Saving our Seeds

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GROWING PLANTS from SEED

Tips for raising plants from seed indoors or outdoors

Plant Life Cycles

Annual: Plants that complete their life cycle within one growing season (a year or less) are called annuals. The plant germinates from the seed in the spring, produces flowers, and then sets seed before winter. Examples include basil, calendula, marigold, and lettuce.

Hardy annual: These are annuals that can tolerate light frosts. They may grow more than one year if brought indoors and set out again in the spring (e.g. peppers).

Biennial: Biennials take two years to complete their life cycle. Seeds are planted from spring to mid summer. During the first year, the plants produce a low-lying rosette of leaves. The following spring, the plant produces a few more leaves and one or more flowering stalks. After setting seed, the plant dies. Examples include evening primrose and burdock.

Perennial: Plants that live more than two years are called perennials. Some are short-lived such as feverfew which may live only two to four years, while others are long-lived, such as lavender. Herbaceous perennials such as Echinacea die back to the root crown during the winter and sprout again from the crown the following year. Woody perennials have aboveground stems that over-winter and sprout new leaves in the spring. Perennials produce fewer flowers for a shorter period of time than annuals, which tend to flower until frost.

Planting Times

Early spring sowing: Sow seeds that require cool or alternating temperatures in the spring to break seed dormancy. Seeds of these cold-dependent germinators can tolerate cold temperatures or light frosts. Sow as soon as the soil can be worked.

Spring sowing: This is the time of year to sow annuals, most perennials, and seeds that require cool temperatures. Seeds of plants that are not frost hardy should not be planted until a week before the last frost date. Seeds of annuals sown in the spring will mature in time to bear fruit or flower, and seeds of perennials will grow large enough to become well established before winter.

Summer sowing for spring emergence: Some herb and flower seeds are multi-cycle germinators and require a sequence of warm/cold/warm seasons to germinate. These are best planted in one-gallon pots or nursery flats, which are left outdoors and observed periodically weeds and debris. The same results may be accelerated and achieved artificially by moving the flat or pot into and out of a refrigerator for two or three-week cycles.

Late summer or early fall sowing: This is the time to sow cold-weather vegetable crops in the cabbage family, or other cool weather crops such as spinach, beets or lettuce. In southern areas these crops may survive the winter.

Late fall sowing for spring emergence: Some herb seeds require cold soil to germinate. They may emerge in late fall or the following spring. This natural process may be simulated by stratification in a refrigerator, typically for a period of at least four to six weeks, or two to four months for certain herbs and trees.

Nursery bed or pots in spring, summer or fall: This is the preferred method for germinating seed of slow-germinating and slow-growing herbs that require oscillating temperatures and moisture levels. Some seeds need to be associated with beneficial fungi that produce a plant growth hormone, gibberellic acid that helps break seed dormancy. For this reason, use natural garden soil, rather than potting soil. Raised nursery beds for herbs and flowers can be created by using rot-resistant wood or masonry block. A raised bed isn't necessary, but it helps define the planting area and makes it easier to observe and maintain. If you have a problem with voles, nursery beds can be constructed of rot-resistant wood frames six or eight inches deep with ¼" hardware cloth nailed to the lower surface. The frame can be left raised or partly buried in the soil. Alternatively, use one gallon or larger nursery pots that are sunk to within an inch or two of the soil surface.

Germination Guidelines

General germination requirements:

Failures in seed germination are almost always caused by improper attention to cultural requirements. The most common causes of seed failure are sowing seed in cold soggy soil, heavy, waterlogged soil, cold soil (warm-weather crops), hot soil (cool-weather crops), or soil that has been allowed to dry out. For seeds started indoors, we recommend use of a *sterile seed starting mix*, not potting soil which may give poor results. For transplants, use a professional quality commercial potting soil.

Sow seed in a light, well-drained soil. Seeds need air as well as water to germinate. If the soil is waterlogged, air is unable to reach the roots and therefore normal metabolic processes can not be supported. To achieve better drainage in waterlogged soil, add well-cured compost or other broken-down organic matter. Do not use sand, unless it is coarse grain sand and do not fertilize until your seedlings are well established.

