



Cauliflower

Brassica oleracea (Botrytis)



**agriculture,
forestry & fisheries**

Department:
Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

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Department of Agriculture, Forestry and Fisheries

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Content

Origin and distribution	1
Climatic and soil requirements	1
Uses	1
Cultural practices	2
Pest and disease control	5
Harvesting and handling	7
References	8

Origin and distribution

Cauliflower, *Brassica oleracea* var. botrytis, belongs to the Brassicaceae (mustard) family, which also includes cabbage, Brussels sprouts, broccoli, mustard and rape seed. Cauliflower was discovered in the Mediterranean region over 2 000 years ago, and has been cultivated in the United States since the 18th century. The edible part of the plant is a cluster of immature flower buds referred to as a “curd”.

Climatic and soil requirements

Cauliflower is a cool-season crop with distinct temperature requirements for producing a marketable curd (the edible immature flower buds). The optimal temperature range for growth and development is 18 to 20 °C during the day. Most growing regions in South Africa have daytime temperatures of 17 to 29 °C and night-time temperatures of 3 to 12 °C, and sometimes even extreme day climates reaching a maximum of 35 to 40 °C in parts of the Northern Cape, North West and Limpopo. At temperatures of 27 °C and higher, cauliflower tends to have small jacket leaves, small curds, solar yellowing and raciness of the curd. At freezing temperatures, the curds may be damaged and when that happens, is that secondary decay occurs.

Cauliflower is grown on many soil types, from clay to loamy sand. Soils with a high moisture-holding capacity are preferred in the summer, because water stress adversely affects curd development. In winter, soils that dry rapidly after a rain are preferred so that farm equipment can enter to perform cultivating and harvesting operations. Cauliflower is considered

moderately sensitive to salinity in soil and water. Although no salinity threshold for yield reduction has been established for cauliflower, it is considered more tolerant to salinity than lettuce but somewhat less tolerant to salinity than broccoli.



Uses

Cauliflower can be roasted, boiled, fried, steamed or eaten raw. Steaming or microwaving better preserves anti-cancer



compounds than boiling. When cooking, the outer leaves and thick stalks are removed, leaving only the florets. The leaves are also edible, but are most often discarded. The florets should be broken into similar-sized pieces so that they are cooked evenly. After eight minutes of steaming, or five minutes of boiling, the florets should be soft, but not

mushy (depending on size). Stirring while cooking can break the florets into smaller, uneven pieces. Cauliflower is often served with a cheese sauce, as in the dish cauliflower cheese.

Human health benefits and concerns

Cauliflower is low in fat, but high in dietary fibre, folate, water and vitamin C, possessing a high nutritional density.

Cauliflower contains several phytochemicals, common in the cabbage family, which may be beneficial to human health. A high intake of cauliflower has been associated with reduced risk of aggressive prostate cancer.

Cultural practices

Soil preparation

Good soil preparation is important when planting cauliflower. The best way to determine your soil conditions are to have a soil test performed.

Cauliflower requires a fairly fertile, well-drained soil with a good water-holding capacity and a pH range of 6 to 7. Working the soil to break up any hardpan, and incorporating manure or compost to a depth of 15 to 20 cm are normally best recommended. If soil must be treated for root-knot nematode, this must be done after the soil is prepared, and allowed an interval of 2 to 3 weeks after treatment before planting.

Planting

No cauliflower is direct seeded on most growing areas, but in fewer parts, it is direct seeded. The majority of growers use greenhouse-grown transplants. With transplants, more uniform plant stands and earlier harvests are possible. Transplanted cauliflower is placed in single rows on beds of

100 cm wide and spaced 30 cm apart. Plants are typically placed with the crown below the soil surface to reduce damage caused by winds. In some cultivars, as plants begin to form flower buds, the leaves surrounding the central growing point must be hand-tied with rubber bands to prevent the developing curd from being exposed to sunlight, which can cause yellowing. Other cultivars form a leaf jacket that shades the flower, eliminating the need for tying. Still, other cultivars do not develop an appreciable degree of solar yellowing even with direct exposure to the sun.

