

CELERY

INTRODUCTION

Celery (*Apium graveolens* var *dulce*) has its origins in the eastern Mediterranean, and has been cultivated for over 2 000 years. In South Africa, celery culture is believed to have a very promising future, especially for specialist growers situated in areas which have moderate temperatures over most months of the year. There is likely to be an increasing demand for good-quality celery because of the changing eating habits of the consumer towards healthful food. Celery is normally consumed fresh.

PLANT FORM

Celery is a member of the family Apiaceae, and is related to such vegetables as parsley, carrot and parsnip. It is a biennial which is grown as an annual (a three-to-four month crop after transplanting), unless established for seed.

The celery plant has a thick, fleshy taproot which may be broken off in transplanting. The plant develops a fibrous root system which is situated in the top 200 mm of soil. Leaves are pinnately compound with a characteristic smell when crushed. The petiole of the leaf is the main plant part consumed, and is long, thick, curved in cross-section, and longitudinally grooved on the outer surface. Leaf blades are used for soups, stews and salads.

The small white flowers are borne on a compound terminal umbel, developing in the second year of growth or after winter cold spells.

ENVIRONMENTAL CONDITIONS

Climate

Optimal conditions conducive to quick plant development and top yields of good-quality celery are moderately cool air temperatures (between 13°C and 24°C), adequate soil moisture without dry periods, and relatively high humidity conditions. Plants will withstand very light frosts, but are susceptible to colder conditions. Extended periods with temperatures remaining below 13°C will cause seed-stalks to be initiated (plant bolting). On the other hand, when maximum daily temperatures consistently rise above 24°C, the edible stalks become more fibrous, and tend to develop a bitter flavour.

Soils

Sandy to heavier loam soils, which are slightly acid and rich in humus, are the most suitable for celery production. Although the plants are fairly shallow-rooted, the ideal soils are relatively deep, fertile, and well-drained soils in which moisture levels remain adequate.

Establishment

The majority of celery plantings are established using seedlings, but if misting irrigation is available then direct seeding might be desirable. With direct seeding, weed control requires more attention. Between 0,5 and 1 kg fresh seed is required per ha of celery plants. Seed germination might often be a problem. Seed could be soaked in water for a day before it is sown, in order to hasten germination. Seedbeds may be used, or trays of styrofoam seedling cells. Seedbeds should be level and standing water avoided. Young seedlings from beds could be pricked out, and placed in seedling cells for further development, before final transplanting into the prepared beds. Specialist seedling nurseries supply a significant proportion of the plants used. Seedlings should develop for about two months before field planting.

Plant population

In the field, single or double rows are commonly planted. At 600 mm single row spacing, with 150 to 200 mm between plants in the row, a plant population of between 85 000 and 110 000 per ha will be achieved.

With a double row bed system of planting, a spacing of 1 m from bed centre to bed centre is recommended, and two rows of plants about 350 mm apart would be established in each bed. This configuration, at a spacing of 200 mm within a row, would give a plant population of 100 000 per ha.

In practice, row spacing and layout would be influenced by the tractor and the implements available to the grower.

Fertilizer

Celery grows best in a slightly acid soil (pH about 6,0). The type and the amount of lime to apply to a more acid soil should be determined by soil analysis. Good yields require high levels of application of the major elements. Three to four weeks after planting, a side-dressing of a nitrogenous fertilizer or 1:0:1 mixture is recommended and, depending upon the extent of leaching, a further nitrogen application may be made up to a month before harvest.

Celery responds well to compost or organic manures. Compost in the root zone area of plants improve aeration and water-holding capacity; unfavourable growth conditions will affect stalk quality. Minor element deficiencies are discussed under physiological disorders.

Irrigation

Growth checks through lack of moisture will result in lower quality of the succulent celery stalks. Because of its shallow root system, frequent, light irrigation is desirable, especially during the second half of crop growth. Nevertheless, prolonged periods when foliage is wet should be avoided, because such conditions favour development of foliage diseases.

After transplanting, the plant forms a rosette of leaves on a short stem; succeeding leaves have elongated stalks which are increasingly fleshy. Thick petioles which are succulent and free of fibrous material should be aimed for at harvest. Any check to growth will favour development of the stringy texture in stalks.

Blanching

Whilst green celery is the most popular type on the market, there is still a demand for blanched celery. Blanching is the process whereby sunlight is excluded from the developing petioles, and the formation of chlorophyll, which gives green colour to the stalks, is inhibited. The pale stalks may be more tender, and have a milder flavour than do the green petioles.

