

Beta Vulgaris L.

A Monograph

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Monograph

Beta vulgaris

Beta vulgaris is an extremely interesting and diverse plant. From developing from sea beets thousands of years ago it is now used to producing thirty percent of worldwide sugar production. The beet contains plenty of antioxidants, fibers, vitamins, and nitrates. It has been cultivated for centuries around the Mediterranean region and has now spread around the globe. Typically associated with Eastern Europe, the beet is a common feature in the Slavic cuisine. The beet has a rich history in Europe where it has developed as a staple with massive production taking place in countries in Europe. Although it has fallen out of favor in the USA in the past thirty years, many new organic beet products are now taking hold in the health food market. Many products from beets are considered super foods. The beet is well suited to grow in the climate of Colombia even though it is not its natural range. Colombia is also used to producing beets, where production peaked at 35,000 tons in 2014. In this monograph I will be discussing different economic and biological aspects of the beet. In the first chapter I will be discussing the ecology of the beet followed by its biology. The last chapter I will be going into the economics of the beet. The beet is one of the most unique plants out there due to its wide variety of benefits and its effect on the world's economy.

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Chapter 1 Ecology

1.1 Origin

Origin of *Beta vulgaris* (the beet) was first reported domestically in Ancient Mesopotamia, 8th century B.C. was when the first written documents started appearing about *Beta vulgaris*. By the 1st century BC, beets were around domestically. In the 1500s beets were beginning to gain popularity as an edible vegetable. This practice began in Europe, following which in the 1800s, different varieties of the common beet were developed. It is thought to have developed in Southwestern Asia. (Armstrong, 9 May 2001) . The *Beta vulgaris* is native to Europe and grows as far as India. It originated around the mediterranean region but has spread to the rest of Europe. The countries in Europe with large scale cultivation are, as follows, Switzerland, Austria, Czech Republic, Romania, and Hungary. In most of Eastern Europe *Beta vulgaris* is an alien species. (Armstrong, 9 May 2001.)

The fossil record for the plant goes back 160 million years in the *sea beet* (a direct ancestor of *Beta vulgaris*) which developed in Europe and western Asia. These plants reproduce through pollination, and spread that way. Like their wild ancestors, beets and chard are salt-tolerant and wind-pollinated.

(Shepherd, 2016)

1.2 Growth Habit

According to the USDA its growth habit is in Forb/Herb which is defined as;

“Vascular plant without significant woody tissue above or at the ground. Forbs and herbs may be annual, biennial, or perennial but always lack significant thickening by secondary woody growth and have perennating buds borne at or below the ground surface.” (USDA, 2008)

In the United States, where the beet was introduced, it grows mostly on the East Coast States, with growth reported in Texas, California, and a few midwestern states (Phillips 1995).

1.3 Family

The family which *Beta vulgaris* belongs to is the Amaranthaceae which includes the Chenopodiaceae – the Goosefoot family. These plants are found in temperate regions around the world. (CABI Crop Protection Compendium, 2010)

1.4 Varieties

The varieties of the *Beta vulgaris* appear in many forms, the following is a list of the few forms the plant is produced and sold in. Fodder beet wurzel or mangold, this type of beet is used as animal fodder in farms and such. Sugar beet, is a type of beet with especially high sugar amounts. This beet has been around since the 1800s and was used for sugar production. About twenty five per cent to thirty percent of sugar production worldwide is of sugar beets (CABI Crop Protection Compendium, 2010). Chard, a variety grown for leaves, not the root. Beetroot, the most common type of beet for direct human consumption, these beets vary widely and are the type we will be growing.

1.5 Ideal conditions

The ideal conditions for *Beta vulgaris* to grow in are moist, fertile, light to sandy soils in full sun. It also can tolerate light shade. It's ideal pH range is 6.0 to 6.8 which is slightly acidic.

1.6 Pests

There are many pests that can interfere with the growth of *Beta vulgaris* such as wireworms, they grow from an half a inch and a half. They are the most common pest for the common beet in North Dakota (Harveson, 2009) Another common pest is the Rove beetle which is active at night.



