

College of Agriculture & Life Sciences
 Department of Horticultural Science

COMMERCIAL GOLDENSEAL CULTIVATION

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Introduction

Goldenseal (*Hydrastis canadensis L.*) is a highly valued medicinal herb which has been collected from the forests in North America for hundreds of years. The historical range for goldenseal in the United States was very broad, ranging from as far north as Vermont and Wisconsin, south to Alabama and Georgia, and west to Kansas. It can still be found growing in patches in moist, rich, hardwood forests in much of this area. The core of the range now appears to consist of Illinois, Ohio, Indiana, and eastern Kentucky. Over the years, goldenseal has been referred to by a large number of other names, including yellowroot, ground raspberry, yellow puccoon, wild circuma, eye-balm, yellow paint, wild turmeric, and yelloweye.

Unfortunately, high demand for goldenseal has caused a serious reduction in native populations. As early as 1884, dramatic declines in wild populations due to overharvesting and deforestation were documented. In North Carolina, goldenseal is an endangered species, making harvest from public lands illegal. In 1997, goldenseal was listed on Appendix II of the Convention for International Trade on Endangered Species of Wild Fauna and Flora (CITES), an international treaty monitoring trade in threatened and endangered species. This listing imposes controls on goldenseal trade designed to protect the species and encourage sustainable use. This has not stopped people from collecting it, however, and populations

continue to decrease. Fortunately, cultivation of this herb is fairly easy.

Regulations

Because of its endangered status in North Carolina, permits from the N.C. Department of Agriculture and Consumer Services, Plant Protection Division are required to cultivate or propagate goldenseal within the state. Permit applications can be obtained by contacting the N.C. Department of Agriculture and Consumer Services, Plant Conservation Program, P.O. Box 27647, Raleigh, NC 27611. Phone number 919-733-3610. You must obtain a CITES permit or certificate before you can export cultivated or wild-collected goldenseal roots or parts of roots. You will need to show that roots, rhizomes, or seeds came from legally acquired parental stock and that the plants were cultivated for four years or more without augmentation from the wild. For permit applications or more information, contact the Office of Management Authority, 4401 N. Fairfax Drive, Room 700, Arlington, VA 22203. Phone 1-800-358-2104 or visit the website at <http://www.fws.gov/r9dia/> for more complete information.

Uses

The medicinal properties of goldenseal are attributed to the alkaloids hydrastine and berberine which are present in concentrations of 2 to 10%. Cherokee Indians used the bitter tasting root of goldenseal for many

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purposes, e.g., as an antiseptic, a general health tonic, and to treat snakebite. Iroquois Indians used it to treat whooping cough, pneumonia, and digestive disorders. Early American pioneers used it primarily as an eyewash and to treat sore throats, mouth sores, and digestive disorders. Commercial demand for the root began in about 1860. It is now a top selling herb in North America and can be found in many formulations in stores across the country. Current uses include treatment of nasal congestion, mouth sores, eye and ear infections, and as a topical antiseptic. It is commonly believed to help boost the immune system and increase the efficacy of other medicinal herbs. Some people also mistakenly believe that goldenseal will mask urine tests for illegal drugs.

Plant Description

(Family-Ranunculaceae, Subfamily-Hydrastioideae). Goldenseal is a herbaceous perennial which emerges in early spring (mid-March to early May) from buds that overwinter on the perennial rootstock. The root system is composed of a bright yellow, horizontal rhizome, $\frac{1}{2}$ to $\frac{3}{4}$ of an inch thick, marked by cup-like depressions where the annual stem falls away. The rhizome is covered with a mass of bright yellow fibrous roots and rootlets. Mature plants (at least three years old) are 6 to 14 inches tall and have two or more erect hairy stems usually ending in a fork with two leaves. The 5 to 7 lobed, palmate, double-toothed leaves are 3 to 12 inches wide and 3 to 8 inches long. After emergence in early spring, flower buds quickly develop and small, inconspicuous, white flowers open as the leaves unfold. Plants started from seed usually flower when 3 to 4 years old whereas vegetatively propagated plants may flower the first year. Each plant can produce a single, green raspberry-like fruit which turns red and ripens in July. Goldenseal spreads into the surrounding area through growth of the rhizomes and fibrous roots. Usually two buds form near the base of the stem on the rhizome for the next season's growth. The plant dies down slowly after the fruit matures.

