



## Growing a Goose Foot Trio: Spinach, Beets, and Chard

The Chenopodiaceae or goose foot family (the reference is to the deltoid-shaped leaves) is a numerically small plant family (100 genera, 1,500 species). The family has many weedy species and only a few garden vegetable crop representatives, mostly annuals and biennials –

<i>Spinacea oleracea</i>	Spinach
<i>Beta vulgaris</i>	Beets (table, sugar, mangel [cattle fodder])
<i>Beta vulgaris cicla</i>	Chard
<i>Atriplex hortensis</i>	Orach
<i>Chenopodium album</i>	Lamb's quarter
<i>Chenopodium quinoa</i>	Quinoa

Family members occur primarily in temperate and subtropical climates. They often populate saline habitats—the salt-rich steppes of Central-Eastern Asia, marshes, bogs and river estuaries of the Eastern Mediterranean Zone, the Red and Caspian Seas. Chenopodiaceae members are classified as halophytes, plants that can tolerate high concentrations of sodium salts in the soil and an associated high pH >7.0. They also reside where there are high atmospheric salts, sea sprays, etc.

Members of the Chenopodiaceae family (Chenopods for short) have evolved several ingenious strategies to cope with salty conditions. Many species have a deeply penetrating tap root that can draw on fresh water beneath either salty or brackish surface water. They also have a waxy leaf cuticle that both retards the transpiration of precious fresh water and protects against depositions of atmospheric salts. Chenopods also have very efficient “sodium pumps” that remove sodium from their cells and deposit it either outside of cell walls or into a membrane-bound cavity within the cell (a vacuole), which functions as a “toxic dump.”

Chenopods are wind pollinated, with small, inconspicuous flowers. Since there is no need to “advertise” for pollinators, they partition their resources differently, putting more energy into developing leaves.



Melissa Beveridge

### SPINACH (*SPINACEA OLERACEA*)

Spinach is a fast-growing annual crop cultivated for its nutritious, succulent leaves. It is generally grown in two ways –

- 1) Baby or loose pack style
- 2) Mature bunching style (whole plant harvested)

Baby or loose pack spinach can be seeded intensively (10–20 seeds/foot), harvested at 20–30 days after germination, and enjoyed raw by itself or included in fresh salad mixes.

Mature bunching spinach is seeded at 6–10 seeds/foot, harvested at 30–50 days after germination, and used either raw, lightly steamed, or in a stir-fry.

**Environmental Conditions.** Spinach is emphatically a cool season crop. Along with peas, spinach is among the first sown and earliest harvested of garden vegetable crops. It is a cool temperature germinator (60 days to emergence at 30°F, 27 days at 40°F), or so the texts claim. At a more genial 50°–70°F, emergence occurs at 6–12 days and maturation at 30–50 days. Thus it doesn't really make sense to sow at temperatures below 50°F. At the upper end of the temperature range, spinach experiences a thermodormancy and markedly suppressed germination will occur when soil temperatures are in the mid 70's. Even at 70°F, germination can be retarded as much as 50%. This thermodormancy is a natural strategy to prevent germination at a time of year when growth would be poor. Quality (succulent and sweet) spinach is best produced with 30–50 days of night-time temperatures from 40°–50°F, and daytime temperatures from 55°–65°F.

Spinach is also a day-length sensitive plant. Most modern varieties respond to day lengths greater than 14 hours (early May–early August in Santa Cruz at 38° latitude) by bolting and running to seed. Some older varieties and over-wintering types bolt at 12 1/2 hours of day length. Thus varietal resistance to bolting is an important selection criterion. With requisite day length and cool temperatures (<75°F) bolting is retarded; with requisite day length and warm temperatures (>75°F) bolting is accelerated. Large plants and crowded plants respond more quickly and run to seed. A cold exposure (<50°F for >10 days) followed by warm temperatures, especially in conjunction with lengthening days, also hastens bolting.

Spinach (as well as lettuce) perceives light via a plant pigment (photochrome) in its outer leaves. Photochrome is biologically active and stimulates enzymatic reactions. It is the basis of photoperiodicity in plants. In this case it causes

the production of the hormone florigen, which translocates from outer leaves to the apical growing point and induces flowering. The home gardener strategy of successive harvests of outer spinach (and lettuce) leaves delays bolting by as much as 1–2 weeks under cool conditions.