Figure 1 (<http://www.dereila.ca/beetles/>)

Many other pests are not exclusive to the common beet and the beet itself does not have many natural diseases except for a few fungal diseases such as *Cercospora beticola*, which is other wise known as a leaf spot which makes the leaves necrotic (Harveson, 2009). Another few fungal diseases are *Rhizoctonia solani*, *Phoma betae*, *Pythium ultimum*, and *Aphanomyces cochlioides*. These fungal diseases all cause the collapse of seedlings and blackened roots.

1.7 Biological Data

Beta vulgaris is a dicotyledon which means a number of things. Here are a few major term definitions for a Dicot:

As shown in figure one below, the embryo has two cotyledons, pollen with three furrows or pores, flower parts in multiples of four or five, major leaf veins are reticulated, stem vascular bundles in a

ring, roots develop from radicle and secondary growth often present. (Speer, 1999)

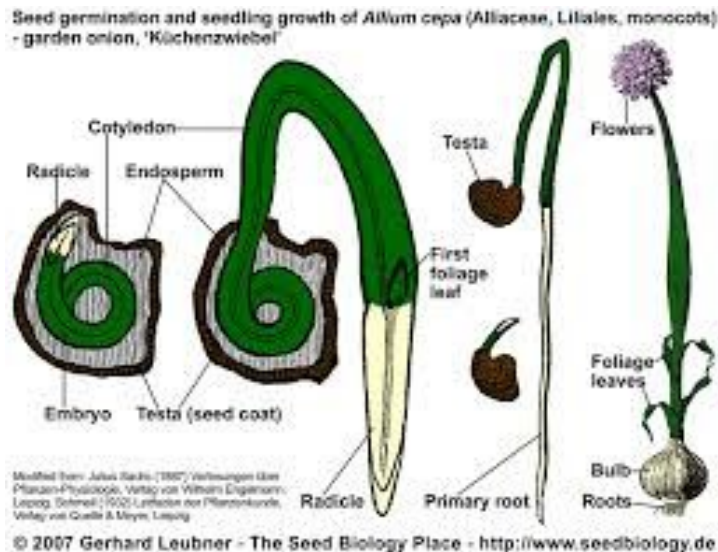


Figure 2 the different parts of a beet.(Geubner, 2007)

1.8 Life Cycle

The life cycle of *Beta vulgaris* starts when beet seed crops sprout from 2nd year beets in about 140 to 160 days. Beet seeds thrive where the temperature does not exceed 25-28 degrees celsius, usually in the Spring. It is generally wind pollinated, and beets have a much higher salt tolerance than many other crops. Beets are classified into two types, tall tops which are in the range of about 25-36 centimeters while the short tops generally have a range of about 15-20 centimeters. (Speer, 1999)

1.9 Importance and significance

Importance to humans of beets has been around since the Middle Ages, where beets were first consumed in Europe, since then they have become a staple in many cultures' dishes. In Napoleonic

Europe in the 1800s the prominence of the Sugar Beet was drastically increased, and up to this day the Sugar beet is an important factor of sugar production (Armstrong, 2001). Production for the beet has increased due to the rising demand for a plant that not only contains many nutrients and vitamins, but a plant that has defined a part of human development in the past few hundred years.(Armstrong, 2001)

Chapter 2: Biology

The biology of the beet in relation to its ecology is pronounced in the following “*varying degrees in different genotypes and is highly influenced by environmental conditions, especially temperature.*

There is a self-fertility gene which, when introduced, can create plants which are self-fertile.” (J. R.

Stander, 1995) The reproductive biology of beets occurs when wind or insect pollination brings a “seed ball” or protandrous flowers shedding pollen for 2-3 days. Beets need a genetically different beet to reproduce, this leads to a lot of genetic diversity although a few beets have been found without this trait.

The pollen the beet produces is extremely light and can travel vary far in the wind. The composition of the beet is made up of the following: 75.9% water, 2.6% non-sugars, 18.0% sugar and 5.5% pulp. In the sugar fraction 83.1% is recovered as crystalline sucrose. The common beet does not compete well with other crops for space in the wild and has no natural crop production counterpart (CABI Crop Protection Compendium 2010).

2.1 Natural regeneration

The Sugarbeet is naturally a cross pollinator, so modern cultivators are highly heterozygous. It is also a biennial species, these factors create a species which evolves and gains traits slowly. All beets grow on a basal rosette, that has alternate leaves on flowering stems, which is able grow to 1.25 m in the sugarbeet varieties, but are usually 0.5 to 0.75 m in Swiss chard and beetroot. The flowers are normally small, varying in color from greenish to yellow (Shepherd, 2016.).