Garden soil. Garden soil is not recommended for seed germination because: (1) it is often full of weeds which can overgrow your seedlings, (2) the soil tends to crust and often is poorly poor aerated and (3) it may contain many soil-borne pathogens. If you have to use garden soil it should first be sifted through ¼" screen to remove clumps, rocks and other debris. Sterilize it by pouring boiling water over it at least three times, or microwave the soil, or sterilize it in the oven. If you microwave the soil make sure it is moist (not soggy) and use a microwavable bowl with loose cover. Microwave approximately one minute for each cup

of soil, and then thoroughly clean the microwave afterwards. For oven sterilization use a baking pan covered with aluminum foil. Soil should be heated to 180°F for at least one-half hour. To do this you'll need to pre-heat your oven to 250°F, and bake for 45 minutes. This process may give your house an earthy smell for a while.

Pay strict attention to temperature and moisture requirements for germination. Many vegetables and common flowers are easy to germinate, but some require cooler or warmer temperatures. Many wildflowers and some herbs have very specific growing requirements so be sure to check if special germination conditions are required.

Planting depth. As a general rule, sow no deeper than three to four times the diameter of the seed, or in the case of oblong seed, no deeper than one to three times the length of the seed. Fine seed should be sown on the soil surface and then pressed lightly onto the surface. Fine seed may be sown more easily by mixing with fine sand, or using a saltshaker to disperse the seed uniformly.

Moistening the germination medium. Moisten the growing medium with mist from a misting nozzle until seedlings are well established. Most seed requires constant moisture to germinate. Do not allow the germination medium to dry out.

Pre-germination indoors (transplanting) versus direct-sowing outdoors. Seeds which are very small or slow growing are generally best sown in pots or flats and then later transplanted to the garden.

Dormancy: Herbs and Wildflowers with Special Germination Requirements

Dormancy is a survival mechanism that prevents seeds from germinating all at the same time or from germinating at a time that is not conducive to the survival of the seed. Also, dormancy helps to ensure that seeds germinate at different times, rather than at the same time. All species of plants have at least one mechanism for delaying germination. Usually the mechanism for breaking dormancy involves a biochemical or physiological process that breaks down certain chemical compounds (germination inhibitors) in the seed. In most cases, dormancy is broken by drying and storage of the seed, exposure to moisture, exposure to certain nutrients (nitrate), or exposure to alternating temperatures or light during germination.

Most of our cultivated crops no longer have a dormancy period because dormancy has been bred out of those crops. On the other hand, most wildflowers, some less commonly grown herbs, and many tree seeds have a dormancy mechanism.

Special germination requirements:

Light-dependent germination: Some seeds, especially certain flowers and herbs require light in order to germinate. Examples include St. Johnswort, catnip and stinging nettle. Often these species are native to woodlands or swampy areas where light levels are low. For light-dependent germinators, light is required to destroy the germination inhibitors in the seed. Generally, the seeds of light-dependent germinators are quite small. Some like chamomile are almost dust-like, and are sown on the soil surface. When a catalog says sow the seeds on the surface, it can be assumed that light is needed for germination. Small seeds can be sprinkled on the surface of moist soil by sowing them from a saltshaker or by mixing them with fine sand and sowing by hand. The seed is then pressed lightly into the soil using just enough pressure to ensure good contact of the seed with the soil. When watering, water from below allowing the water to move upwards by capillary action, or water from above using a misting nozzle or spray bottle. It is important not to allow the surface of the soil to dry out.

Temperature-dependent germination: Most seeds germinate best at 65 to 80°F. Germination inhibitors are destroyed by exposure to moisture. Seeds of this type generally have rapid and uniform germination.

Heat-dependent germination: Heat-dependent germinators are generally warm-weather crops. These seeds need a high soil temperature (at least 80°F or more) in order to germinate well. Use bottom heat, or sow seeds during the summer, or sow in late spring in a greenhouse or cold frame. For example, pepper seed germinates much better at higher temperatures in the range of 80 to 85°F. Though pepper seed will germinate at 65°F, germination may be very slow and the seed may rot.

Cool temperature-dependent germination: Some seeds, such as cool weather crops and some herbs (German chamomile), require cooler (but not cold) temperatures to germinate well. Certain herbs and cool-weather vegetable seeds germinate well at temperatures in the range of 55 to 65°F, but some of these same seeds will not germinate above 80 to 85°F (e.g. lettuce).

