



Brussels sprouts

Brassica oleracea



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Department of Agriculture, Forestry and Fisheries

Origin and distribution

Brassica oleracea L., Gemmifera group, also known as Brussels sprouts, is a tall-stemmed cabbage in which the axillary buds in the axis of each leaf form tiny heads or sprouts. It has a common origin from the wild cabbage of southern Europe with other cole crops, including cabbage, broccoli and cauliflower. Brussels sprouts prefer a cool growing environment.

First recorded in Belgium in 1752, Brussels sprouts rapidly spread to England and France. Early planting and constant aphid control are important to good sprout production. The crop is believed to have derived from savoy cabbage.

Sprouts form in the leaf axils of an elongated stem. Sprouts start forming in the lowest leaf axil and progress upward.

Soil and climatic requirements

Brussels sprouts are grown like cabbage and require a long, cool growing season. Because of these requirements, the plant never gained widespread acceptance. The cool temperatures and fog that are characteristic of many parts of the coastal areas, are ideal for Brussels sprouts production. This vegetable is considered to be “hardy,” in that it is relatively resistant to frost and light freezes (Maynard & Hochmuth, 1997).



Soil should be well drained with plenty of organic matter. Brussels sprouts are grown during the autumn and winter. Planting of Brussels sprouts can begin as early as August, and is usually completed by late November. Temperatures during the growing season range from -1 to 32 °C.

Prolonged temperatures below 10 °C will initiate flowering. Brussels sprouts are grown on soils that range from sandy-loam to clay-loam with a pH of 7,5 to 8,0.

Uses

The edible parts which include axillary buds, are either consumed raw or cooked. Most consumers use the produce as fresh and frozen vegetable, and as a pot-herb.

Human health benefits and concerns

- Brussels sprouts have a large quantity of vitamin C, which is essential for the human body.
- The antioxidants, which are a part of Brussels sprouts, can help us to prevent breast cancer.
- The fibre contained in Brussels sprouts can aid in increasing the functioning capacity of the digestive system.
- High cholesterol levels are not good for the heart. By consuming Brussels sprouts you can reduce the development of heart diseases.
- The deficiencies caused by potassium can be curbed by eating Brussels sprouts as it contains a high level of potassium.
- The quantity of fat in Brussels sprouts is less and it is an ideal food item for a balanced diet.
- The folate acid enhances the development of the baby in pregnant women.

Cultivation practices

Soil preparation

Prior to planting, the field is deeply tilled, disked, land-planed, the beds are prepared and pre-irrigated. Often a fertiliser and a preplant herbicide application is made prior to planting. If a preplant fungicide, such as mefenoxam, is utilised, it is usually applied after bed formation, but prior to planting.

Planting

Brussels sprouts seed is planted in greenhouses at the beginning of the annual growing season. This typically occurs from January through May, with seedlings ready for transplanting into fields 50 to 60 days later.

In preparation for transplanting, Brussels sprouts fields are treated with lime to raise the pH as a preventative treatment for club root disease. In addition to liming, a large percentage of fields is also fumigated with met-

am-sodium or 1,3-dichloropropene to control nematodes, and to provide additional suppression of club root. Bed size in Brussels sprouts fields is 76 cm and the seedlings are planted in a single line, 30 to 46 cm apart, depending on the variety planted.

Brussels sprouts are directly seeded, 1 cm deep, in beds with 102 centres. There is one row of Brussels sprouts per bed, and the plants are spaced 8 to 10 cm apart. Sprinkler irrigation may be used to establish seedlings. The beds are later thinned, allowing 60 cm of space between plants.

Normal cultural practices of cabbage production must also be employed when planting Brussels sprouts. The secret to a good harvest is a proper planting date. This is a cool-weather plant, so, when setting out the plants they will need about 90 days to develop until harvest.

For summer harvest, plants have to be transplanted from an early, heat-resistant variety in the very early spring. Sprouts maturing in hot weather or under dry conditions are more likely to develop a bitter taste. Autumn production is the most practical and rewarding in most parts of the country.

They are most dependably grown when started indoors as transplants. Seedlings are preferably grown in late March; 6 weeks prior to the last average frost date.

Sowing depth of the seed is $\frac{1}{4}$ cm deep in 10 cm pots, and the seedlings would have to be transplanted outside after the danger of hard frost has passed (early May). For autumn harvest, plants are set out in early July. Days to emergence fall between 5 to 17 days. Optimum soil temperature range for germination is 14 to 19°C.

The plants are spaced 60 cm apart in both directions and in other respects grown like broccoli. Younger, smaller (10 to 12 cm) transplants will establish stronger roots and stems than larger ones. This will mean less floppy, stronger mature plants. Cool temperatures during sprout development are important for compact, quality buds. Excess nitrogen can cause discoloured, loose buds.