**Sowing.** Because spinach develops a deep tap root (and therefore doesn't transplant as effectively as crops with more fibrous roots, such as lettuce) it should be directly sown 1/2" deep. It can be planted in rows as close as 4"–6" apart for baby loose-pack or rows 10"–12" apart for full size plants. Seeding density –

- Baby: 10–15 seeds/foot, no thinning
- Full size: 6–10 seeds/foot, thin to 6"–8" early and throw the trimmings (*sans* roots) into a salad bowl.

Timing and strategies for sowing –

*Spring crops* – sow 4–6 weeks before 14 hour day lengths

*Summer crops* – pre-chill (refrigerate) seed 3–5 days to overcome thermo dormancy. Cold, frequent water, light shade cloth, and a thick mulch can retard soil temperatures and prolong cropping.

*Fall/Winter crops* – sow 4–6 weeks before first frost, mulch heavily once crop is established.

Spinach seed is only viable for 2 to 3 years, so buy small lots annually.

**Watering.** Spinach can tolerate some soil drying during germination—but don't push it. Once germinated, spinach is all about quick, succulent growth: provide 1"–2" of irrigation per week at 3–5 day intervals to a depth of 12" at maturity. Overhead watering is okay, but warm and wet weather promotes mildew; T-tape or other drip irrigation is a valuable tool in preventing mildew problems.

**Soils/pH.** Spinach can succeed in a wide range of soils. Sandy soils offer quick drainage and early warming in the spring. Clay soils offer greater water- and nutrient-holding capacity. The issue with clay is drainage, which is requisite for the 8"–15"-long primary tap root of spinach; the well-dug raised bed can be an ally in helping clay soils drain effectively.

Spinach is a very pH-sensitive plant (as are all chenopods) and does not perform well in even mildly acidic soils (<6.5 pH). Under acidic conditions it exhibits chlorotic (yellow) and stunted leaves that mature slowly. Soil pH can be adjusted by adding lime. Liming agents (calcium carbonate and dolomitic lime stone) have ancillary benefits in addition to adjusting soil pH. Lime increases the availability of nitrogen by promoting nitrifying bacteria (nitrosamines) that convert ammonium ( $\text{NH}_4^+$ ) to nitrate ( $\text{NO}_3^-$ ), a more usable form for plant uptake. Liming also promotes heterotrophic organisms that speed up the breakdown of organic matter, making phosphorous and molybdenum more available. *Caveat:* Adding too much lime, especially on sandy soils, can liberate nutrients in the short run but "burn out" a soil in the long run unless accompanied by the addition of organic matter. Thanks to the soil types on which it evolved (see above),

spinach is tolerant of alkaline soils (pH >7.0), the optimum range being pH 6.5–7.5.

**Nutrients** [N 60–100 lbs/acre; P 12–35 lbs/acre; K 50–100 lbs/acre]. As a fast-growing leaf crop, spinach puts a premium on quickly available nitrogen in the form of nitrate ( $\text{NO}_3^-$ ). Availability or uptake can be a problem in cold, wet, and poorly drained soils seasonally. The remedies –

- Wait until the soil warms (patience).
- Incorporate fully mature, fine particle size compost, as the smaller the particle size, the quicker and greater the  $\text{NO}_3^-$  availability.

Potassium (K) is a much overlooked but important nutrient for all leaf crops. In layman's terms, potassium "mellows" the rapid growth of nitrogen by creating a good "rib structure" to support the succulent growth. It gives the leaf "strength." Potassium speeds growth, enabling quick maturation while the weather is still cool and days are short. On a cellular level, potassium regulates the opening and closing of stomata as well as water retention. This regulation promotes rapid photosynthesis and quick, succulent growth, all toward a good end (product). A well-seasoned compost that contains poultry manure (high N, high P), and horse or pig manure (high K) goes a long way toward meeting the primary nutrient needs of spinach.

**Seed Saving.** Spinach is dioecious (literally meaning two houses), with male plants (pollen bearing) and female plants (seed bearing). Additionally, plants express themselves according to their flowering habits –

*Extreme male plants* – small plants, small deltoid-shaped leaves, early bolting. These are usually the weakest plants and the first 10% of bolters in a stand. They should be rogued out (pulled and discarded).

*Vegetative males* – larger leaves, early bolters.

