

PEA SHOOTS

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ABOUT PEA SHOOTS

Pea shoots are the young, tender vine tips of green or garden peas (*Pisum sativum* L.) and are consumed as a vegetable. Pea shoots are eaten fresh, lightly steamed or sautéed, and are most commonly served in salads, stir-fries or as an attractive edible garnish. Pea shoots are generally 2–6 inches long, and include 2 to 4 pairs of leaves and immature tendrils; they may also include small flower buds or blossoms. Shoots have a mild “pea pod” flavor and are delicate, crisp, light and refreshing. Hmong, an Asian ethnic group, introduced the use of pea shoots throughout China, Japan and Southeast Asia (Larkcom 1991). Hmong farmers also introduced pea shoots to farmers’ markets in western Washington (Figure 1). Today pea shoots are a popular specialty vegetable in some parts of Asia and Africa (Muehlbauer and Tullu 1997; Kay 1979), and they are gaining popularity in the United States.

CLIMATE

Peas grow best in cool weather and should be planted in early spring or late summer. The ideal mean temperature for growth is 55–65°F (13–18°C). Young pea plants can withstand a little frost, though frost may damage the flowers and pods. As a winter crop, peas tolerate temperatures down to 28°F (-2°C)

in the seedling stage, but top growth may be damaged when the temperature falls below 21°F (-6°C) (Slinkard *et al.* 1994).



Figure 1. Hmong farmer selling pea shoots at Pike Place Market in Seattle, Washington.

SOILS

The best soils for peas are silt loams, sandy loams, or clay loams. Peas generally tolerate both sandy and heavy clay soils; however,

proper drainage has to be ensured as peas will not thrive well in waterlogged conditions. Peas grown in wet soils develop a shallow root system, and when the soil dries, the root system will be insufficient to absorb enough water to sustain plant growth. Root rot is also a predominant disease in cool, wet soils, and is a major problem in early season peas (Hemphill 2001). Peas are very sensitive to soil compaction, so it is best to avoid or reduce cultivation when soils are wet.

SOIL pH

Peas are fairly sensitive to soil acidity and the optimum soil pH range for pea production is 6.0 to 7.0. In the maritime Pacific Northwest, soils typically have a pH range of 5.3 to 5.5 (slightly acidic). Lime application is suggested when the soil pH is 6.5 or below, or when calcium (Ca) levels are below 5 meq Ca per 100 grams of soil. Conduct a soil test in early fall of the year preceding pea planting to determine if you need to apply lime to your soil. If test results indicate the soil pH is too low, apply ground agricultural limestone at the recommended rates based on your soil analysis test. Soil pH and recommended application lime rates will be given in the analysis report of your soil test. Table 1 gives general guidelines for lime application based on soil pH if specific recommendations for your soil are unavailable; however, lime application rates depend on soil type. To be most effective, apply the lime in the fall preceding spring planting and mix it with the surface 5 to 6 inches of soil.

TABLE 1. Lime application rates for peas in tons per acre (T/A) based on soil pH test results (Hemphill 2002).

Soil test pH	Apply lime (T/A)
Below 5.5	6
5.5–5.7	5–6
5.7–5.9	4–5
5.9–6.1	3–4
6.1–6.3	2–3
6.3–6.5	1–2
Over 6.5	0

FERTILIZER

Optimum soil fertility is essential to produce top quality pea shoots and high yields. If you use compost, broadcast it prior to final field preparation and thoroughly incorporate into the top 5–6 inches of soil. Base compost application rates on the nutrient content of the compost. That is, apply enough compost to meet the nitrogen, phosphorus or potassium needs of the crop, but do not exceed any of the nutrient application rates. Refer to *Fertilizing with Manure*, Pacific Northwest Extension publication PNW 533, to learn more about how to calculate appropriate application rates for compost and manure (Bary *et al.* 2000). Fresh manure should not be applied within 90–120 days of harvest for a crop that will be eaten fresh or uncooked (Rangarajan *et al.* 2000). Before using fresh manure for vegetable production, check with your local Extension office to obtain current recommendations.

Apply fertilizer at planting in a band next to the seed row. Band the fertilizer approximately 2 inches to the side of the seeds and 2 inches below the seeds. If you do not have equipment to band fertilizer at planting, broadcast and plow down the fertilizer prior to planting.

Nitrogen

Peas are a legume and have the ability to fix nitrogen from the atmosphere. Applications of large amounts of nitrogen fertilizer are not required to grow a healthy crop of pea shoots. To ensure a healthy young pea crop, apply 20–30 pounds of nitrogen per acre at planting in the fertilizer band with phosphorus and potassium. Applying higher rates of nitrogen to the soil will inhibit the nitrogen fixation process (Hoare 1935).