Cultivation

Goldenseal has been cultivated since the early 1900's and many of the current recommendations for growing goldenseal are surprisingly consistent with those found in a 1914 U.S.D.A. Farmers' Bulletin. The best success with goldenseal will probably be obtained in areas where goldenseal is native. Success in other areas will depend on how well those conditions can be duplicated.

Site Selection

Site selection is the most important factor for producing healthy goldenseal. Goldenseal grows best in a rich, moist, loamy soil with good air and water drainage. Planting on a slight slope will improve drainage. Do not plant in a bottom or in a heavy, poorly drained soil. If growing in the forest, look for a site where there are other woodland plants growing such as mayapple, trillium, bloodroot, and black cohosh. Do not select a site where there is no undergrowth because it is probably too dark for goldenseal. Conversely, try to avoid sites where the undergrowth is particularly thick, such as in a rhododendron thicket, for the effort required to remove the plants and their roots would be too costly. A site with mixed, deeply rooted hardwoods is preferred to a solid stand of conifers or other shallow rooted trees which can compete with the goldenseal for moisture and nutrients. Plantings established under oak, poplar, walnut, and basswood have been successful.

If growing under artificial shade in an open field situation, it is important to choose a site with few weeds or to control the weeds before planting. Grasses can be a very big problem if planting into a pasture without adequately turning the soil to kill existing weeds and seeds.

Do not plant in an area known to be infested with soil-borne diseases, especially *Rhizoctonia*. Also, to reduce the risk of disease, do not replant goldenseal immediately after a crop of goldenseal.

Shade

Goldenseal needs to be grown in the shade, which can be provided artificially or by a natural forest canopy. Artificial shade can be provided by a wood lath structure, a polypropylene shade structure, or by vining plants growing over a support. In a study in progress in western NC, four levels of shade are being evaluated. To date, the best plant growth has occurred under 63% to 80% shade. Plant stand counts and survivability have been highest under 47% and 63% shade. The influence on root growth will not be determined until the fall of the year 2000.

When designing the shade structure or preparing an area in the forest, provide for adequate air circulation. For artificial shade, make the structure 7 ft tall or higher with two ends open to the prevailing breeze. For forest culture, select a site with good air and water drainage in an area shaded by tall, preferably hardwood, trees.

Site Preparation

In a woodland site, remove small, undesirable trees, tree roots, weeds, and other undergrowth. In all cases, till or turn the soil and amend, if necessary. To promote good water drainage and to warm the soil early in the spring, raised beds should be constructed. Beds should be 2 to 6 inches tall and 3 to 4 ft across. Leave sufficient space between beds to allow for easy walking, pushing a wheelbarrow, and kneeling for weeding and picking fruit.

Soil Amendments

Several months before planting, collect soil samples for fertility testing and nematode assays. For most soil testing laboratories, it will be necessary to identify the crop as “native ornamentals.” If soil tests reveal low organic matter at the planned site, increase it through addition of compost. In a study conducted on forest soil in western NC, goldenseal produced the highest root yield when grown in soil amended with 2.7 to 5.2 tons of lime/acre which resulted in a soil pH of 5.5 to 6.0. In this same study, plant survival and root yields decreased as nitrogen (supplied as ammonium nitrate) rate increased. The addition of superphosphate had no effect on plant survival or growth. Based on these results and grower experiences, on a high organic matter soil goldenseal should only receive light fertilization, preferably from an organic source. Sandier soils will require more. In all instances, a balanced fertilizer can be applied at a low rate each spring as growth commences. Some people are reporting positive growth responses to high applications of calcium in the form of gypsum. Preliminary results from studies on the influence of gypsum on goldenseal at the Mountain Horticultural Crops Research Station, however, did not support these observations. In our studies, gypsum applied at 2000 to 5000 lb of calcium per acre, resulted in reduced leaf number and leaf size, increased disease incidence and earlier dieback compared to plants grown in soil without additional calcium.

Propagation

Goldenseal can be propagated from rhizome pieces, root cuttings, one year old seedlings, or seed. It takes 5 to 7 years to grow harvestable roots from seed and 3 to 5 years to grow harvestable roots from rhizome pieces. Root cuttings or seedlings usually take 4 to 6 years. Fall planting has been successful in all growing

areas. Spring planting has also been very successful in the Southeast. In a recent study, goldenseal planting stock (rhizomes with roots or one year old seedlings) held at 40⁰F until planting in early July experienced no ill effects as a result and could not be distinguished from the spring planted material by the following season.