*Female plants* – these are largest leaved and the last to bolt. Spinach is a wind pollinated species. Pollen is light and transferred by wind (up to 1 mile) from male to female plants.

Commercial seed mixes contain mostly vegetative males and female plants. A ratio of 1 male to 2 female plants is adequate for pollen transfer. Only one variety at a time can be saved, or varieties can be isolated by caging them with cheesecloth or remay (the fine grained pollen can pass through mesh screen). The seed is mature when it is hard and turns dark, dirty brown and can easily be stripped off the plant. By only saving seed from the last 10–20% of bolting plants it is possible to develop an endemic variety in your garden with higher yields and a longer cropping period.

**Nutrition:** 1 cup of spinach –

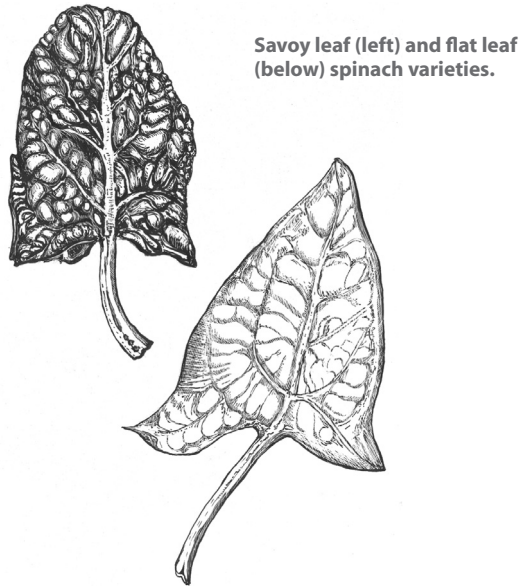
40 calories	
100% RDA	Vitamin A
62% RDA	Vitamin C
60% RDA	Thiamine
40% RDA	Iron*

It is also a moderate source of vitamins B6 and Niacin

\*Note: Oxalates are the salts of oxalic acid, which is a byproduct (waste) of plant metabolism found in most chenopods. Oxalic acid crystals can be seen on the underside of spinach leaves. Its presence is most pronounced just prior to flowering. The sodium and potassium salts are soluble, but the calcium salts are insoluble. They can irritate the mouth and digestive tract. Calcium combines with the soluble oxalates to form kidney stones. So while spinach is a healthful foodstuff, there can be too much of a good thing.

### Spinach Varieties of Note

Spinach varieties come in two basic leaf types: flat leaf and savoy (wrinkled) leaf (see illustration). In general, western growers favor flat leaf types and eastern growers savoy types. Flat leaf types are more succulent; savoy leaves are sturdy, darker, and more nutritious. The leaf vein on savoy leaves grows more slowly than the rest of the leaf, giving it more surface area and more nutrition per unit of space.



Savoy leaf (left) and flat leaf (below) spinach varieties.

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*America* (43–55 days; Seed Savers Exchange) – Bloomsdale type. Longstanding, bolt-resistant, compact plant, dark, thick savoyed leaves, slow growing, slow bolting, heat tolerant.

*Bloomsdale Longstanding* – (50 days to maturation; Territorial Seed Co., Fedco Seeds, Seed Savers Exchange). Longtime open pollinated, thick, dark savoy leaf standard. Definitely prone to bolting despite what catalogs advertise. Best as early spring, late summer crop. About the best winter cold tolerance (if fully established). Dates back to early 1900s and Holland. Best as full size plants.

*Geant d'Hiver (Giant of Winter)* (Fedco Seeds) – Old rapidly vanishing French variety that, along with the aptly-named *Monstreaux* (virtually vanished) offers some of the biggest, thickest, yet melt-in-your-mouth succulent, most bolt-prone spinach on the market.

*Olympia* (38 days; Fedco Seeds) – A hybrid bred specifically for fall, winter crops. Bolt prone in spring. Fast growing, tender taste, high yields.

*Oriental Giant*: (40 days; Territorial Seed Co.) – Produces up to three times yield of other varieties. 12–15 inches tall, upright, smooth leaf, sweet taste.

*Space*: (37 days; Johnny's Seeds, Fedco Seeds) – Slowest-bolting smooth leaf type. New highly productive hybrid. Upright growth, smooth, slightly savoyed leaf. Vigorous and quick to mature in all seasons, especially fall–winter.