Fertilisation

Cauliflower demands a great deal of nutrients and care must be taken to provide adequate nutrition to the crop. Phosphorus fertilisation should be applied based on the soil-test level of bicarbonate-extractable phosphorus. Levels above 50 ppm are adequate for cauliflower growth; for soils below this level, especially in winter, preplant applications of 45 to 90 kg/ha of phosphorus pentoxide are recommended. The need for potassium (K) can also be determined from soil tests; soils with greater than 150 ppm of ammonium acetate exchangeable potassium have sufficient quantities of potassium for the crop. Potassium fertilisation presents no environmental risk and many growers routinely apply potassium, even in fields with high exchangeable soil potassium. While applying approximately 112 to 157 kg/ha of potassium to replace potassium removed by the harvested crop is appropriate to maintain soil fertility, fertilisation rates above that level are economically wasteful. Zinc fertilisation is recommended if DTPA-extractable soil level is less than 1,5 ppm. Zinc fertilisation is frequently applied owing to high soil phosphorus levels, which reduce zinc uptake by plants.

Autumn application of nitrogen is not recommended owing to the risk of NO_3N leaching beyond the root zone by the winter rains. Small quantities of nitrogen, 22 to 34 kg/ha, are applied preplant or at planting. At the first side-dressing, 56 to 90 kg/ha of nitrogen is incorporated into the beds. One or more additional side-dressings are common, typically several weeks apart. Seasonal nitrogen application to late-autumn, winter or spring cauliflower crops ranges from 202 to 270 kg/ha. Owing to residual nitrogen from prior crops and mineralisation of nitrogen from soil organic matter, the nitrogen fertilisation rates for cauliflower grown during the warm part of the year typically range from 179 to 224 kg/ha. The side-dress nitrogen requirement can be estimated by pre-side-dress soil nitrate testing (PSNT). Soil nitrate levels higher than 20 ppm in the top 30 cm are adequate for crop growth. The test can be repeated later in the season to ensure continuing nitrogen sufficiency. In drip-irrigated fields, nitrogen can be applied through the drip system as well. Typically, drip systems deliver

nitrogen fertiliser more efficiently than do furrow or sprinkler irrigations, often allowing drip users to reduce fertiliser application by 20 to 30%.

In areas where soil test phosphorus is usually lower, most growers apply preplant P_2O_5 at 168 to 336 kg/ha. Ammoniated phosphate fertilisers are broadcast before listing or are applied in bands during listing. The remainder of the nitrogen is applied in one or two side-dress applications of 56 to 90 kg/ha.

Irrigation

Cauliflower requires adequate soil moisture to maximise yield and quality. It is irrigated most frequently with furrow and overhead sprinklers. Most growers use sprinkler irrigation to establish transplants and either continue with sprinklers or switch to furrow or drip irrigation for the remainder of the crop. After transplants are established, sprinkler irrigations are usually applied at weekly intervals during the spring and summer. A small part of the hectare can be grown under surface drip irrigation. Some drip irrigated fields are planted on beds of 2 m wide with three lines of plants per bed and two lines of drip tape between the plant rows. Using drip irrigation can provide improved access to fields during harvest, especially on heavy soils with limited drainage. Approximately 1 500 to 2 000 m³/ha of water is needed to grow a furrow-irrigated cauliflower crop and 1000 to 1 500 m³/ha is required for cauliflower production with sprinklers during the summer. Furrow irrigated crops receive approximately 2 000 m³/ha of water. Drip irrigation may reduce water use by as much as 25% on soil types prone to runoff or on sandy soils that have a limited water-holding capacity.