Types of dormancy and methods of breaking dormancy:

Stratification or cold conditioning (cold, moist storage): Stratification is a prerequisite for germinating seeds of many herbs and some wild flowers. Seeds which require stratification need to be exposed to low temperatures and moisture in order to germinate. During this time, cold-dependent enzymes break down germination inhibitors. In most cases, four to six weeks of stratification is sufficient, but some species may need to be stratified for three to four months or more. Seeds may be stratified indoors by planting the seeds in moist sand or seed-starting mix. The flats or pots are covered with a plastic bag to retain moisture and then placed in the refrigerator for the required period of time before planting in a warm place. If stratifying seeds outdoors, plant them in flats or pots in the nursery bed in the fall. Cover the tops of the flats or pots with screen to keep out insects, mice, voles, and other seed eaters.

Scarification: Scarification is necessary when seeds have an impermeable seed coat which water is unable to penetrate. In nature, some seeds eventually germinate after the seed coat is broken down by microbial action or abrasion. To break dormancy, sand the seed with an Emory board, sandpaper, or a file until a small opening is made in the seed coat. The aim is to produce a small opening in the seed coat deep enough to see the cream-colored seed underneath the brown or black coat. If the seed is large, scarification may be accomplished by cutting or scraping through the coat with a sharp knife to make a small hole, or by poking a hole in the seed coat with a thumbtack, penetrating just deep enough to break through the seed coat. Examples of seed, which requires scarification, are licorice, sweet shrub, and mimosa.

Temperature cycling dependence (multi-cycle germinators): Seed must be subject to seasonal and daily temperature cycles to germinate well. The easiest way to germinate these seeds is to plant them outdoors in flats or pots in the fall. Examples include bloodroot, certain species of columbine and phlox.

Slow or prolonged germination: Some species are slow to germinate even when planted in the proper medium under proper growing conditions at the proper season. Examples include rosemary, agrimony, and angelica. Even after germination, some seedlings (e.g. rosemary) may grow very slowly.

Seeds in fleshy fruits: A number of woodland herbs have seeds embedded in fleshy fruits (e.g. ginseng and goldenseal) or seeds which have an aril or fleshy protuberance, (e.g. bloodroot). Ants or birds often disperse these species to suitable germination habitats. When harvested, these seeds are stored refrigerated and kept moist by placing the seeds on moist paper towels or in moist sphagnum in a zip-lock bag Generally these seeds are best sown immediately because they do not tolerate dry storage, or take longer to germinate if dried. In other species, the fruit pulp contains powerful germination inhibitors that once leached away, allow the seed to germinate.

Cold-stored seed: Certain species are adversely affected by storage at room temperature and are therefore kept refrigerated to prolong seed life (e.g. blue cohosh and lovage). Seed which has been cold-stored should be planted soon after receipt or kept refrigerated until planting time.

Fire-dependent germination: A few seeds are naturally dependent on fire to break dormancy. The seedlings are planted ¼" deep in moist potting soil or sand in a flat. Use a wood flat (not plastic) and water thoroughly including the sides of the flat. Place dry tinder such as pine needles and pine cones on top of the flat and light it. After the fire has burned completely, water the flat daily.

Starting Seeds Indoors

Seed starting mixes and potting soils: Many cheap potting soils are poorly drained and need to be lightened with coarse vermiculite or perlite. The best quality mixes can be found at garden

supply stores. Don't buy cheap stuff at your local discount store. Some of the recommended commercial seed-starting mixes include ProMix B-X or Peters Seed Starting Mix. These are well worth the modest investment.

Types of containers for starting seed: There are lots of possibilities for containers. Cut-down milk cartons, egg cartons, yogurt cups, Styrofoam cups, and disposable drinking cups will do. The main requirement is that the container has drainage holes punched or drilled in the bottom. If you do a lot of seed starting it is worth having plastic pots or flats that can be re-used year after year.

Sowing seed: Seed containers should be filled to within ¼ to ½" from the top of the rim after the soil mix is lightly firmed. This allows a space to hold water while watering, after the seedlings have emerged. Plastic pots have a soil line set down from the rim that is a guide for the proper depth of the soil. Moisten the planting mix before you sow the seed. Tweezers are often a handy tool for sowing small seed. For large seeds it is often helpful to poke a small hole in the soil with a dibble if you have one. A blunt pencil or pen can substitute as a dibble. When sowing in flats you can make small furrows about ¼"deep and then gently tap the seed packet so that the seeds fall more or less evenly into the furrow. Most small seeds do not need to be covered, or are covered only lightly. Mainly it is important that the seeds be in good contact with the moist soil. Fine or tiny seeds must be sown on the soil surface. Mix the seeds with fine sand to make them easier to distribute, or place seeds in a saltshaker and sprinkle over the surface, or tap the seed packet while guiding the packet over the soil surface. Water from below by placing the container in a shallow tray of water and bring the water level about ¼" deep, and/or mist the surface with a misting nozzle or spray bottle.