To ensure that peas can fix nitrogen, inoculate pea seeds with *Rhizobium leguminosarum* before planting. Rhizobia are naturally occurring soil bacteria that fix nitrogen. They live in symbiosis with legume plants and can be found in the nodules on legume plant root systems. Many species of *Rhizobium* exist and each is specific to a particular species of legume plant. If you use a *Rhizobium* species specific to beans, soybeans or any other legume, it will not work for peas. Although the *Rhizobia* are naturally occurring, they may not be found in every soil or every year. Inoculating the seed each year ensures that the nitrogen-

fixing bacteria will be available each year. Rhizobium can be purchased from most seed catalog companies that sell pea seeds.

Phosphorus and Potassium

Refer to your soil test results to determine how much phosphorus (P) and potassium (K) should be applied for good pea production (Table 2). Do not apply more than 80 pounds of phosphate (P_2O_5) and 60 pounds of potash (K_2O) per acre in the band at planting. If additional phosphorus or potassium is required, apply the balance in a side dress application 6–8 weeks following planting (Hemphill 2001).

Sulfur

Small quantities of sulfur may be required for good pea production. Refer to your soil analysis results to see whether sulfur is recommended. Gypsum is a good source of sulfur and because it also contains calcium, it does not alter the soil pH. Fertilizers such as ammonium sulfate can be applied at planting and will provide the sulfur needed for good crop growth. Apply 20–30 pounds sulfur per acre in the form of sulfate at or prior to seeding. Elemental sulfur is another source of sulfur, but it must be converted to the sulfate form in the soil before it is available for plant uptake. Apply fine-ground (less than 40-mesh) elemental sulfur in the year preceding pea production. Sulfate and elemental sulfur both have an acidifying effect on soil and will cause the soil pH to drop. If you apply these sources of sulfur, also apply lime to maintain a soil pH in the range of 6.0–7.0.

Magnesium

When the soil test value for magnesium is below 0.5 meq/100g or when the calcium level is 10 times greater than the magnesium level, apply 10–15 pounds of

magnesium per acre in the fertilizer band at planting (Hemphill 2001). Dolomite, a form of limestone, is a good source of magnesium. Broadcast dolomite and mix it into the seedbed several weeks in advance of seeding and preferably the preceding year. An application of dolomite can be effective for several years.

Manganese

Under low soil pH conditions, manganese may be unavailable for plant uptake. Symptoms of manganese deficiency include bright yellow interveinal areas on leaves while leaf veins remain green. To ensure that soil manganese is available for plant growth, maintain a soil pH of around 6.5. If the soil is low in manganese, apply no more than 75 pounds manganese sulfate per acre prior to planting. If manganese deficiency symptoms are observed in a growing pea crop, apply a foliar spray of manganese chelate at a rate of 0.12 pound per acre at first bloom (Hagedorn 1984).

Selecting a Variety

Though many pea varieties can be used for producing pea shoots, snow and snap pea varieties may be the most flavorful and attractive (Table 3). Sweetness, succulence and tenderness are the major qualities valued in pea shoots while varieties that are leafy with short, tender stems and few tendrils are the most suitable for culinary uses (Figure 2). Pea shoots that have immature blossoms are attractive for use in fresh salads or as an edible garnish; thus, flower color may be a factor for consideration when choosing a variety. Current trends appear to favor pea shoots with pink or purple blossoms, but all blossom colors can be attractive in a fresh salad.

Afila pea varieties produce many tendrils and may appear attractive as a garnish (Figure 3). However,

TABLE 2. Phosphorus (P) and potassium (K) application rates in pounds per acre (lb/A) based on soil test results in parts per million (ppm) (Hemphill 2001).

Soil test P (ppm)	Apply Phosphate (P_2O_5) lb/A	Soil test K (ppm)	Apply Potassium (K_2O) lb/A
0–15	120–150	0–100	90–120
15–60	80–120	75–150	60–90
Over 60	40–80	150–200	40–60



Figure 2. A snow pea (left) and a snap pea variety (right) at approximately six weeks after planting. Snow pea variety is more compact with shorter vines than the snap pea variety.