Vegetative Propagation

Goldenseal can be vegetatively propagated by dividing rhizomes into 1/2 inch or larger pieces (2 to 5 grams). Each piece should have healthy roots and, ideally, a bud. Research showed that pieces as small as one gram would produce a plant, but it greatly extended the time to root harvest. In that same study, the presence of roots on the rhizome piece proved to be more important for plant survival than the presence of a visible bud.

Another method of vegetative propagation, called layering, involves removing two inch sections of the strong fibrous roots exhibiting buds or even just a swelling and layering them under one inch of soil or chicken grit in a nursery bed in early spring. The root pieces, which should form buds during the summer, can be planted into production beds the following autumn. Although several growers have reported success with this method, the author has not.

Rhizome pieces, seedlings, and layered plants should be planted in narrow trenches about 2-3 inches deep. Place the planting stock in the trench with the bud facing up and bury with soil. It is common practice to plant goldenseal on a 6 inch x 6 inch spacing. In an effort to optimize production per unit land area, spacing studies are currently underway. Spacings ranging from 2 inch x 2 inch to 12 inch x 12 inch are being tested.

Seed Propagation

Propagation of goldenseal from seed can be difficult with unpredictable results. Germination rates of purchased seed, which has usually been stored in moist sand in a cooler or buried in the soil, can range from 0% to 90% the first spring after seed harvest. In an effort to develop methods to obtain reliable germination rates, seed handling studies have been in progress at the Mountain Horticultural Crops Research Station for several years. In the first study, we found that the best germination rates the first spring after seed harvest were obtained when seeds were quickly extracted from the fruit using a sieve method. The seeds were then stored in moist sand at 70⁰ F until sowing in late fall. This treatment resulted in an average germination rate of 37%

(range 25% to 88%). For many of our treatments, seed did not germinate until the second season after seed harvest. The highest germination rates the second season were from seed that were extracted from the fruit by the sieve method, held at 70° F for 30 days followed by 40° F until planting or held at 40° F. In both cases, the seed were planted the spring after seed harvest and germinated two seasons later. Average germination rate with this method was 45% (range 30% to 71%).

Seed Collection and Stratification

Although studies are currently in progress to determine the best methods for seed handling, within the industry the most popular method is as follows. To collect seed from goldenseal, harvest fruit when fully ripe (red). Mash the fruit by kneading, being careful not to damage the seed, and ferment in water until the flesh can be easily removed from the seed. This usually takes several days. Add water, decant, and rinse until the water and seed are clean. Alternately, spread the seeds out on a fine-mesh screen and spray with a high pressure stream of water. For the large-scale producer there are seed cleaners available that will do all this in one step. Goldenseal seed are small, round, black, and hard. Like ginseng seed, they should never be allowed to dry out. If the seed will not be sown immediately, the most common way to handle it is to mix it with fine, clean, damp sand and place it in a screen pouch or a wooden box with a fine-mesh screen top and bottom. Bury in a shaded, well-drained area exposed to natural rain. If the weather has been very wet or dry, after two weeks, uncover the box and ensure that the sand is damp and not waterlogged. The seed can be planted in late fall or early spring.

Seeds are best planted in a nursery bed. Sow 10 to 12 seeds per ft in rows 3 inches apart with seeds 1/2 inch deep. Use of a mechanical seeding device is recommended. Cover lightly with a mulch to prevent drying of the soil. Goldenseal seed is most commonly sown in the fall. It can also be planted in the spring, but it must be done very early and handled very gently because some of the seed will certainly have germinated by that time.

Mulch

Goldenseal should be mulched to hold in soil moisture, reduce weed growth, moderate temperatures, and provide winter protection. The mulch layer should be

several inches deep at time of planting. Depending on the type of mulch, it may need to be replenished every year or two. In areas where the soil tends to freeze and thaw, several inches of extra mulch should be provided to protect the roots during the winter. The mulch should be raked back to a depth of 1 to 2 inches before the plants emerge in the spring.

Goldenseal is commonly mulched with whole or shredded leaves, hardwood bark chips, hardwood bark and sawdust mixture, or straw. Although straw is used successfully in many areas of the country, in studies at two locations in NC straw has performed poorly. The straw tends to hold excessive moisture near the crown of the plant causing rot. Slugs have also caused significantly more damage in the straw mulched plots than in any other mulch treatment. In two years of growth, hardwood and pine bark mulches have performed well. Plants grown with a fresh sawdust mulch were nitrogen deficient the first year but grew well the second year.