Watering: During germination, the soil surface must be kept moist at all times. If the soil dries out once, your germinating seeds may die. For this reason, if your seeds are being germinated in direct sunlight it is helpful to have a tray of water underneath the growing container. A few seeds like to have a slightly drier soil medium. For example, peppers and eggplant seed do better when the soil is only slightly moist.

Lighting: Seedlings require a lot of light, often at least twice as much light required by mature plants. Most mature herbs should have a minimum of four to six hours of strong sunlight. Vegetables should have six to eight hours of direct sunlight to keep them from becoming leggy. If seedlings become leggy they may become too weak to transplant and will not thrive when transplanted, or they will not stay erect. When starting plants indoors, if you do not have enough light, you can supplement the light level using a fluorescent light fixture. The light level from a fluorescent light is very low, so the lamp must be only about two inches above the surface of the plants and must be left on for about 16 hours a day. Do not waste money on special fluorescent (Grow Light) lamps. They do not give as good results as the cool-white fluorescent lamps. If you have to add more light, use a regular light bulb to add more light. Regular light bulbs (incandescent bulbs) add more light in the red end of the spectrum even though the bulb appears yellow-white. If you are a commercial grower, it is well worth purchasing a high-pressure sodium lamp for germinating seedlings and growing plants.

Care of seedlings after germination: After the seedlings appear, be sure there is good air circulation around the seedlings in order to avoid damping-off disease. Damping off is caused by

a soil fungus that attacks the seedlings at the base of the stems causing the seedlings to collapse. It can be helpful to direct a gentle breeze over the seedlings from a fan. This serves two purposes: (1) it helps prevent damping-off disease, and (2) it makes the seedlings shorter and stockier and is a way to prevent seedlings from getting too spindly from low light levels.

Transplanting and fertilizing: Seedlings are ready to transplant when they have two sets of true leaves. Some herbs and flowers with long taproots do not transplant easily so they should be thinned quite early and transplanted to the garden as soon as possible. These varieties probably should be direct sown if possible. Examples include anise, parsley, dill, coriander, fennel, cumin, and poppy. Many herbs and some flowers can benefit from being transplanted to a richer soil mix in larger (3") containers before being planted to the garden. To transplant seedlings, lift the seedlings out of the soil mix using the end of a pencil or handle of a teaspoon. If the roots are intermingled with each other, tease the roots gently apart. When transplanting, moisten the soil and prepare a hole large enough to accept the roots of the transplanted seedling. Keep the seedlings at the same planting depth. After transplanting, water the seedlings and keep out of direct sunlight for at least one day in order to avoid transplant shock. Seedlings can be fertilized with soluble fertilizer once a week at one-fourth the recommended strength. Fertilization may not be necessary as long as the leaves are uniformly medium green. Yellowing of the leaves may be a sign of nitrogen deficiency (or over-watering). A purple coloration on the leaves is typically a sign of phosphorous deficiency. Browned or tan leaf edges may be a sign of potassium deficiency (or drying out of plants). Do not over fertilize since it can make the plants too succulent and more susceptible to disease.

Hardening off before transplanting: Plants grown indoors are tender and succulent and not ready for the outside world without some preparation called "hardening off." If plants are placed directly outside without being first acclimated, the seedlings will be burned by the bright sun, dried, or broken by wind, stunted by hot or cold growing conditions, or damaged by frost. Start the process by putting the seedlings out in bright sun for no more than an hour the first day, or less if it is windy. You can put them out longer if they are in dappled shade. The next day, put the plants outside for up to two hours. Each day increase the time by an hour or more, and by the end of a week the plants are ready to be outside. Allow up to ten days or longer if they are to be transplanted to the garden. This hardening off period will allow the plants to withstand weather extremes and will cause the cuticle of the leaves and stems to become thicker so that they lose less water and become thicker and stronger. The planting media may dry out quickly under bright sunny conditions, especially when windy. Check them frequently. During the hardening-off period hold back on fertilizing the plants unless color cues indicate they really need it.