The volume and frequency of sprinkler or furrow irrigation depend on soil type, weather conditions, crop-production area and crop maturity. The combination of soil-moisture monitoring and weather-based irrigation scheduling can be used to determine the water needs of cauliflower. Water use is highest during the last month of the crop when vegetal growth is high. Soil moisture tensions are typically targeted for less than 25 to 30 kPa during this period. Soil moisture is often allowed to reach moisture tensions greater than 30 cbars between the first side-dressing and the onset of head formation. The volume of water cauliflower extracts from the soil can be estimated by using reference evapotranspiration data, adjusted with a crop coefficient, that are closely related to the percentage of ground covered by the canopy. At a maximum canopy cover of 100%, the crop coefficient is nearly 1,0. Crops grown with sprinklers should use a crop coefficient between 0,3 and 0,7, depending on the frequency of irrigation until the canopy is greater than 30% ground cover.

Weed control

Integrated weed management should be practised prior to planting cauliflower. Management steps include crop rotation, field selection and weed removal before weeds produce seed and preplant irrigation to stimulate weed emergence so that these seedlings can be killed off with herbicides, propane flaming or shallow tillage. In addition, careful preparation and spacing of beds and precise planting make close cultivation more effective.

Weed control is most critical for the first 30 days following transplanting until the crop begins to close the leaf canopy and shade out weeds. Preplant or post-plant herbicides are available for use on cauliflower. Surface spray-banding of liquid fertiliser may have the added benefit of burning small weed seedlings as well as fertilising the crop. Given the planting configuration, effective weed control can be achieved with cultivation. The first cultivation removes weeds from the entire bed except for a band of 10 cm wide around the seedlings. The second cultivation carried out just before the canopy closes throws dirt at the base of the plant, which smothers small weeds. After this cultivation, the canopy shades newly emerged weed seedlings. Hand-weeding may be necessary to remove weeds between the plants in the seed-line.

Weeds of concern include common groundsel (*Senecio vulgaris*), prickly lettuce (*Lactuca serriola*), annual sowthistle (*Sonchus oleraceus*), London rocket (*Sisymbrium irio*), shepherd's purse (*Capsella bursapastoris*), nutsedge (*Cyperus* spp.), little mallow (*Malva parviflora*), burning nettle (*Urtica urens*), and chickweed (*Stellaria media*), depending on the region and the time of the year.

Pest and disease control

Insects

The most damaging insect pests are worms, aphids and whiteflies, depending on the region and time of year. The cabbage aphid (*Brevicoryne brassicae*) is the most important pest, though larvae of the cabbage maggot (*Delia radicum*) can chew and damage the hypocotyls of young transplants. Turnip aphid (*Hyadaphis erysimi*) and green peach aphid (*Myzus persicae*) are more common pests. Several predators and parasites attack aphids, especially in fields that are not sprayed or sprayed with less-toxic materials. These natural enemies, including general aphid predators such as the seven-spotted lady beetle (*Coccinella septempunctata*) and the parasites *Lysiphlebus testaceipes*, *Aphidius matricariae*, *Aphelinus semiflavus* and *Diaeretiella rapae*, may provide adequate control under certain

circumstances. The silver-leaf whitefly (*Bemisia tabaci argentifolii*) causes slow growth and delayed maturity of the crop. In most production areas, several worm pests such as loopers (*Trichoplusia ni* and *Autographa californica*), imported cabbage worm (*Pieris rapae*), beet armyworm (*Spodoptera exigua*), diamondback moth (*Plutella xylostella*) and others are potential problems, depending on the time of year and weather conditions. Worms should be managed by using selective materials to avoid making other insect problems more severe. Rotation of insecticide classes is essential for insecticide resistance management. Concerns of resistance to new generation pesticides are present whenever one chemical is heavily relied upon as a control measure.

Diseases

Greenhouse transplants may be stunted and weakened by downy mildew (*Peronospora parasitica*) and bacterial leaf spot (*Pseudomonas syringae* pv. *maculicola*) foliar diseases, but once plants are transplanted and established in the field, these diseases are not usually important. Newly transplanted cauliflower is subject to wire-stem immune until plant hypocotyls thicken and become immune to the soil-borne pathogen (*Rhizoctonia solani*). Wire-stem can be minimised if soil is not overly wet when plants are transplanted and if plants are not placed too deeply into the soil.

Black rot (*Xanthomonas campestris* pv. *campestris*) may cause significant problems when introduced on greenhouse-grown transplants. To prevent this disease, black-rot-free seed should be used for producing transplants.

