as possible. As mentioned earlier, seed cleaning is a very important practice to ensure good germination outcomes. Because cuttings often come with a suite of parasites and pathogens, they should be gently rinsed in a dilute soap chlorine and fungicide solution to remove pests. A simple way of eliminating some pests from established plants is to move them outdoors, where beneficial insects or microbes can colonize them and eliminate the pest naturally. Likewise, particular diseases may be controlled by moving plants to a different environment, usually drier and sunnier to favor new plant growth. If cultural methods fail, treatments chemicals such as of sulfur, oil, pesticides, or fungicides may be necessary.

Annotated bibliography:

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- A detailed description of the physiological processes of dormancy and germination

CSU (Colorado State University) Extension. 2010. Colorado Master Gardener: Notes 137. http://www.ext.colostate.edu/mg/gardennotes/137.html. Last visited October 2, 2013.

Emery, D.E. 1988. Seed Propagation of Native California Plants. Santa Barbara Botanic Garden. Santa Barbara, California.

- Dara Emery is a plant breeder at the Santa Barbara Botanic Gardens. This is an excellent resource that can be checked out from the UCSC Greenhouse library. It offers comprehensive information on treatment for a huge range of California plants, as well as seed collection and storage methods.

Hartman, H.T. and Kester D.E. Plant Propagation Principles and Practices. 4th edition. Prentice-Hall Inc. Engelwood Cliffs, New Jersey.

- This textbook thoroughly covers all methods of plant propagation and germination as well as the biology behind it. It offers a more in depth guide of propagation and more methods of propagation. This book can also be checked out from the UCSC Greenhouse Library.

Keeley, J. E. & C. J. Fotheringham. 1998. Smoke-induced seed germination in California chaparral. Ecology **79**:2320-2336

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Ornduff R. and Faber P.M. Introduction of California Plant Life. University of California Press. 2003.

- This book offers an introduction to California plants and habitats and what shapes them.

Schmidt, M.G., Greenberg, K.L., Merrick, B. Growing California Native Plants, First Edition. Berkeley: University of California Press, 1980.

- This book gives advice for gardeners eager to plant native California species and gives an overview of where in the garden to plant certain species as well as certain treatment methods, and a brief overview of propagation methods