Starting Seeds Outdoors (Direct Seeding)

Choosing the site: Any sunny location with rich, well-drained soil is fine for most plants. For sun-loving plants, eight hours (bare minimum of six hours) of direct sun is important. For shade-loving herbs, select a site that has about 75% shade. If the soil is not well-drained, add composted leaves, well-rotted sawdust, or other finished organic matter to a depth of 6 to 8." Most herbs are not fussy about soil type as long as the soil is well drained. Herbs grown in rich soil grow more luxuriantly but may be less aromatic.

Soil preparation: There is a wide range of garden soils. Most soils are adequate as long as there is good fertility and drainage, and the soil pH is in the range of 6.0 to 7.0. Some plants benefit from a more acidic soil. If you don't know the soil pH, consider testing it. You can have an abundance of nutrients in your soil, but they may not be available to plants if the pH is too acid or too alkaline. Beyond the basic requirements of proper pH, fertility, and drainage, all soils benefit from the addition of organic matter. Organic matter has a number of benefits which include: (1) increased moisture retention with better drainage and aeration, (2) higher fertility, (3) sustained release of nutrients, (4) less leaching of nutrients, (5) beneficial soil fungi which help release nutrients and resist disease, and (6) pH buffering which helps keep the soil pH in the proper range. Good sources of organic matter include well-rotted manure tilled into the soil, well-rotted sawdust, broken-down leaves, and compost. It is important to dig in organic matter to a depth of 6 to 8" to prevent loss of nutrients, especially nitrogen. Nitrogen is best supplied from organic matter because there is less pest damage due to the fact that the nitrogen is released to plants primarily as ammonium ions rather than nitrate ions. Phosphorous and potassium are best supplied from rock powders which provide these nutrients as well as trace minerals. Phosphorous can be supplied in the form of rock phosphate and potassium can be supplied from greensand (a rock powder derived from granite). These minerals and trace minerals are also available in good quality compost.

Seedbed preparation: Seedbeds should be tilled or dug under several weeks before planting to help kill weeds and break down plants that have been tilled into the soil. The bed should be dug again before sowing seeds to remove debris and stones. The aim is to break up the soil into small particles. If the seed is small you may have to seed heavily to compensate for environmental factors. For large seeds, like peas, beans, and corn, the soil particles can be relatively large. For small seeds (e.g. basil and parsley) the soil should be well worked and then raked smooth. Small seeds can be sown on the surface and then pressed or tamped into the soil surface. Pressing the seeds lightly into the surface helps maintain consistent moisture levels.

Seed Storage and Longevity

Seed Longevity: Most seeds maintain their viability for about two to three years if they are stored indoors away from excessive heat and humidity.

- **Effect of temperature:** Each 10°F reduction in temperature (down to 32°F) doubles the storage life of seed. This is true only if the moisture content of the seed is less than 14%. At temperatures below 32°F seeds can be stored for several decades provided the seed moisture is low, but if the seed moisture is 14% or above, ice crystals form during freezing and the seed will be damaged.

- **Effect of moisture:**
  Each 1% reduction of seed moisture content doubles the storage life of seed. This is true for seed moisture contents in the range of 5% to 10%. Additional drying below 5% may damage some seeds, especially legumes, because a small amount of moisture is necessary to sustain metabolic processes. Seeds stored in an air-conditioned or heated house

usually have a seed-moisture percent of 11% or below. Seeds stored with a moisture content of 10 to 18% may support the growth of fungi which will slowly degrade the seed. If seed moisture content is greater than 18% moisture content, seeds will decay rapidly due to the metabolic effects of microorganisms. If the moisture content rises above 30% most seeds will sprout.

There are two inexact methods of measuring seed-moisture content: (1) bite test - if the seed feels rubbery when you bite it, the moisture content is too high; (2) hammer test – if the seed shatters under a hammer blow the seed is dry enough for storage.

How to dry seed: Seeds should never be subjected to drying methods that raise the air temperature above 100^{o}F, nor should they be dried so rapidly as to damage the surface of the seed. The best way to dry seed is to place equal weights of seed and color-indicating silica gel in a sealed container for seven days, and then remove the silica gel at the end of that period. Silica gel will lower the seed-moisture content to about 5 to 7% when dried by this method. Then the seed may be safely frozen in an airtight container. This is the way which we store all of our seed after harvest.