*Teton*: (45–50 days) – Good for late spring, summer, fall production. Slow bolting, dark green, smooth leaves. Upright growth habit. Easy to harvest.

*Tyee* (44 day; Fedco Seeds) – An older hybrid. The most bolt-resistant spinach with savoy leaf, upright habit, good taste.

### BEETS (*BETA VULGARIS*)

Beets are herbaceous biennial plants requiring two seasons (parts of two calendar years) to produce seed. The species probably evolved from a wild species, *Beta maritima* (Sea Beet), native to coastal marshes and estuaries in southern Europe. The crop has been in cultivation in one form or another since Roman times.

Beets are an extremely versatile crop offering a variety of shapes, sizes, colors, and uses. They can be grown as a leaf crop, using baby thinnings raw in salads to full-size steamed greens. In fact, there are varieties that are bred primarily for their abundant, attractive, tasty, and nutritious tops. One cup of beet greens provides 185% R.D.A. of Vitamin A, 20% R.D.A. of riboflavin, and 20% R.D.A. of iron (see varieties section). Other beet types and uses include: round table beets of diverse colors, pickling beets (cylindrical shape), sugar beets (rough and coarse-textured, from which 30% of the world's sugar is produced), and fodder mangel or mangel wurzels (often fermented and used as an animal fodder for diverse livestock—from rabbits to pigs to cattle).

**Cycle of Growth.** Beets usually complete their life cycle in two years. Germination and vegetative establishment occur in the spring and summer of year one, followed by root enlargement. The “root” of the beet is actually the swollen hypocotyl (the germinating shoot in seedlings, from the prefix *hypo* meaning under). In mild climates beets stay evergreen over the winter; in colder climates they lose their foliage. In the spring of year two beets make a little foliage growth and then—as a response to a cold chill (< 50°F for greater than two weeks) followed by a warm period in conjunction with the lengthening days of spring—will flower, set seed, and die. Sometimes as a response to back and forth weather, early spring beets will receive a cold chill sufficient to cause bolting.

A variety of plants (beets, carrots, radishes, turnips, etc.) form storage roots as a dividend after first meeting their basic foliage and root requirements. Thus with beets, quick establishment and a healthy, leafy plant give way to big, sweet beets.

Beets form concentric rings of vascular cambium (xylem and phloem) as part of the root enlargement process. The rings or zonation in a beet consist of conductive tissues (xylem



toward the inside and phloem toward the outside). Mixed in with these narrow, light-colored conductive tissues are bands of dark, broad storage tissues. This zoning varies in thickness and color with different cultivars. Probably the most striking example of this is the Italian heirloom variety Chioggia—with its alternating interior rings of pink and white, and its sweet flavor, the epithet candy stripe or candy cane befits it.

Beets get their color from a group of pigments called anthocyanins. The specific pigment betacyanin contributes to red coloration. Golden and yellow varieties derive from betaxanthin. Betacyanin is neither heat nor water soluble, so it is not destroyed in the cooking process and will bleed red into soups and stews. The yellow betaxanthin is destroyed by cooking and thus doesn't stain.

Chioggia beets display alternating rings of pink and white conductive and storage tissues.



### Cultivation

*Seed viability.* 2-4 years optimal

*Seed planting depth.* 1/2"–3/4"

*Seeding density.* Direct in rows 10"–14" apart with 10–15 seeds per foot. Thin to 3"–5" apart (depending on the size of the variety at the four-leaf stage).

*Germination.* 50°–85°F/65°–75°F optimal  
10–14 days/7–9 days

*Soils/pH.* As with most root crops, an open, friable soil with good aggregation and a sandy or silty texture well fortified with organic matter grows the biggest roots with even shape. As with all Chenopods, acid conditions slow growth; a pH of 6.2–6.8 is optimal. Beets can tolerate a pH as high as 8.0.

*Water.* 2"–4" every 7–10 days

*Nutrients.* Moderate nitrogen, 50–100 lbs/acre; moderate phosphorous, 25–50 lbs/acre; high potassium, 100–300 lbs/acre

Nitrogen is needed early in the growth cycle, but should be limited later. Beets have high micronutrient needs, especially for boron. Boron deficiencies cause black spotting (internally and externally) and are also exacerbated in soils low in boron, high in calcium, with a high pH and under dry conditions. Other important beet micronutrients: iron,

manganese, copper, and molybdenum. Granulated and liquid kelp products are an organic gardener's insurance policy against micronutrient deficiencies.

