



– PRODUCTION GUIDELINE –

Brussels sprouts

Brassica oleracea



agriculture,
forestry & fisheries

Department:
Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

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2012

Department of Agriculture, Forestry and Fisheries

2012

Printed and published by

Department of Agriculture, Forestry and Fisheries

Design and layout by

Directorate Communication Services

Obtainable from

Resource Centre

Directorate Communication Services

Private Bag X144

PRETORIA

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GENERAL ASPECTS

Classification

Brussels sprouts is a cultivar group of wild cabbage cultivated for its small (typically 2,5–4 cm) leafy green buds, which resemble miniature cabbages. They are part of the cruciferae or mustard family, so known because of a four-part flower in the shape of a cross.

Scientific name: *Brassica oleracea* Gemmifera Group

Common names: Brussels sprouts

Family: Brassicaceae

Origin and distribution

Sprouts were believed to have been cultivated in Italy in Roman times, and possibly as early as the 1200s in Belgium. The modern Brussels sprouts that we are familiar with were first cultivated in large quantities in Belgium (hence the name “Brussels” sprouts) as early as 1587, with their introduction into the US in the 1800s.

Major production areas in South Africa

The vegetable is not popular in South Africa. Brussels sprouts may be grown all over the country in winter, although results may be poor in subtropical areas compared to regions that have cool to cold winters.

Description of the plant



The sprouts form at the base of each leaf petiole, in a spiral along the stem, where 80 to 100 sprouts per plant yield 0,91 to 1,13 kg sprouts per plant. The plant grows 0,76 to 1,0 m tall. The edible portion of this crop is the “bud” or small cabbage-like head in the axils of each leaf. Occasionally the tops are used as greens.

It is a cool weather crop. In hot weather, the plant produces flowers and the little sprouts are ruined.

Roots

Seedling with epigeal germination, with a taproot and lateral roots; hypocotyl 3 to 5 cm long, epicotyl absent; cotyledons with petiole 1 to 2 cm long, blade cordate, 1 to 1,5 cm long, cuneate at base, notched at apex.

Stem

Erect, glabrous, biennial herb up to 120 cm tall, with unbranched stem, developing lateral buds (sprouts) in leaf axils; root system strong and branched.

Leaves

Leaves alternate, simple or lower ones with some small side lobes at base; stipules absent; all leaves with distinct petiole, but upper ones with short petiole, giving the top of the plant a rosette-like appearance; blade more or less circular, undulate or irregularly incised, blue-green.

Flower

Flowers bisexual, regular, 4-merous; pedicel up to 2 cm long, ascending; sepals oblong, 1 cm long, erect; petals obovate, 1,5 to 2 cm long, clawed, pale to bright yellow or whitish; stamens 6; ovary superior, cylindrical, 2-celled, stigma globose.

Seeds

Seeds are globose, 1,5 to 2 mm in diameter, finely reticulate and dark brown.

Cultivars



Variety	Days to maturity	Sprout shape	Sprout colour	Sowing	Remarks
Adagia	130–135	Round	Dark green	Dec./Jan.	Freezing and prepack
Amoroso	165	Round	Green	Dec./Jan.	Freezing and prepack
Veloce	110–120	Round oval	Green	Dec./Jan.	Freezing and prepack
Densia	145	Round	Dark green	Dec./Jan.	Freezing and prepack

Variety	Days to maturity	Sprout shape	Sprout colour	Sowing	Remarks
Speedia	105–110	Round	Dark green	Nov.	Freezing and prepack
Octia	120–130	Round	Dark green	Nov./Dec.	Freezing and prepack

Climatic requirements

Temperature

Like cauliflower, it thrives best in a cool, humid climate. Brussels sprouts grow in temperature ranges of 7 to 24 °C, with highest yields at 15 to 18 °C.

Soil requirements

Brussels sprouts may be grown on a variety of soils but they grow best on a well-drained, loam soil well supplied with organic matter. Sandy loams are preferred for early crops. Adjust the soil pH to 6,5 or higher for maximum yields and avoidance of club root.

Site and soil

The plants need to be in full sun. They will grow in almost any soil, but prefer to be in loose soil that drains well, but that still retains moisture as sprouts should never be allowed to dry out (dry soil will result in a bitter flavour). They have a shallow root system and resent being disturbed, so they need to be in an area free of weeds.