Figure 3. Snow pea variety (left) and afila pea variety (right). Afila variety produces many tendrils which may appear attractive, but are not palatable.

the tendrils are not palatable. The afila (*af*) gene is a naturally occurring mutation in peas that replaces pea leaflets with tendrils (Goldman *et al.* 1992). Tendrils can cause an unpleasant eating experience. A Southeast Asian saying which best describes this phenomenon is “tendrils tie your tongue” (Chao 1998, personal communication).

The flavor of different pea varieties can vary from site to site and from year to year. To ensure good-tasting pea shoots, it is especially important to adjust soil pH and soil nutrition to meet specific pea needs. It is important to note that the shoots of flowering sweet pea (*Lathyrus odoratus* and other *Lathyrus* spp.) are poisonous (Bluhm 1991). They are classified into toxicity category 1 and can cause systemic toxicity of varying degrees from mild abdominal cramping to serious cardiac complications depending upon the quantity ingested or the part of the plant consumed (Kingston 1994).

Disease Resistance

If you plant peas after April 1, or if you intend to harvest throughout the summer, plant varieties that are resistant to pea enation virus, such as Oregon Giant, Oregon Sugar Pod II and Cascadia. Pea enation virus is a disease spread by the pea aphid (*Acyrtosiphon pisum*) and green peach aphid (*Myzus persicae*). By planting after April 1, young plants are exposed to migrating aphids that carry the disease. The disease causes vein flecking (translucent windows), blister-like outgrowths in the leaves, pod distortion, stunted plants and reduced yield (Zitter 1984). Peas are particularly susceptible to pea enation virus when tem-

TABLE 3. Pea varieties well-suited for pea shoot production (Miles *et al.* 1999).

Variety	Type	Growth Habit	Disease Resistance
Snowgreen	Snow	Short Vine	None
Oregon Sugar Pod II	Snow	Bush	Fusarium wilt race I Pea enation virus
Oregon Giant	Snow	Bush	Fusarium wilt race I Pea enation virus Powdery mildew
Cascadia	Snap	Bush	Pea enation virus Powdery mildew

peratures are greater than 72°F (22°C) (Hagedorn 1976). In addition to pea, the virus affects broad bean, sweet pea, alfalfa and other perennial legumes (Pscheidt and Ocamb 2002).

PLANTING

Pea shoots can be produced in the field or in the greenhouse. In the field, plant peas once soil temperatures reach 40°F (4°C) and the ground is dry enough to work. This may be as early as February in the maritime Pacific Northwest. Peas can also be planted in the late summer and early fall for a late-season crop.

Pea seeding rate (pounds per acre) will depend on in-row and between-row spacing (Table 4). To calculate how many pounds of pea seed you will need, it is helpful to know that a pound of pea seed contains 1760 seeds on average. In the field, space rows far enough apart to accommodate machinery and harvesting needs. Ideally, in-row spacing should be 2–4 inches, and rows should be spaced at least 6 inches apart. If you are planting on beds, plant 2–6 rows per bed. Two rows per bed will accommodate most standard cultivation equipment, whereas 6 rows per bed will result in a solid bed of peas that will require hand weeding. The width of the bed should be such that a person can reach into the center to harvest shoots. Plant peas 1–1½ inches deep (Elkner *et al.* 2001).

In the greenhouse, pea shoots may be grown all winter long with little or no heat. Maintain a minimum greenhouse temperature of 40°F (4°C) to grow pea shoots, though plants will not be damaged by temperatures as low as 28°F (-2°C). Greenhouse lighting will be nec-

essary from November through March to prevent vines from growing too tall and thin. Specific studies have not been conducted with pea shoots; however, greenhouse lighting studies with lettuce and other green leafy vegetables showed that high pressure sodium (HPS) or low pressure sodium (LPS) lamps increased plant yield (Koontz *et al.* 1987; Cathey and Campbell 1979). Wittwer (1965) showed that supplemental carbon dioxide and light increased lettuce yields up to 150%, and the time required for growing a crop could be reduced by as much as one-third. For more information about greenhouse lighting refer to *Lighting for Plant Growth* by Elwood D. Bickford and Stuart Dunn.

Plant peas in the greenhouse when temperatures begin to cool in September, or four weeks before field production of pea shoots ends. In this way, a continuous supply of pea shoots can be produced. Direct seed peas into pots or flats. Space seeds 1–2 inches apart, being careful not to allow seeds to touch as this increases the chance of seed rot (Larkcom 1991). Clip off the tips of the pea vines when the plants are 6–8 inches tall to encourage them to develop multiple branches or vines that can in turn be harvested as pea shoots (Figure 4). If you clip off the tip plus a pair of leaves, this can be your first harvest.

