

Agronomy – Rabi Crops

Sugarbeet

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SUGARBEET

Botanical Name: *Beta vulgaris* L.

Family: Chenopodiaceae

Chromosome number: $2n=18$

Sugarbeet producing roots in first year and seeds (germs) in second year is a biennial herb grown in 45 countries of the world, and provides about 25% of world's sugar requirement in 2005. The crop is a major source of sugar in temperate countries. Beet sugar is demulcent and diuretic. The crop matures in April-May, when the cane crushing season is nearly over. Thus supply of sugarbeet can extend the crushing season of mills by nearly 2 months. Original forms of sugar beet derived from white Silesian beet, which are used as a fodder, contained only 4% sugar. Repeated selection and breeding have raised the sugar content to its present level.



Source: <http://www.ars.usda.gov/Main/docs.htm?docid=16027>

Beet pulp accounts for 5 (dry basis) to 30% (wet basis) of total roots, which is a good source of feed (forage/silage) for livestock. Ethanol is produced from impure sugary pulp (molasses). It is also fermented to beers. The tops with 10% digestible crude protein, form low cost substitute (forage/silage) for grain in feed concentrates. The tops contain growth stimulant 'saponin'. Leaves are rich in carotene (1.4 – 6.2%), vitamin C, E and exhibit estrogenic activity. The tops should not be fed to livestock at rates > 25%.

In 1747, it was found that beet roots are rich source of sucrose. It took about 50 years to develop a method to extract beet root juice and its crystallization in the form of sugar. F.C. Achard was the first person to set up a sugar factory for processing of beet roots and making sugar out of their pulp. It was introduced in the U.S.A. as a sugar crop in early 18th century. Though sugarbeet cultivation in India was initiated in 1914, its commercial cultivation started in Sriganaganagar area of Rajasthan after producing first beet sugar in 1968 by Sriganaganagar sugar mill.

Origin and history

Sugar beet is believed to have originated in the Middle East, near the Tigris and Euphrates Rivers. Cultivated form of sugar beet is believed to have evolved from wild maritime beet (*B. vulgaris* subsp. *maritima*) through selection (Cooke and Scott, 1993). Wild annual (*B. patellaris*, *B. webbiana* and *B. procumbens*) and perennial species (*B. trigyna*, *B. lomatogona*, and *B. Macrorhiza*) of beet have been found (Cooke and Scott, 1993).

Geographic Distribution

Sugarbeet is essentially a crop of temperate region grown on 5.49 mha with major share (>72%) of production from Europe (Table 1).

Table 1. Area, production and productivity of major sugarbeet producing countries in 2004

Continent/country	Area (m ha)	Production (m tonnes)	Yield (t/ha)
Africa	0.118	7.420	62.81
Arab Magherab Union	0.059	0.456	77.41
Asia	0.857	31.626	36.89
Austria	0.045	2.934	64.60
Belarus	0.086	3.088	35.90
Belgium	0.087	6.215	70.83
Canada	0.014	0.743	52.38
Chile	0.030	2.370	78.82
China	0.190	5.860	30.84
Croatia	0.026	1.000	37.65

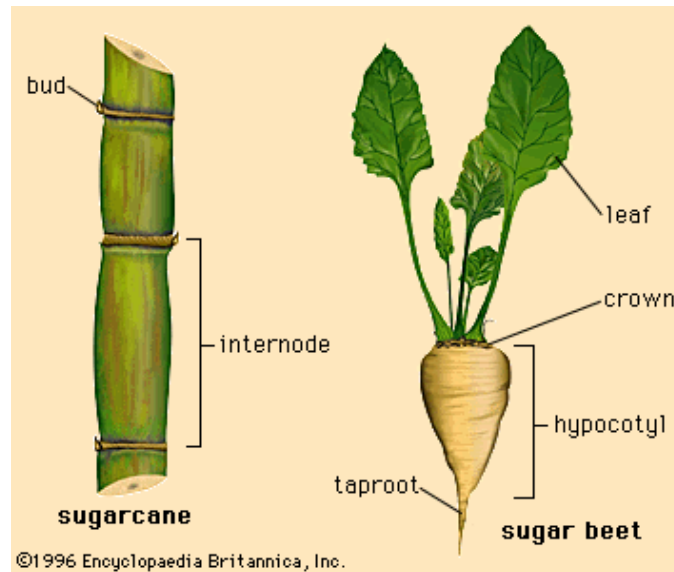
Continent/country	Area (m ha)	Production (m tonnes)	Yield (t/ha)
Czech Republic	0.071	3.579	50.34
Denmark	0.048	2.828	58.08
Egypt	0.059	2.850	48.29
Europe	3.947	179.760	45.54
France	0.386	30.554	79.13
Germany	0.440	27.159	61.65
Iran	0.180	4.900	27.22
Ireland	0.031	1.861	59.85
Italy	0.185	8.473	45.60
Japan	0.068	4.656	68.47
Latvia	0.367	0.505	36.71
Lithuania	0.023	0.904	38.83
Morocco	0.058	4.560	77.41
World	5.497	249.118	45.31

Source: FAO Production Year Book, 2004

Until recent past sugarbeet was famous as a ‘salad’ crop for table purposes in India, but it is now in semi-commercial testing in sub-tropical parts of the country. In Kashmir valley, sugarbeet is grown as a spring season crop. A beginning of commercial cultivation of sugarbeet has now been made in Sriganganagar area in Rajasthan, Phaltan in Maharashtra and *tarai* in Uttarakhand.