To avoid disease and pest problems, the crop should not be planted in the same area where a crop within the same family with Brussels sprouts was planted before. At least three years between plantings of the cabbage-family (cabbage, kale, cauliflower, and broccoli) should be allowed in the same area. Sprouts grow really well in soil in which previously legumes like peas and beans were grown. Brussels sprouts grow well in either flat rows or raised beds, and it is very important that the soil is rich and well prepared because sprouts have such a long growing season.

CULTIVATION PRACTICES

Propagation

It is propagated by means of seedlings.

Soil preparation

The soil must be prepared in the previous autumn, adding a spade's depth of manure and compost. Soils should not be prepared for planting when too wet or too dry. If the soil sticks to your shoes or shovel, it is too wet. When the moisture is right, the soil crumbles and breaks into small clumps. If it is too wet, it stays moulded in a ball.

Seed and seedbed treatments

SEED TREATMENT

The number of seed is approximately 100,000 per kg, but this crop is most commonly transplanted rather than direct-seeded. Pelletising is not necessary but primed and coated seed is now becoming popular.

Use hot water and fungicide-treated seed for seedbeds to protect against several serious seed-borne diseases. Hot water seed treatments are very specific (50 °C exactly, for 25 to 30 minutes; the wet seed must then be quickly cooled and dried). The seed treatments are best done by the seed company, and can usually be provided upon request.

SEEDBED TREATMENT

The fields are fumigated prior to transplanting with Vapam (sodium methyl dithiocarbamate) to prevent nematodes from damaging the crop.

Planting

Organic material is spread along with lime to raise soil pH to prevent club root, and it is incorporated into the soil.

Planting period

Brussels sprouts are planted in nursery flats in the late winter, from January through May, and spend the first 50 to 60 days in the nursery. During this time, the fields are prepared for transplanting by discing and ploughing.

Planting dates

In zones where frost is unlikely after March, seeds may be sown outside as soon as the soil is dry enough on the surface. In 4 to 6 weeks the seedlings may be transplanted into their permanent positions, 45 to 60 cm apart, in rows, 60 to 76 cm apart. In areas further north, where late spring frosts are

usual, seeds may be sown in seedbeds made of finely sifted soil in a greenhouse, hotbed, or anywhere the temperature will be 50 °C at night (minimum) and there is full sun exposure. This may be done in early April to late May. When the seedlings form their first true leaves, they should be transplanted into flats or pots, or 8 cm apart in a cold frame. It will take about 6 weeks from sowing to being able to be planted outside. Planting should be accomplished before the end of June.

Spacing

The sprouts are transplanted into the fields on 91 cm beds with row spacing of 65 to 75 cm and in-row spacing of 40 to 50 cm.

Seeding rate

The plant population of Brussels sprouts per hectare under normal cultural practices reaches approximately 25 000 to 30 000/ha.

Fertilisation

A soil test is the most accurate guide to fertiliser requirements. Good management practices are essential if optimum fertiliser responses are to be realised in the production of Brussels sprouts. These practices include the use of recommended varieties, selection of adapted soils, weed control, disease and insect control, good seedbed preparation, proper seeding methods and timely harvesting.

Because of the influence of soil type, weather conditions, and other cultural practices, crop responses from fertiliser may not always be accurately predicted. Soil test results, field experience and knowledge of specific crop requirements help determine the nutrients needed and the rate of application.

The fertiliser application for Brussels sprouts should ensure adequate levels of all nutrients. Optimum fertilisation is intended to produce top quality and yields in keeping with maximum returns.

The suggested fertiliser applications are based on 91 cm row spacing. With decreased row spacing, increased fertiliser rates are suggested.

Field fertilisation

NITROGEN (N)

A total application of 68 to 91 kg N/ha is suggested. Broadcast about half of the N just prior to direct seeding or transplanting or bandplacing 27 to 40

kg N/ha with the phosphorus. For both direct-seeded and transplanted crops, side dress 34 to 45 kg N/ha at the time of last cultivation, or 1 to 2 weeks before the first harvest. At the higher rates, two applications should be made 2 to 3 weeks apart.

PHOSPHORUS (P)

Phosphorus fertiliser should be bandplaced at the time of seeding or transplanting. Bands should be located 5 to 8 cm to the side of the seeds or plants and 8 to 10 cm deep.