PEST CONTROL

Weeds will likely be a major pest in pea shoot production in the field. Cultivate the peas early to control weeds. Once pea vines begin to develop, cultivation becomes very difficult. If you use herbicides or other pesticides, pay strict attention to preharvest intervals as pea shoots are harvested when the plants are only

TABLE 4. Number of plants per acre and seeding rate (pounds per acre) of peas based on in-row and between-row spacing.

Between-row spacing (inches)	In-row spacing (inches)	Number of plants per acre	Pounds seed per acre
6	2	522,720	297
6	4	261,360	149
24	2	130,680	74
24	4	65,340	37



Figure 4. First cut pea shoots when plants are 6–8 inches tall (left). Plants will continue to grow by developing branches at the leaf nodes (right).

6–8 weeks old. Read all pesticide labels carefully before application and refer to your local Cooperative Extension office if you have any questions regarding pesticide application.

Root rot is the primary disease affecting peas in the Pacific Northwest. Root rot is a general term used to describe disease that is caused by several different fungal pathogens commonly occurring in this area, including *Fusarium*, *Aphanomyces* and *Pythium* species. The effect of all the pathogens on aboveground growth is somewhat similar, but the symptoms on roots are different (Table 5). Aboveground plant growth is generally stunted and chlorotic, and leaves begin

to die from the bottom of the plant upwards due to reduced root growth and low ability to take up water and nutrients. Refer to *Pacific Northwest Plant Disease Management Handbook* (Pscheidt and Ocamb 2002) or *Compendium of Pea Diseases* (Kraft ad Pflieger 2001) for detailed descriptions of disease symptoms.

There are essentially no cost-effective chemical controls for root rot. Fumigation will control root rots, but is not typically cost effective, and seed treatments are generally not effective. There are currently no resistant pea varieties. The best control strategies are to manage the soil and planting environments to minimize the likelihood of infection. Factors that stress the plant and reduce root growth can promote the diseases. Thus, do not plant peas in fields where soil is saturated, compacted, acidic (pH below 6.2), or is of low fertility. Avoid disease buildup in the soil by rotating peas—do not plant peas in the same field more than once in five years. Plant peas early in the year when soil and air temperatures are cool, and avoid summer production. Use high quality seed and do not save seed from infected plants.

Pea enation virus is another common disease affecting peas in the maritime Pacific Northwest. To avoid pea enation virus, plant resistant varieties, plant early, and exclude aphids that vector the disease. If using pea enation susceptible varieties, plant before March 31 to avoid aphid infestation.

TABLE 5. Symptoms on pea roots due to infection by pathogenic *Fusarium*, *Aphanomyces* and *Pythium* species (Kraft and Pflieger 2001).

Pathogen	Predominant Point of Infection	Root Symptoms
<i>Fusarium</i>	Main and secondary roots	Reddish brown streaks turning to dark reddish brown especially at the soil line.
<i>Aphanomyces</i>	Main roots	Straw-colored tissue that softens and turns honey-brown as infection progresses. When an infected plant is pulled from the ground, a strand of vascular tissue may be all that remains of the roots as the outer layers are destroyed due to rot.
<i>Pythium</i>	Secondary root tips	Tan to light brown color. "Root pruning" or reduced root length.

IRRIGATION

Irrigation is not necessary for a spring or fall pea shoot crop, but it is necessary for peas grown from June through August. Irrigation rates and frequency depend on soil conditions and air temperatures. Heavy soils will require less irrigation than lighter soils, and you may need to apply irrigation more frequently when temperatures are above 80°F for more than a week at a time. In the summer months, apply approximately 1 inch of water every two weeks to a well-drained, medium-weight soil. Over-irrigation and irrigating before peas develop their first flowers will reduce yields (Hemphill 2002). Do not irrigate peas after flower petals begin to fall as this may increase diseases. If water pools on the soil surface during irrigation, reduce the amount of water being applied. If water does pool on the soil surface, this is an indication of waterlogged conditions and drainage needs to be improved for future plantings.

HARVESTING

If you clipped off the growing point plus one pair of leaves when the plants were 6–8 inches tall to encourage branching, this was your first harvest. Otherwise, harvest pea shoots when plants are 12 inches tall, about 6–8 weeks after planting. Clip the top 2–6 inches of the plant. The first harvest will yield only 1 shoot per plant, but the second harvest will yield 2–3 shoots per plant. The plants can be harvested again after sufficient regrowth has occurred, in approximately 3–4 weeks.