*Timing.* Cool nights (40°–55°F), warm, sunny days (60°–75°F) coupled with an open, permeable soil and a steady supply of water (2"–4" every 7–10 days) promote rapid, uninterrupted growth, good color, and sweetness. Seed should be sown 4–6 weeks before the last frost in cold winter areas, and in March to early April in mild winter sites. Successive sowings are possible through August, with the last sowing overwintering for spring harvest.

*Growing Tips and Addenda.* While beet culture is much like spinach culture, beets remain vegetative under warm conditions and long days. Young beets have poor tolerance for water stress and weed competition. Established stands are good at out competing weeds owing to their broad leaf cover.

Despite their relatively shallow tap root system (6"–10" deep), beets are efficient at foraging for nutrients. Don't over-feed—especially with nitrogen—late in the growing cycle; this retards root development, suppresses sugar content, and contributes to hairy roots. Thin early as competition affects root size.

A tip on thinning—do it carefully so as not to disturb remaining plants and do it late in the day to avoid heat stress. After thinning, lightly water remaining plants to firm in roots and minimize "weeding wilt." If root tops are exposed to sunlight they become tough and corky. Close spacing of rows and/or hilling soil up around the shoulders solves the problem.

It takes 60–70 days to produce a good-sized table beet. Baby beets are truly varieties that are small at maturation with full color, flavor and nutrition, not merely immature, full-size varieties.

### Beet Varieties of Note

*Leaf types* (can begin harvesting at 20–30 days)

*Lutz Green Leaf*, a.k.a. *Winter Keeper* (60 days; Fedco Seeds, Territorial Seed Co.) – An heirloom variety from Europe, introduced to the U.S. in early 1900s. The leaves are a glossy yellow, green and are excellent young in salad mixes or mature steamed. Roots are slow to develop but get quite big (4"–5") and are especially sweet when baked.

*McGregor's Favorite* – An old Scottish heirloom grown for its striking metallic red/purple narrow triangular leaves. Unfortunately it is all but impossible to get seed (Seed Saver's Exchange — crop failure in 2006).

*Bull's Blood* (60 days) – Similar to McGregor's but readily available. The roots are rough textured and odd shaped.

### Novelty types

*Chioggia*, a.k.a. *Bassano* (55 days; Johnny's Selected Seeds) – Named after the Venetian hill town where it was developed. Old heirloom with good sweetness, light red exterior and pronounced zonation of pink and white. Zoning blurs when steamed but stays intact baked.

*Golden* (60–70 days; Fedco Seeds, Johnny’s Selected Seeds, Seed Savers Exchange, Territorial Seed Co.) – An old Burpee Seed Co. introduction. Green tops, yellow stems and bright golden/orange exteriors. Mild, tender, not sweet flavor, doesn’t bleed when cooked. That’s the good news. The bad news is: an erratic seed supply year-to-year, poor germination, especially in soils cooler than 65°F, prone to damping off fungus problems, slow to size up, variable size and rough odd-shaped exteriors, and expensive seed (average price/oz [1500 seeds] for beets \$3–\$5; Golden beets \$9–\$12/oz).

*Cokes Golden* (55 days; Fedco Seeds) – Salinas area grower Dale Coke has been growing his own golden beet seed for over 10 years. He has developed a more vigorous, quicker-maturing, rounder, more uniform variety.

*Albino* (50 days; Seed Savers Exchange) – A white, sweet beet owing to its sugar beet parentage. A little rough textured.

*Blankoma* (55 days; Johnny’s Selected Seeds) – An improved white beet. Best taste when harvested 2”–3” across.

*Cylindra*, a.k.a. *Formanova* and *Forono* (Fedco Seeds, Johnny’s Selected Seeds, Seed Savers, Territorial Seed Co.) – An old, carrot-shaped, oblong variety 6”–8” long, that is sweet, peels easily, has a smooth texture, and is easy to slice for canning and pickling. Keep shoulders hilled to prevent sunburn.

### Red Types

*Kestrel* (53 days; Territorial Seed Co.) – A great baby beet! Sweet, smooth, dark red beets that are the most bolt-resistant variety. A clean leaf that is resistant to cercospora fungus.