2.2 Nursery propagation

Beet crops are propagated from seed, and should be sown in early spring when the ground is suitable. In gardens successive plantings can be made every 10–14 days until 3–4 plantings are in, to insure a continuing supply of fresh beets. The main crop, should be planted in May or June. The beet seed varies in size and the seeds germinate irregularly, so that a uniform crop is difficult to achieve. Most cultivation is done by hand weeding, because lateral roots are very shallow and happens to be easily damaged. Seed stalks are likely to be produced after temperatures of 5–10°C for 15 days or longer (Shepherd, 2016.) Beet crops should not be rotated with col crops, which are hosts for sugar beet nematodes; otherwise, plant beets in rotation. (Chartier 1980)

2.2.2 Sowing and the germination process

The sowing process begins by sowing thinly half an inch deep, with one to two inches apart, be sure to firm soil well. Space rows around a inch apart, and thin four inches between plants, and transfer the thinnings for any later crop. Temperature around fifteen degrees is the ideal for growth. Full sun to some shade, well-drained light soil are the ideal sun conditions, and is also best grown in hilled rows or beds; provide ample water (Shepherd, 2016)

2.2.3 Storage

Start to harvest the greens as soon as they are large enough. Then begin to harvest beets when they are 2.5 cm are larger in diameter than before in their previous state. Secondly, check by gently probing the soil at the plant's base, after that pull them out carefully to avoid bruising. Get the beets ready for storage

beets before hard frost begins, although that is not a predicament in Colombia, and when removing the tops, leave 2.5 cm of the stem connected to the roots to stop bleeding. Finally, refrigerate for several weeks, or layer in a box filled with sand, sawdust, or peat and store in a cool area for two to five months. Beets can also be canned or pickled.

2.3 Vegetative propagation

The Sugar beet seed is only produced by biennial flowers during the second year although in certain conditions during the first year may cause bolting prematurely. The flowers of the Sugarbeet reach anthesis in about 5 to 6 weeks after the beginning of reproductive development. Anthesis then continues on for a period of several weeks. (Stander, 1995) Sugar beet pollen is very sensitive to moisture, however, under dry conditions its viability is lost within 24 hours. The main method of pollination is cross pollination due to the lack of synchrony between pollen release and receptiveness of the stigma. Since the pollen has to be carried by the wind over long distances, breeding stock and commercial seed production fields must ensure the isolation of flowering sugar beet plants. According to the (CSGA, 2005) regulations, pedigreed sugar beet crops must be isolated by 400 meters from any plants that are a source of contamination through cross pollination.

2.3.1 Grafting

Grafting is a now well-established agricultural practice. In trans grafted (artificially combined) plants, only one part (scion or rootstock) is transgenic with the other part untransformed. However, transgenes may affect both mobile and immobile endogenous metabolites (e.g., RNAs, proteins, and phytohormones)

and mobility has implications for trans grafting (Walworth, 2015). These procedures have successfully been implemented on the *Beta vulgaris*, with positive results.

2.4 Planting

A soil pH above 5.5–6 is a good amount to plant the beetroot, otherwise growth will be stunted. You need to till in aged manure before planting. Beets need especially good nutrition and a high phosphorus level to germinate. (CSGA, nd) Nitrogen is very helpful however, an excess will cause sprawling greens and tiny bulbs beneath the soil which is not good. In areas with low moisture, you have to soak the seed for 24 hours. The seed has to be at 50 degrees before planting.(Shepherd, n.d.)

2.5 Management

Thinning is necessary, as you may get more than one seedling out of each seed. Thin when they read about 2 inches high by pinching them off. (Armstrong 2001) Pulling them out of the ground may disturb the close surrounding roots of nearby seedlings. Established plants should be thinned to 3 to 4 inches between plants.(Shepherd, 2016.) Mulch and water well. Beets need to maintain plenty of moisture. Any necessary cultivation should be gentle, beets have shallow roots that are easily disturbed.