POTASSIUM (K)

Limit band applications of K to 41 kg K₂O per hectare. Broadcast the remainder of K and work into the seedbed prior to planting. The total of N plus K₂O in the band should not exceed 41 kg per application.

SULPHUR (S)

Include 11 to 18 kg S per hectare in the fertiliser programme. Sulphur is sometimes contained in fertilisers used to supply other nutrients such as N, P, and K, but may not be present in sufficient quantity.

Plants absorb S in the form of sulphate. Fertiliser materials supply S in the form of sulphate and elemental S. Elemental S must convert into sulphate in the soil before the S becomes available to plants. The conversion of elemental S into sulphate is usually rapid for fine ground (less than 40 mesh) material in warm, moist soil.

Sulphur in sulphate form can be applied at planting time. Some S fertiliser materials such as elemental S and ammonium sulphate have an acidifying effect on soil.



MAGNESIUM (Mg)

When the soil test value for Mg is below 2 meq/100g soil, bandplace 7 to 9 kg Mg per application at transplanting or seeding time. If Mg deficiency symptoms develop, spray with 4 kg of Epsom salts in 378 l water per application. Magnesium can also be supplied in dolomite form,

which is a liming material and reduces soil acidity to about the same degree as ground limestone. Dolomite should be mixed into the seedbed at least several weeks in advance of seeding and preferably the preceding year.

BORON (B)

Brussels sprouts are sensitive to boron deficiency. A satisfactory foliar spray contains 0,45 kg B per 378 ℓ water. Fertilisers containing B should not be bandplaced.

LIME

If a mineral soil is below pH 6,3 or an organic soil is below 5,5 and/or the calcium (Ca) level is below 8 meq/100 g soil, lime should be applied. Compared to other vegetables, Brussels sprouts has a fairly high lime requirement.

The application of lime is suggested when the soil pH is below 6,3 and during transplant bed fertilisation. Lime is broadcast and worked into the transplant bed:

- 18 to 32 kg N/ha.
- Apply phosphorus, potassium, sulphur, magnesium, boron, molybdenum and lime up to the maximum rates suggested below for field applications.

Irrigation

Brussels sprouts are a long-season crop. The total water requirement for the crop is 440 mm and weekly requirement is 30 to 38 mm.

Soil type does not affect the volume of total water needed, but does dictate frequency of water application. Lighter soils need more frequent water applications, but less water applied per application.

Weed control

Beds are cultivated several times to prevent weeds from taking over, and are irrigated every 3 to 4 weeks during the growing season by overhead sprinklers. Chemical control of grasses and weeds to supplement cultivation is suggested. If cultivation is used it should be shallow (8 cm or less) to avoid root damage and frequent to keep out grass and weeds. It is a long-season crop and weeds can be a serious problem. Pre-emergence herbicides are also very helpful.

Pest control

Cabbage worms and cabbage loopers

Affected area: Leaf

Description: Loopers are caterpillars that are generally green or greyish, taking on the colour of the host plant. They may blend well and be difficult to see. They eventually develop into white or yellow-winged moths, often seen fluttering around the plants. Caterpillars feed on the underside of leaves, which results in ragged holes, sometimes to the extent that plants starve and die.

Control: Spray with *Bacillus thuringiensis* (Bt) (commercially available as Dipel or Thuricide).

Cutworms

Affected area: Stem

Description: Plants are chewed off just above ground level. Cutworms are caterpillars 2 cm long and mottled or with green, brown or grey stripes. When they are disturbed, they roll up into a coil. They usually position themselves at the moisture line in the soil, moving up and down according to the water content. If the soil surface is dry, they will be found a couple of centimetres below the surface where the moisture begins. When the soils has recently been watered, they will be at the surface.

Control: Put a cardboard collar around new transplants to extend 2 to 5 cm above and below soil level. Cutworms can be controlled chemically by using chlorpyrifos.

Root maggots

Affected area: Roots

Description: Leaves wilt and growth is stunted. The insect is common, a white, root-feeding maggot. The long adult flies emerge from the soil about the time that cherries blossom and lay eggs at base of plants in the surrounding soil. Legless larvae feed on host plants for three weeks, riddling the roots with brown tunnels before they pupate. Two or three generations can occur each growing season.