Botanical Description

Root system: The tap root forms the tuberous roots containing sucrose. There are vertical grooves along opposite side of the root from which lateral root arises. Sometimes roots are flattened on 2 sides. The mature root is divided into 3 regions: the crown which is a convex cone, and just below is neck, which is the broadest part of the beet. The lowermost part is the root, which terminates in a long tap root.



Source: http://en.wikipedia.org/wiki/Sugar_beet

Stem: The stem is very much reduced in size.

Leaves: The leaves arise in basal rosettes on the much condensed stem. The leaves are simple and smooth with a large blade and a petiole.

Inflorescence: The inflorescence is a terminal open panicle with specate branches. Flowers are imperfect regular and without petals.

Fruit: The sugarbeet has a typical aggregate fruit that yields a seed ball with 2 or more viable seeds, or germs. The fruits consist of 2-5 seeds which are shiny, having lentil like structure and are about 3 mm long.

Climatic requirements

Sugarbeet is a crop of temperate climate requiring high moisture conditions throughout the growing period. It is grown between 35°N to 60°N latitudes. It is highly versatile and can be grown successfully in any region with temperature ranging from 12 to 45°C during the crop season (October-May). The favourable soil temperature for the germination of sugarbeet seed is around 15°C. For proper growth of the plants and sugar accumulation, an average temperature of about 20-22°C is ideal. Temperatures above 30°C retard sugar accumulation. The commercial cultivation of roots is possible in the plains during winter season. The seed production is done on the hills of Himachal Pradesh by the Government of the Himachal Pradesh with an associated efforts of the National Seeds Corporation.

Soil and its Preparation

Sugarbeet prefers well-drained loam to clay loam fertile soils. Though it can tolerate soil pH >8.5, but the sucrose content is decreased. The acidic soils are not suitable for raising this crop.

It requires a good tilth, which is achieved by repeated ploughing and planking operations. The field is finally divided into ridges and furrows or flat beds based on the method of sowing to be adopted. Usually sowing on ridges is preferred over flat-bed planting. Ridges of 10-15 cm height are preferred at a distance of 50 cm between them with the help of ridger after mixing manure and fertilizers in the field.

Seed and sowing

Seed rate and spacing

For optimum plant stand, a seed rate of 8-10 kg/ha has been recommended.

Seed treatment

Seed should be soaked for 4-5 hours in 0.25% solution of mercurial compound or aretan or agallol overnight for better germination.

Time of sowing

In north Indian plains, sugarbeet is raised as a *rabi* crop, and the optimum time is 15 October to 15 November. Delayed sowing adversely affects the yield and quality of beet. Time of sowing for seed production is 15 April in the valley of Himachal Pradesh.

Spacing

The crop is sown in rows 40-60 cm apart. The seedlings are thinned at 4th leaf stage to a spacing of 20-25 cm in the rows. The optimum plant stand for sugarbeet varies from 70,000-1,00,000/ha.

Method of sowing

There are 2 common methods of sugarbeet sowing, viz. ridge sowing and flat bed sowing. The depth of sowing should be 4-5 cm with 50 cm row to row and 10-15 cm plant to plant spacings. This requires 10 kg seed/ha. Generally sowing is done by dibbling manually or by drilling with cotton seed drills. Indian Institute of Sugarcane Research, Lucknow has designed and fabricated a push type drill for sowing sugarbeet.

Thinning or gap filling

Sugarbeet seed is a multigerm that produces 4 seedlings / glomerule. To avoid the competition, maintain single healthy plant/glomerule by plucking off the remaining ones when the seedlings develop 3-4 leaves. Thus a uniform spacing of 20 to 25 cm between the plants should be maintained.

To maintain a uniform population, some times gap filling is required which should be done by sowing the seed instead of transplanting the seedlings, because transplanting results in production of 'malformed' or 'frongy' roots having less weight. Gap filling should be done soon after germination.

Varieties

Sugarbeet, being a recently introduced crop into India, has mostly exotic varieties. The varieties are mostly from Germany, Russia, USA, UK, Denmark etc. Some varieties have also been evolved in the country especially from IISR, Lucknow. The important varieties are given below (Table 2).

Table 2. The exotic and Indian varieties of sugarbeet recommended for cultivation in India.