Chapter 3: Economic Data

Although beets are used in a variety of ways the market in the USA is taking a big hit to due to GMO seeds becoming unpopular. Here, natural society sums up the beets declining popularity in the USA: Sugar beet demand (with most of all sugar beets being grown in the US being genetically modified) fell to less than 41% of the U.S. total of 11.8 million tons in the last fiscal year, a low down from 47% of 10.4 million tons in the 2008 crop year. The US sugar beet market is currently protected through quotas and marketing allotments (government subsidies) which give growers a 4-cent a pound premium over global prices, which have lately been depressed due to oversupply. (Prentice, 2015) However, beets still account for a large portion of the world's sugar supply and are extremely important to the economy.

3.1 Flavor in *Beta vulgaris*

The earthy taste of beets is due to an organic compound produced by microbes in the soil, its name is geosmin. Geosmin gives off a aroma similar to freshly plowed earth or a field after a rainstorm. Human noses are extremely sensitive to geosmin, and while some people don't like it, others love it. Other foods that contain large amounts of geosmin include spinach, lettuce and mushrooms. (Goldman, 2009) Geosmin is not toxic or harmful,. Beets are low in calories and contain vitamins A, B and C, beta-carotene, folic acid and many minerals, such as potassium and iron. (Akis, 2014) Beets are high in iron, which is why they're recommended for people with anemia. This may give them a metallic taste in certain beets.

3.1.1 Products made from juice

Beet juice has a number of useful products from its juice, starting with energy drinks to specialized beverages. The introduction of beet juice among endurance athletes begins in a 2009 study done by Exeter University in the United Kingdom. Its findings: drinking regular beet juice increased blood nitrate levels and reduced resting blood pressure. Also, and perhaps more importantly for runners, it reduced oxygen consumption during moderate running and increased time to exhaustion by 15 percent. At the time that the study started making its way around endurance sports circles, there weren't many beet-related products marketed toward endurance athletes. As a result, Olympic athletes, Tour de France riders and even age-group endurance athletes had to make beet juice while awaiting the market of beet-related products. (Ryan Wood, 2015) One other major use for beet juice is to use as a snow remover in the US. In Indiana, K-Tech Specialty Coatings has been distributing "Beet Heet," a sugar beet molasses-based product that increases rock salt's ice melting capacity when the two are mixed. The mixture helps rock salt melt ice below its 15-degree limit, according to Beet Heet distributors, and helps municipalities melt larger amounts of ice and clean up snow more quickly. It is also sticky, preventing salt rocks from bouncing off of the road as cars drive past, this year about 175 municipal agencies, mostly in the Midwest, are using the product. (Rhodan, 2017)

3.1.2 Products from fermentation.

Beet juice has traditionally not been fermented, due to the taste and the fact that it is not that popular. However fermented beet juice is sold at health stores across the world. Beet wine is also produced in small quantities, chiefly in Northern France.

3.1.3 Products from skin

Beetroot has a number of important benefits in the body such as improving liver function, boosting hemoglobin levels, reducing inflammation, helping prevent cancer, helping detoxification, improving stamina, preventing dementia, and lowering blood pressure. This is due to a large number of vitamins and minerals that the beet contains. (Panda, 2017) Beetroot also contains one very important pigment in its skin, its name is Betanin. This red pigment is used commercially around the world for food dye. The intensity of the red pigmentation of the root of the beet has an important relationship to the commercial value and use of this crop both in the market gardening and canning industries. Betanin, the conspicuous red pigment of the root of the beet. It has been classified as an anthocyanin, related to the pigments of the petals of many flowering plants, but differs from typical anthocyanins in that it contains nitrogen (Lawrence, 2017). The pigment is a somewhat unstable substance and great difficulty has been experienced in preparing pure specimens; the yields reported are small.

3.2 Medicinal uses for beets.

The main benefits of beets is a remineralizing and vitamin tonic. It contains a proven hepatoprotective effect of intoxication because of the concentration of betaine which is a methyl group donor involved in the transmethylation hepatic metabolic processes. Properties attributed to the beet leaves include vulnerary, anti parasitic, digestive, laxative, antifungal and contraceptive. To the fresh beets juice benefits are attributed: antitumor, pectoral, diuretic, emmenagogue insecticide. Tubers: antifungal, antibacterial and anti-mitotic. Also hypolipidemic and vasoprotective. These are a large amount of

benefits for a natural medicine. (Pharmacognosy - Medicinal Plants, 2017) The beetroot is indicated to:
hepatitis, cirrhosis, gallbladder disease, prevention of arteriosclerosis. Anemia, asthenia, and
convalescence.

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