Control: Use Diazinon before planting as a soil treatment. Rotate from year to year.

Flea beetles

Affected area: Leaves and roots

Description: Tiny holes/pinholes/chewed into the leaves by the adult insects, which are long, hard-shelled, shiny, dark-coloured beetles that jump when disturbed. Slender, whitish, cylindrical larvae feed in or on the roots but root damage is generally minimal. Be particularly careful to control these on emerging direct seeded plants as damage can occur quickly.

Control: Remove debris. Rotate location of planting from year to year.

Aphids

Affected area: Leaves

Description: Green, red-black or white insects that cause curled yellow leaves and exude a honeydew substance.

Control: Aphids are the most difficult insects to control on Brussels sprouts. Insecticidal soaps or a strong jet of water or most labelled insecticides like Diazinon. A layer of aluminum foil under the plants reflects light to underside of leaves, making them an undesirable habitat for aphids.

Slugs and snails

Affected area: Entire plant

Description: Large portions of young plants are missing.

Control: Slugs and snails are very susceptible to desiccation (drying out) and require a moist, shady place to live. Cultural practices which promote a sunny, dry environment will discourage them. Avoid too-frequent waterings and allow the soil surface to dry out between irrigations. Keep the garden free of debris, boards, bricks and stones under which they usually hide.

Hand picking these pests is very effective. Create traps for hand picking by laying boards in the garden. Slugs and snails will congregate under these. Lift the boards each morning and collect the slugs and snails. Kill and dispose of them in garbage as they will crawl back if tossed out of the garden and eggs inside dead snails can still hatch to produce more of these pests. Slug and snail bait containing metaldehyde can be placed near food plants as long as they do not come into contact with the edible portions of the crop.

Snail bait is most effective when moistened, but not saturated. It attracts slugs and snails from several metres away so bait stations are effective. Stations help protect birds, pets and other non-target animals which are also attracted to the bait. Place small piles of bait under a slightly propped up board or use a container such as a cottage cheese or yoghurt carton. Bury the carton to the mouth of the container.

Place a small quantity of commercial bait inside and moisten with apple juice, orange juice or water. Cut a hole in the lid to allow access and place the lid on the container. Containers may also hold beer or yeast water to attract slugs and snails in where they drown. Place bait stations wherever slugs and snails are active or around the perimeter of the garden.

Disease control

Powdery mildew

Powdery mildew is a disease of Brussels sprouts but generally it is not too severe.

Damping off

Affected area: Seedlings

Description: Young seedlings wilt and die

Control: Use treated seed and let the soil dry out between waterings

Black leafspot/Grey leafspot

Leafspot is caused by *Alternaria brassicae*, *A. brassicala* and *A. raphani*.

This fungal disease can be particularly destructive in wet, cold August weather, especially because there is such a huge reservoir of fungal inoculum in canola fields in some seasons. All cruciferous vegetable crops grown on the prairies are subject to very high inoculum levels of disease and insect pests.

*Clubroot (*Plasmodiophora brassicae*)*

This disease is controlled by fumigating with methyl bromide.

Bacterial spot

Warm water treatment of seed prior to planting is the most effective control method of bacterial spot where it tends to spread rapidly and in most affected areas.

Other cultivation practices

Transplant production

Plant the seed in a greenhouse for an early crop, in a cold frame for a less early crop, and in outdoor seedbeds when the weather is warm enough for germination and growth (above 10 °C). In each case sow the seed 5 to 6 weeks ahead of when the plants are wanted for transplanting.

A quantity of 113 to 170 g of high-quality, sized and density-graded seed will provide enough transplants to plant 1 ha. In the seedbed use a drill with a scatter shoe to drop 15 to 20 seeds per 30 cm in rows 25 cm apart, or a precision vacuum seeder or belt seeder with three lines per drill.

Greenhouse transplant production

Broadcast seed into flats containing a peat-lite (peat-vermiculite) mix or a sterilised soil and transfer individual plants into other flats when the first true leaves have formed or seed directly into modular flats, styrofoam trays or blocks of a growing medium. Crowding should be avoided. Provide 16,129 cm² per plant in modular trays.

Temperatures should be maintained above 7 °C at night and below 29 °C during the day. Start the hardening off process seven days before transplanting.

Follow the same process in a cold frame, or seed directly into the covered soil after it has been limed, fertilised and fumigated as for outdoor seedbeds.