*Red Ace* (55 days; Fedco Seeds, Johnny’s Selected Seeds, Territorial Seed Co.) – An improved hybrid that is quick to grow, sizes up quickly and uniformly. Uniform beets that are large, smooth, and sweet even when older.

*Moneta* (46 days; Johnny’s Selected Seeds) – A hybrid monogerm variety containing only one seed. Most beet seeds are fruits containing 2–6 seeds. Eliminates the need for thinning.

*Early Wonder Tall Top* (45 days; Johnny’s Selected Seeds, Territorial Seed Co.) – As the name implies, this early cool season beet allows early seeding. Staggered maturation, non-uniform roots. Mild, sweet taste.

### SWISS CHARD, *BETA VULGARIS CICLA*

The word chard is derived from the French word *chardon* for thistle, owing to its large, succulent, savoyed leaf similarity. Chard is also referred to as perpetual spinach, or sea kale beets in England. In essence it is a beetless beet, or a spinach with panache.

In the kitchen chard is actually two different vegetables—the leaves (leaf blade) and stem or rib (petiole). In cooking they should be separated and prepared separately. The leaves steam or sauté quickly; the ribs are tougher and require longer cooking.

Chard varieties fall into two camps –

“Old School”—full size, thick, dark green, white-stemmed or rhubarb with deep crimson leaves contrasted with dark green veins and an apple-red stem. Old School varieties are actually sweeter and full of flavor as they mature.

“New School”—plants with stems of many colors: gold, pink, yellow, purple, red, and white. They have smaller, less-savoyed leaves. The catalogues tout them as “mild tasting,” arguably a euphemism for bland. Additionally, plants of this type are often weaker, to the point of lacking enough turgor to stand fully erect, and are easily damaged in post-harvest handling.

### Old School Varieties of Note

*Argentata* – Vigorous; the most cold hardy chard. Wide silver mid-rib. Sweeter with less salty, oxalic acid taste than other chards.

*Fordhook Giant* – Introduced by Burpee Seed Co. in the early 1900s. Broad white stems, dark green leaves. Vigorous 3’-tall plants.

*Rhubarb* – An heirloom European variety (1850s). Deep crimson stalks and leaf veins. Dark, metallic-green foliage. A striking ornamental plant as well as good tasting.

*Italian Silver Rib* – Old Italian variety. Wide ribs of silver-white. Large, glossy, heavily savoyed leaves. Big plant, big succulent leaves.

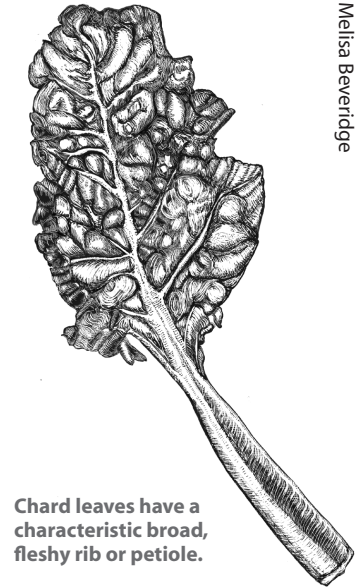
### New School Varieties of Note

*Bright Lights* – Originally selected and bred by amateur gardener John Eaton of New Zealand. Brought up to commercial standards by Johnny’s Selected Seeds (All American Selections winner 1998). Many-colored stems—purple, pink, gold, yellow, red, and white. Smaller, flatter-leaf type with light green or bronze color. Mild taste. Impressive looking on the shelf and in salad mixes. There are a number of individual colors offered from this mix: bright yellow, pink passion, magenta sunset, pot of gold, etc. A word of note, in the “nothing new under the sun” category: Aristotle first observed colored pigmentation in chard in 400 BC!

– ORIN MARTIN

### Seed Sources

Fedco Seeds, [fedcoseeds.com](http://fedcoseeds.com)  
 Johnny’s Selected Seeds, [www.johnnyseeds.com](http://www.johnnyseeds.com)  
 Seed Savers Exchange, [www.seedsavers.org](http://www.seedsavers.org)  
 Territorial Seed Co., [www.territorial-seed.com](http://www.territorial-seed.com)



Chard leaves have a characteristic broad, fleshy rib or petiole.

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