Irrigation

When grown under a forest canopy, goldenseal rarely, if ever, requires irrigation. Under drought conditions, however, if not irrigated the plants will drop their foliage and go dormant earlier than usual. This usually does not harm the plant, but will reduce root growth for that year. If that loss is not acceptable, site selection should include consideration of how to irrigate if necessary.

Pests

Under natural conditions and when grown in small, isolated plots in the woods, goldenseal suffers few attacks from diseases or insects. The major problem in many small plots in the Southeast is slugs which can eat the entire crown of the plant and fruit. Slug control can be difficult and successful methods are often site specific. Control methods that have been successful at some sites include using beer traps, spreading diatomaceous earth (must be replaced after every rain) or a mixture of lime and woodashes around the plants, or applying a commercially available slug and snail bait. If the populations of slugs are intolerable, it may be necessary to remove the mulch from around the plants. Moles and voles may also damage the beds and should be controlled with traps or by bordering the beds with wire mesh set 8 to 12 inches deep in the soil.

If the field is properly prepared and the beds mulched adequately, weeds are not often a serious problem. They can usually be managed by hand weeding several times during the season.

Root knot nematodes will severely reduce growth and root yield of goldenseal. Soil should always be tested for their presence before planting, even in a forest setting.

Five years ago, the only disease commonly reported on goldenseal was botrytis leaf spot. Removal of the affected foliage and the mulch in heavily infested areas, has provided reasonable control. As more and more goldenseal is cultivated on a large scale in the U.S. and Canada, there have been increasing reports of disease. Most of these diseases, however, have occurred under artificial shade structures, not in the forest. Diseases known to attack cultivated goldenseal in recent years include alternaria, rhizoctonia, and fusarium. In artificial shade structures, there may be some problems with damping-off in areas where there is excessive drip from the structure, as under joints and seams. There has been an unconfirmed report of phytophthora root rot. In North Carolina, however, goldenseal has been grown successfully in old ginseng beds known to be infested with *Phytophthora cactorum*.

Harvest

When goldenseal plants have fully occupied the land they were planted in, usually in 3 to 5 years, either harvest the roots or divide the plants. If left undisturbed, the plants will start to crowd themselves out and the oldest roots will eventually die. Dig roots in the fall after the tops have died down. If a market exists for the leaves and stems, harvest them in early autumn while the foliage is still green. Dig roots carefully, keeping the many fibrous roots intact. Small plots can be dug with a fork. Large fields will require some kind of mechanical digger. Modified potato, horseradish, and bulb diggers have been used. Select large, healthy plants for replanting and have a container available to keep them moist and cool or have beds prepared to replant immediately.

Washing and Drying Roots

Carefully wash the remaining roots by spraying with a hose over a large-mesh screen. Remove all dirt, breaking larger roots if necessary, but do not use a brush. There are commercial ginseng root washers available that consist of a drum that turns and tumbles the roots as water is sprayed over them. Simple root washers can be easily constructed.

Spread the clean roots on screens and dry in a well-ventilated area in the shade or in a forced air drier. Simple driers can be constructed from small sheds or rooms in barns. Bulk tobacco barns can also be modified to successfully dry goldenseal roots. The key points are to keep temperatures low, around 95 to 100^o F, and to provide good air flow around the roots. If the roots are dried too hot and fast, the outside of the root dries first, leaving the inside of the root moist. It is then very difficult to extract moisture from the interior of the root. The quality of the roots is then destroyed and the roots will bring a substantially lower price than properly dried roots. Roots will lose about 70% of their weight during drying. Test for dryness by breaking a large root; it should snap cleanly but not be brittle.

Yields and Packaging

Good yield estimates for goldenseal are not currently available due to the tremendous differences among growers in amount of planting stock used, plant spacing, bed and row spacing, and years to harvest. Most commonly reported yields for artificial shade structures are 1000 to 2000 lb of dried root per acre. Yields as low as 800 lb per acre and as high as 3000 lb per acre have been reported. Dried roots should be packed loosely into cardboard cartons or barrels, clean, untreated burlap sacks, or poly-sacks. Store in a cool, dry, dark area secure from insects and rodents.

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