Phytophthora root rot (*Phytophthora* spp.), club root (*Plasmodiophora brassicae*) and *Verticillium* wilt (*Verticillium dahliae*) are three soil-borne diseases that affect the crop during its main growth phase. *Phytophthora* root rot is best managed by careful irrigation scheduling. Club root is a persistent disease that is effectively managed by raising soil pH with calcium and magnesium liming materials. *Verticillium* can be controlled if effective soil fumigants are used or if infested fields are planted to cauliflower in winter. Some hybrid cauliflower cultivars grow vigorously and can be tolerant to this pathogen.

Sooty mould or curd smudge is caused by a contaminating fungus (*Cladosporium* sp.) that sometimes develops on curd surfaces when the crop is near harvest. This non-infecting fungus is held in check by the use of chlorinated water sprays before packing. Washing also helps to remove dust and debris from the curds.

While mature cauliflower is subject to several foliar diseases, including *Alternaria* leaf spot (*Alternaria brassicae* and *A. brassicicola*), white mould

(*Sclerotinia sclerotiorum*) and downy mildew (*Peronospora parasitica*) affect all stages. The crop is usually not significantly impacted by these diseases and control measures are rarely needed.

Other pests and problems

Cauliflower is a host to the cyst nematode (*Heterodera schachtii*). However, it appears that extremely high populations of this nematode need to be present for significant yield reductions to occur. Threshold levels have not been established for cyst nematode on cauliflower.

Wind whip causes girdling and dying off of small seedlings. Later, surviving plants may wilt and fail to form a flowering head. The stems of affected plants become very brittle. Seedlings are more susceptible to wind whip after weeding. During certain times of the growing season, cauliflower may develop a physiological condition in which sections of the curds turn light tan to brown while retaining normal texture and firmness. With time, these areas may soften and decay owing to secondary rot organisms. The exact cause of this condition is not known, but it is most likely linked to changes in environmental conditions and the physiological status of the plant. In some cases when environmental conditions favour rapid growth of the curd, underlying floret branches may crack and result in discoloured sections.

Field mice (*Microtus* spp.) may be a problem near harvest. Once mice become established in a field, they are nearly impossible to control. Prebaiting and destroying grassy areas on the perimeter of the field may be an effective way of prevention and control.

Blind bud, a condition in which no central growing point and flowering head form, may be as a result of mechanical injury, insect chewing or bird feeding. In some cases, blind bud develops in a small percentage of plants from a certain seed lot indicating that this type of blind bud may be a genetic trait.

Harvesting and handling

Cauliflower is hand-harvested in the field. Fields are normally harvested two to four times or more, depending on the market. Mature heads of 15 cm or larger are hand-selected and trimmed of excess wrapper leaves, making a crown-cut shape. Smaller heads will usually grow enough to be harvested as the next larger size within a couple of days. The heads are placed on a harvesting platform, sorted, covered with plastic wrap and packed by size. Cauliflower should never be allowed to roll or have the

white curd make contact with objects or work surfaces because the curd readily bruises and turns brown. Damaged curds may even be subject to post-harvest decay.

Heads are usually placed in plastic bags, sealed with tape and packed in cartons according to size (cartons of 9, 12, 16 or 20 heads). Normally, the markets prefer 12s. Cauliflower is always packed in single layer cartons to prevent bruising and subsequent discolouration and decay. Some cauliflower is cut into florets for fresh-cut products, usually for food-service outlets. Cartons containing 1,4 kg bags of 3,7 to 7,5 cm florets are common. In addition to conventional cartons, cauliflower is marketed as small and large-cut pieces and mixed with other vegetables such as broccoli and carrots. Yields of 10,4 kg cartons (200 to 240 per ha) are possible.

Some cauliflower is hand-harvested, placed in bulk bins and transported to a freezer plant. These heads are harvested with more jacket leaves than carton-packed cauliflower to prevent curd damage during transport and unloading. The heads are trimmed again at the freezer plant.

References

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