Exotic varieties	Indian Varieties
Hh-Monitor 212, Maribo maroepoly Maribo magnapoly, Mezzanopoly-A Ertype E, US 75, Bush E, NP poly, AJ poly, USH 6, USH 8, USH 9, US 36, MSH 102, Kawemagapoly Kawegigapoly, Tribel, Ramonskava 06, US 35, Maribo Resistapoly, Triplex, BGW 674, Crimson glob, Detroit Dark Red, GWH 14, GWH 66, VSH 6, VSH 7	Suitable for all regions Pant S-1, Pant S-2 , Pant S-3, Pant S 10, Pant composite 6, Pant composite 3 Certified varieties Pant composite 1, IIST composite 1 IISR 2, IRSR composite, Rajendra Sakarkand 35, Rajendra Sakarkand 43, Sree Bhadra and Sree Rathna Suitable for saline soils Pant S 1, Pant S 10, IISR Composite 1 and IISR 2

Manures and Fertilizers

Sugarbeet is a heavy feeder of nutrients. Besides application of 20-30 t/ha FYM or compost before the ridging, 120-80-80 kg N-P₂O₅-K₂O/ha should be applied for better crop growth and development. Half of the N and entire P and K should be applied before last ploughing. The remaining N should be side-dressed after thinning. In light textured soils, it should be applied in 2 splits i.e. at thinning and earthing up in December. Boron deficiency in sugarbeet results 'heart shed' disease, hence 45 kg borax/ha is beneficial in B deficient soils.

Water management

The crop is sensitive to both drought and excessive moisture. The crop requires 8-10 irrigations depending upon the climatic conditions. One or two irrigations are required till thinning is over. Subsequent irrigations may be provided at an interval of 20-25 days.

Weed control and earthing

Sugarbeet faces severe competition from weeds in the early stages of growth. The crop should be kept weed free for the first 45-60 days.

Use of herbicides like phenmediphan gives good control of weeds in sugarbeet. The soil should be little loosened and earthing up of the crop should be done by December after finishing the last top dressing of fertilizer.

EPTC @ 3 kg/ha in 600-1,000 litres of water can also be used as pre-emergence for controlling the annual broad leaved as well as grassy weeds. Phenmediphan @ 2 kg/ha in 600-1,000 litres of water can be used as post-emergence herbicide 25-30 days after sowing. Pre-emergence application of Sirmet @ 2.0 kg/ha controls all types of weed in sugarbeet.

Cropping Systems

Companion cropping of sugarbeet with autumn sugarcane has been found very successful. It provides maximum sugar per unit area. Sugarbeet is a *rabi* crop. It can be sown after harvest of *kharif* crops. Some of the rotations are:

Maize-sugarbeet	Paddy (early)-sugarbeet
Blackgram-sugarbeet	Greengram-sugarbeet
Cowpea (fodder)-sugarbeet	Soybean-sugarbeet

Harvesting and storage

An October-sown crop becomes ready for harvest in April-May. At the time of harvesting, there must be enough moisture to facilitate the harvesting but field should not be wet. Brown-grey colouration of tops is an indicator of crop maturity. Brix value of ~20 is another indicator used for judging crop maturity. The harvesting may be done by running a country plough along the rows on both sides and lifting the roots by a slight pull of *kudali*. The adhering soil should be cleaned off the root by a thorough shaking but the roots should not be washed in water for cleaning as it causes rapid deterioration. The roots should be topped at the leaf-crown because allowing the leaves to remain on the roots affects the recovery of sugar adversely. Storage of roots beyond 36 hours at higher temperature will render the beets unfit for processing. Under unfavourable circumstances, the product of the field should be stored by covering the piles with foliage and tops of the same field.

Yield

A well managed crop of sugarbeet produces about 50-70 tonnes roots/ha. Sugarbeet roots have ~95% juice. Sugar from sugarbeet roots is extracted by adopting the diffusion process. Sugar content in sugarbeet ranges from 13-17%. The important yield attributes/by-products of sugarbeet are given below:

Attributes	Value
Test weight of seed	20 g
Pulp yield/t roots	0.5-0.7 t (wet basis); 0.08-0.1 t (dry basis)
Molasses/t roots	0.05 t
Ethanol/t sugarbeet	86 litres

Seed production

Sugarbeet is propagated by seeds; hence its production is important. In India, seed production is done in Kalka (Kinnaur district) of Himachal Pradesh and Shalimar region of Jammu and

Kashmir. The crop needs over wintering for seed production. Heavy snow fall in winter and 10-15 cm rainfall in summer are preferable. The seeds are produced from roots and seeds.

In seed production from roots, the matured roots are cut at the base taking away the neck, crown and leaves (called stocklings of 0.2 – 0.3 kg weight). The stocklings are over wintered either in covered trenches or by planting them in the field. In the field, the planted stocklings are subjected to moisture stress. After winter, the stocklings starts to regrow and produce flowers in 5-6 months and seed by end of summer.

In seed to seed crop method, the matured are allowed to pass through in the field as such (*in situ*). Thorough rouging of plants is done for maintaining purity of seed. The isolation distance must be maintained for seed production of this cross pollinated crop. It varies from 2 km in commercial to 5-6 km in foundation seed production. Nucleus and breeder seeds are produced in muslin cloth chambers. The seed yield varies from 1.6-2.0 t/ha. This method is ideal for areas with severe winter.

Additional Reading:

<http://www.sbreb.org/>

<http://www.sucrose.com/images/beet1.jpg>

<http://www.tnau.ac.in/tech/swc/sugbeet.pdf>