Whether you grow pea shoots in the field or in the greenhouse, harvest the young growing tips of the pea vines. Pea shoots should include the top pair of small leaves, delicate tendrils, a few larger leaves, and blossoms or immature buds. Shoots that have immature blossoms are especially attractive for use as an edible garnish or as a fresh salad green. However, to concentrate the plant energy on vine production, remove flowers to prevent the formation of pods. Select shoots that are fresh, crisp, bright green in color, and undamaged. Pea shoots are hand harvested and bundled; therefore, they are not suitable for mechanized farming systems. Immediately after harvest, pre-cool pea shoots in ice water and place

in cool, moist storage. Do not pack tightly into boxes or crates as pea shoots will be bruised and crushed.

Though pea blossoms and pea pods are susceptible to frost damage, pea shoots can be harvested throughout the winter if the crop is protected from severe temperatures. A single planting can be harvested throughout the growing season. It is important to check the flavor of the shoots to ensure high quality. If shoots begin to taste bitter, stop harvesting. Observations in western Washington indicate that it is possible to mow plants to 2–4 inches in height in July and the plants will regrow to produce a fall crop.

STORAGE

Pea shoots are fragile, very perishable, and best used within one or two days of harvest. At home, keep them wrapped in paper towels in an open plastic bag in the vegetable bin of the refrigerator (Ross 1996). Very little information is available on pea shoot storage conditions; however, they are likely similar to the storage conditions for lettuce and spinach. Rapidly precool pea shoots to 32°F (0°C), and store at 32–34°F (0–1°C) and 98–100% relative humidity (Graeme 1999). Freezing will damage leaf tissues, so maintain storage temperatures above 28°F (-2°C) (Hardenburg *et al.* 1986).

MARKETING

Pea shoots can be marketed as a salad green, a green vegetable, or an edible garnish and should include the top pair of immature leaves, tendrils, and flower buds or immature pods. Pea shoots tend to be larger when they are used as a green vegetable or an edible garnish (4–6 inches), and smaller when they are used as a salad green (2–4 inches) (Figure 5). Young flowers or immature pods can increase the value of pea shoots in a salad mix. The market value of pea shoots as a salad green is generally greater than the value as a green vegetable. Prices for pea shoots as a vegetable vary between \$4–\$8 per pound depending on quality and location. To determine an approximate price for pea shoots as a salad green, evaluate the price by weight of a high-quality salad mix in your area, and

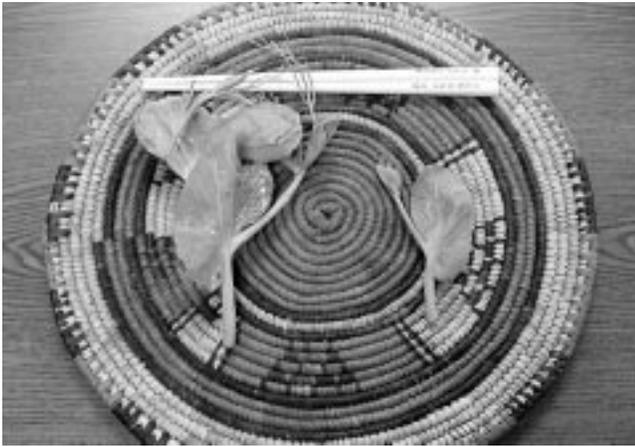


Figure 5. Pea shoots are larger when they are used as a green vegetable or an edible garnish (4–6 inches), and smaller when they are used as a salad green (2–4 inches).

price your pea shoots similarly. A lightly packed cup of pea shoots weighs approximately 1/2 oz (14g), and there are approximately 32 cups of pea shoots in a pound.

NUTRITIONAL VALUE OF PEA SHOOTS

Pea shoots are a green leafy vegetable and generally are a good source of several vitamins and minerals (Table 6). They are high in Vitamin K and Vitamin C, and are an excellent source of Vitamin A. To preserve the healthy nutritional aspects of pea shoots, eat them fresh or lightly steamed or sautéed. Before eating pea shoots, remove any coarse stems, rinse under cold water, and spin dry in a salad spinner.

TABLE 6. The percent of recommended daily amounts (RDA) of vitamins and minerals for adults contained in one ounce (approximately 2 cups) of fresh pea shoots (adapted from the Japanese Standard Tables of Food Composition, 4th edition).

Potassium	3%	Folate	10.5%
Vitamin C	35.5%	Thiamin	5.75%
Vitamin A	15%	Riboflavin	7%
Vitamin E	8.75%	Vitamin B-6	4.75%
Vitamin K	132%	Fiber	3.5%

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