If plant setting begins in summer for an autumn crop, shading them from the hot sun is highly recommended.

About a month after setting out, hilling-up the stem by building a small mound of soil around it to a depth of about 10 cm is important for good growth stages. In windy sites, plant support, especially the stem with a stake 1 m high, is critical during the early stages of transplant. Brussels

sprouts should be planted firmly, with the lower leaves just above soil level.

Fertilisation

Brussels sprouts should have uninterrupted growth. Any delay in growth will cause disappointing yield and loss of quality of sprouts. A soil that is high in organic matter so that it will hold a lot of moisture is necessary to keep the plants growing vigorously.

The crop requires plenty of nitrogen while it is growing to keep it vigorous. However, the quantity and frequency that should be applied, varies depending on the variety or the cultivar. The best recommendation is to apply one side-dress application at some point, such as when the plants are 30 cm tall three to four weeks after planting or when the plants are half grown.

Other options include the following:

- Reapplying the fertiliser every three to four weeks.
- Other sources suggest reapplying the fertiliser two more times every two weeks.
- Too much nitrogen causes loose sprouts and splitting.

Irrigation

After the Brussels sprouts are transplanted, fields are irrigated through overhead sprinklers. This type of irrigation incorporates preplant herbicides and fertilisers into the soil and stabilises the planting beds until the root systems become established. Irrigation continues at weekly intervals in sandy soil, or two to three-week intervals in heavier soil.

Brussels sprouts, like all cole crops, require large volumes of water. Ample moisture should be provided in the heat of summer to keep the crop growing vigorously.

Furrow irrigation is used for Brussels sprouts production. Fields are cultivated two to three times during the production season. In addition, a side-dressing of fertiliser is added two or three times, depending on necessity.

Weed control

This is generally a weed-suppressing crop and can be ridged up to improve weed control around the plant. The wide spacing of the crop gives ample scope for mechanical weed control. Transplanted Brussels sprouts have an initial advantage over emerging weed seedlings, nevertheless, if sprout plants are left unweeded, yield is likely to be reduced by 13 to 24%.

Close crop spacing (45 x 45 cm) increases weed suppression compared to wider spacing (61 x 61 cm), but within-crop competition then tends to reduce the yield of individual plants. At closer row spacing, access for tractor steerage hoes becomes more difficult after early August. Early weed control is vital to avoid yield loss. As with cabbage, the plants have some tolerance to flame weeding, and treatment at three weeks after crop planting has been tried successfully.

Effective weed control should include a combination of management practices designed to suppress weeds during the entire year. Some of these practices are crop rotation, cover cropping, high planting density, mulching, cultivation, flooding and herbicide use. The extent and timing of cultivation has been shown to be very important. Cultivating more than one or two times early in the season was shown to reduce head quality and yield in Brussels sprouts.

The most effective weed management strategies must be made long before the crop is planted.

Pest control and disease control

INSECTS

The imported cabbage worm, cabbage looper and diamondback moth are three key pests of cole crops.

Diamondback moths are particularly troublesome because of their tolerance to many chemical insecticides. All cole crops are susceptible to attack by these three pests.

Imported cabbage worm adults are the white butterflies frequently seen flying in great numbers on warm summer days. Female butterflies have two black dots on each forewing while the smaller males only have one dot per wing. Larvae are velvety green worms up to 2 cm long with a faint yellow stripe running down the back. If the worm population is small, another effective control method is to hand pick them from the plants and destroy them. Bt (*Bacillus thuringiensis*) is a bacterium that will kill cabbage worms without harming beneficial insects, birds, pets or other life forms in the garden and is harmless to man.

The cabbage looper got its name from the way it arches its body while moving. When fully grown, its greenish body is 3 cm long and tapers near the head. There is a thin, white line along each side and two white lines along the back. The cabbage looper adult is a greyish-brown, night-flying moth with a wingspan of 3 cm. The mottled brown forewings are marked near the middle with a characteristic small, silver-white figure 8 or letter Y.

Caterpillars can be detected by scouting the crop, while adults can be monitored by using light or pheromone-baited traps. Neem-based pesticides are reported to control the cabbage looper by interfering with the growth of young caterpillars. Fairly good control of this pest has been obtained with a 2% ethanolic extract of neem seeds.

Bt (*Bacillus thuringiensis*) products give good control of the cabbage looper and do not harm natural enemies. For optimum control, treatments should be applied when caterpillars are small. Frequent crop monitoring is helpful to know the optimal time to apply Bt and other insecticides.

The diamondback moth is a small, greyish-brown, night-flying moth with a 2-cm wingspan. It holds its wings together, roof-like over its back, when at rest. When in this position, a pattern of three diamond-shaped spots can be seen along the top of the moth's body. The small caterpillars (up to 8 cm long at maturity) are pointed at both ends and range in colour from cabbage green to yellow. When disturbed, the larva rapidly wiggles its body back and forth, often causing it to fall off the plant.