Seedbeds for transplants

When seedlings are to be grown in a seedbed for production of transplants, choose a site where cole crops have not been grown before or fumigate prior to seeding with an approved material following the manufacturer's and label recommendations.

Locate these in an open, well-drained area, free of club root. Fumigate prior to seeding if the area has been planted to cole crops in the past.

Transplanting

Space the plants 41 to 46 cm in the row and space the rows 91 to 102 cm apart. Use only healthy plants that are about 15 cm tall and about 6 weeks old. Irrigate immediately after transplanting to set plants firmly into the soil. Use a transplant starter fertiliser solution high in phosphorus when transplanting.

Direct seeding

FIELD SEEDING

Because of the cost of seed and time required to reach the harvesting stage, direct-seeding Brussels sprouts is not recommended. If field seeding is to be done, preparation for direct-seeding needs the same attention a transplant seedbed area would be given. A fine-textured soil, free of rocks, clods and plant debris, firm and level, is required for precision seeding.

Use a precision seeder such as a Stanhay, or Gaspardo vacuum planter, to drop two seeds 5 cm apart every 38 cm. After the first true leaves have formed, thin out the plants so as to leave one plant at each location. Spacing between rows should be 91 to 102 cm. The use of vermiculite anticrustant is recommended. Or, have solid-set irrigation available to keep the soil surface moist and free from crusting until the stand has been established.

Thinning

Seeds should be planted closer together and then thinned out when they come up. The seedlings are thinned out to 8 cm if the rows become too overcrowded. Thinnings can be transplanted if the roots have not been damaged.

Harvesting

The “small heads”, “buds” or “sprouts” are found at the base of each leaf. These buds are harvested when they attain 2,5 to 5 cm in diameter, are firm, but before they turn yellow. Harvesting starts about 90 to 100 days after the field seeding. The sprouts begin maturing from the bottom upwards. The sprouts can be picked several times or harvesting can be delayed and the entire stalk taken at once. In picking, the leaf below the sprout is broken away from the main stem. Harvesting should start before the lower leaves begin turning yellow. Often the central growing point is removed to speed up the harvesting stage. This is done when the sprouts have developed well.

As the lower leaves and sprouts are removed, the plant continues to grow upwards, producing more leaves and sprouts. The plant will withstand frost and can be harvested until freezes occur. The best quality sprouts are produced during periods of sunny days and light frosts at night. Hot weather results in soft, loose or open sprouts of poor quality.

One plant is capable of producing about 1,1 kg to 1,3 kg sprouts; however, commercial production is terminated at 900 g. The frequency of harvesting and the number of harvests depend entirely on the weather. During the earlier, warm periods harvests may be every 7 to 14 days with about 2 to 6 sprouts being removed per harvest. As the weather becomes cooler, harvests may be delayed to once every 3 to 4 weeks, with as many as 10 to 15 sprouts being removed from a plant at each harvest.

Harvest maturity

Fields are ready for harvesting 90 to 180 days after planting. The edible sprouts grow like buds in a spiral along the side of long, thick stalks of approximately 60 to 120 cm in height, maturing over several weeks from the lower to the upper part of the stalk.

Harvesting methods

Most Brussels sprouts are hand harvested. Harvest sprouts when they are round, firm, tight, and of good colour. The lower sprouts mature first and should not be left on the plant too long as they will break down and become diseased. Alternatively, the crop can be mechanically harvested (once over).

Sprouts may be picked by hand into baskets, in which case several harvests are made of 5 to 15 sprouts at a time, by cutting the entire stalk at once for processing, or by mechanical harvester, depending on variety. Each stalk can produce 1,1 to 1,4 kg, although the commercial yield is approximately 900 g per stalk. In the home garden, "sprouts are sweetest after a good, stiff frost.

Deterioration of Brussels sprouts, -yellowing of the sprouts and discolouration of the stem end is rapid at temperatures above 10 °C.

Topping

The sprouts are "topped" 50 to 60 days prior to harvesting by machine; the terminal bud is pinched out by hand to prevent the plant from growing taller and to channel the plant's energy into the development of the sprouts.

To stimulate growth of the sprouts at the top of the plant and to provide uniform development for once-over harvesting, top (pinch off the growing point) the plants when they are almost fully grown and when the lower sprouts have a diameter of about 1,3 to 1,9 cm.