Weather: — cool, windy weather reduces adult activity, and females often die before they lay all their eggs. Heavy rainfall can drown small larvae and reduce numbers by more than half. Humid conditions within the crop following a rainfall can promote the spread of fatal fungal diseases throughout the diamondback moth population.

Biological factors: — Diamondback moths are affected by diseases, parasites and predators.

Entomophthorales fungi cause natural disease outbreaks in diamondback moth populations. These outbreaks usually occur late in the growing season when populations are high. The rate of infection of diamondback moth larvae can be high enough to limit the development of additional generations late in the season.

In Western Canada, three species of parasitic wasps attack the diamondback moth. *Diadegma insulare* (Cresson) and *Microplitis plutellae* (Muesebeck) attack the larval stages while the third species, *Diadromus subtilicornis* (Gravenhorst), attacks the prepupal and pupal stages.

Flies, wasps, lacewings, plant bugs, pirate bugs, beetles, spiders and birds also prey on the diamondback moth larvae.

Adult flying cabbage worms can be screened out with the use of floating row covers such as a Reemay or AG-19 tent.

There are also a wide variety of chemical insecticides such as Bt (*Bacillus thuringiensis*) that are effective in controlling caterpillar pests of cole crops.



Flea beetles can also wreak havoc. Flea beetles chew tiny pinholes in the leaves. Early control is essential to minimise the damage.

They can also be screened out with the use of floating row covers. Aphids can be controlled with an intense spray of water as well as applications of hot pepper wax, insecticidal soap or liquid Rotenone. Late varieties will not form many sprouts in summer, so there is much less chance of severe aphid damage. The aphid popula-

tion usually drops dramatically after the first frosts.

DISEASES

Diseases that affect cole crops are black leg, black rot, downy mildew, Fusarium wilt and cabbage yellows. The home gardener growing Brussels sprouts can prevent many cole crop diseases by practising crop rotation, using sterile starting mixes and adopting strict garden sanitation methods. Treating seeds in a hot water bath before sowing may help to control diseases such as black rot, black leg and damping off.

Harvesting and handling

Prior to the 1960s, a typical Brussels sprouts field would have been harvested by hand eight or nine times. Harvesters would pick from the bottom of the plant and work their way upward with each subsequent harvest as the plant matured (Knaster & Jarrell, 1997).

Harvesting begins in October and is usually completed by March. At maturity, the plants are approximately 1 m tall. Brussels sprouts are harvested when the heads are bright green and firm. Sprouts that are not firm or are off-colour will be woody and have an undesirable flavour. Brussels sprouts can be either harvested mechanically or manually.

Brussels sprouts packed in the field are packed in 11 kg cartons. Brussels sprouts are graded, washed and packaged in the field. Most often Brussels sprouts are packaged into one-pint packages that are usually over-

wrapped. Brussels sprouts are very delicate; therefore they are very difficult to store.

In order to meet market standards, all Brussels sprouts must be fairly well coloured, fairly firm, not withered or burst and free from soft decay, seed stems and serious damage.

HORTICULTURAL MATURITY INDICES

Harvest maturity is based on sprout size and compactness. Sprouts should be 2,5 cm or more in diameter but not more than 7 cm in length. Stem elongation, resulting in space between older leaves, is a sign of overmaturity.

Optimum storage conditions: The recommended conditions for commercial storage are 0 °C at 95 to 100% RH. Under these conditions, quality can be maintained for 3 to 5 weeks. Their storage-life is half as long at 5 °C and only 10 days at 10 °C.

Brussels sprouts can be stored attached to their stems to prolong storage-life (Pelleboer, 1982). Packaging in vented poly-bags or overwrapped cups is advantageous to reduce wilting. Their highest freezing point is -0,8 °C (Cantwell, 1997).

The sprouts will develop where the leaves join the main stem of the plant, so it is best not to break off any leaves at first. The fruit will first start maturing at the bottom of the plant. Harvest matured sprouts when they are 2 to 3 cm in diameter. High-quality sprouts should be bright green, firm and well formed. Picking should begin at the bottom, breaking off a leaf below the sprout, and then removing the sprout. The upper sprouts will continue to mature as the lower ones are harvested.

On later-maturing varieties (115 plus days), it is important not to take off the leaves, as they protect the plant from foul winter weather. For a once-over harvest, pinch out the growing point at the top of the stem when the lower sprouts are ½ to ¾ cm in diameter. A full stem loaded with full-sized sprouts will develop in about 2 weeks. As with many Brassicas, sharp frosts enhance sugar content and increase tenderness.

High-quality fresh sprouts will store for approximately 3 to 4 weeks at 0 °C.

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