POST-HARVEST HANDLING

Just prior to harvest the leaves are cut off by hand with a machete (large knife). The plant is then cut off at ground level and fed through a stripping head, which removes the sprouts from the stalk. The stalks remain in the field and then go on to a cleaning shed, where they are cleaned and sorted, then sized and sent on to the packing facility. The smaller sprouts, 1,7 to 3,1 cm in diameter, are sent off to the processors for freezing and the larger sprouts are cooled, sorted again and packed for the fresh market.

Sorting and grading

A good yield would be about 3 175 kg/ha. Sprouts can be picked in hampers or baskets and hauled out of the field as soon as possible for packaging and refrigeration. Sprouts should be cleaned, the loose leaves trimmed off, and the sprouts sorted to remove those that are soft, damaged, or too large. The sprouts are packaged in either 11 kg drums, or 340 g cellophane bags. Unless refrigerated, the sprouts' colour and quality deteriorate rapidly. They can be stored for periods as long as 30 days if kept at 0 °C and 90 to 95% humidity.

Packaging

Film packaging is recommended to prevent wilting. The sprouts are usually packaged in 11 kg loose-pack cartons or in flats or cartons containing 12 cups of 283 g each.

Storage

Once harvested, sprouts last 3 to 5 weeks under ideal near-freezing conditions before wilting and discolouring, and about half as long at refrigerator temperatures. Store the sprouts at 0 °C and a relative humidity of 95 to 100%. The sprouts can be kept in good condition for a maximum of 3 to 5 weeks at 0 °C. Longer storage may result in black spots on the leaves, loss of fresh bright green colour, decay, wilting, and discolouration of the surface. The rate of deterioration is twice as fast at 4 °C as at 0 °C. At 10 °C and above, deterioration—yellowing of the sprouts and discolouration of the cut surface—is rapid; yellowing becomes evident within 1 week at 10 °C.

Market preparation

The “tops” are sometimes saleable in late winter, and fetch about R42,00 per ton. The stumps of the plants, after the sprouts have all been collected, make valuable food for stock, either sheep or cattle.

PRODUCTION SCHEDULE

Activities	January	February	March	April	May	June	July	August	September	October	November	December
Soil sampling	X	X	X	X								
Soil preparation		X	X	X	X							
Planting	X	X	X	X	X							
Fertilisation	X	X	X	X	X							
Irrigation	X	X	X	X	X							
Pest control	X	X	X	X	X							
Disease control	X	X	X	X	X							
Weed control	X	X	X	X	X							
Topping	X	X	X	X	X							
Leaf sampling	X	X	X	X	X							
Harvesting		X	X	X	X	X						
Marketing	X	X	X	X	X	X	X					

UTILISATION AND NUTRITIONAL VALUE

Culinary/Cooking

Cooking methods include boiling, steaming and roasting; however, boiling results in significant loss of anti-cancer compounds. To ensure even cooking throughout, buds of a similar size are usually chosen. Some cooks will make a single cut or a cross in the centre of the stem to aid the penetration of heat.

Whatever cooking method is employed, overcooking releases the glucosinolate sinigrin, which has a sulphurous odour. The odour is the reason many people dislike Brussels



sprouts, having only ever tried them overcooked. Generally 6 to 7 minutes boiled or steamed is enough to cook them sufficiently.

Nutritional value

Brussels sprouts, as with broccoli and other brassicas, contains sulphoraphane, a chemical believed to have potent anti-cancer properties. Although boiling reduces the level of the anti-cancer compounds, steaming, microwaving, or stir-frying does not result in significant loss.

Brussels sprouts and other brassicas are also a source of indole-3-carbinol, a chemical which boosts DNA repair in cells and appears to block the growth of cancer cells.

They contain good quantities of vitamin A, vitamin C, folic acid and dietary fibre. Moreover, they are believed to protect against colon cancer, as they contain sinigrin. Although they contain compounds such as goitrin that can act as goitrogens and interfere with thyroid hormone production, realistic quantities in the diet do not seem to have any effect on the function of the thyroid gland in humans.

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<http://nwrec.hort.oregonstate.edu/brussprt.html>

<http://www.brussels-sprouts.com/BSINFO.html>

Further information can be obtained from

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