Blanching is commenced during the second half of growth, when plants have reached a height of at least 250 mm. Sleeves of bottomless pulp cardboard (similar to those protecting bottles) are slipped over the plant, or boards 200 mm or more wide, or opaque plastic sheeting, erected on either side of a row of plants, ensure that petioles of plants remain in the dark or in dense shade.

So-called self-blanching cultivars, whose petioles are naturally a light yellow to yellow-green colour, are also grown. They may be blanched further, by excluding sunlight from reaching the petioles. This produces a milder flavour. However, these types generally have fewer petioles per plant, and thus do not have the same compactness nor heart development, as do the commercial green celery cultivars.

Cultivars

One of the most popular self-blanching cultivars is Golden Self-blanching.

The Utah type of green celery, which includes a number of varieties, is the most popular celery grown. These selections typically give large and dense plants, with petioles that are well overlapped, and with good heart formation.

Weed control

In some countries pre-plant and post-transplant herbicides are used for control of annual broad-leaved weeds and grasses. However, no herbicides are currently registered for use on celery lands in South Africa, so weeds need to be controlled by mechanical working of the soil, or by manual weeding.

Physiological disorders

Blackheart results from calcium deficiency. Young heart-leaves of a plant develop dark water-soaked tips, and the affected areas turn black as they dry. The condition is caused by low calcium levels in the soil, or by reduced uptake of calcium by the plant because of moisture stress or high levels of potassium or soluble salts. It can occur when the growth rate of young leaves is faster than the uptake of calcium by the plant's roots. Blackheart can be prevented by spraying calcium, as the chloride or nitrate salt, directly onto the heart leaves. Between five and ten kg of the salt in 1 000 litres water is applied per ha, and can be repeated at weekly to ten-day intervals. Soil application of calcium will not correct the condition once it appears.

A condition known as cracked stem is caused by a deficiency of boron. Symptoms of the condition are longitudinal brown streaking on the inner surface of petioles, and cracks along the ridges of the outer surface. Expression of the symptoms of boron deficiency is often encouraged by the presence of excessive nitrogen in the soil and the plant.

A deficiency of magnesium is expressed by chlorosis or yellowing, especially on leaf tissues between the veins, of older leaves. A spray application of one percent magnesium sulphate (Epsom Salts) should correct the condition; the application can be repeated to foliage about ten days later.

Diseases

It has been explained that celery grows best under moderate temperature conditions and with adequate water. Such conditions are often associated with cool, cloudy situations where free water is present on foliage for prolonged periods. Several leaf diseases are promoted by these conditions, and might be limiting factors to successful celery production.

Symptoms of early blight (caused by *Cercospora apii*) are necrotic leaf spots which are ash-grey in colour, and about 10 mm in diameter. They are first visible as yellow circular spots on leaves; with petiole infection the lesions are elongated.

Two species of *Septoria* cause late blight and leaf blotch, respectively. The former is more prevalent, and incidence is favoured by mild temperatures and free moisture. Chlorotic spots occur on mature leaves and stalks, later turning grey with black pinpoint-sized pycnidia (spore-forming structures) embedded in the spots. Under severe conditions unprotected leaves will blacken, and the plant has a withered appearance.

Of the registered fungicides for use on celery, copper oxychloride can be fairly effective as a protective spray against late blight infection. The *Cercospora* leaf spot could be controlled more effectively with prophylactic sprays of several fungicides which are not currently registered for use on celery. It is hoped that registration will take place.

The causal fungi of the above diseases can be transmitted on celery seed. If seed transmission occurs then infection of young seedlings will be initiated in the seedbed. To avoid this, seed should be heat-treated. Fresh celery seed should be held in water preheated to a temperature of 48°C, for 30 minutes (as a comparison, fresh cruciferous seed is treated at 50°C).

Pests

Cutworms may be a problem immediately after transplanting. A number of insecticides are registered for cutworm control. Some may be used as bait formulations, but most would be sprayed onto the damp soil in the row, or applied next to the seedling transplants and gently watered into the soil.

Of other insect pests, chewing insects such as army worm and Plusia looper might attack leaves. Aphids might also become a problem. Red spider mite is another pest which is often not noticed. No specific insecticides or miticides are registered for use on celery.

HARVESTING, STORAGE AND MARKETING

Depending upon the cultivar and the season, harvesting should commence from less than three months to more than four months from the time of transplanting. Stalk or petiole size increases with time, but defects such as development of fibrous tissue will also become more marked. Thus there will be an optimal time for harvesting as heavy a crop as possible which is a high quality product for the consumer. A uniform planting would be expected to attain this stage, and to be completely harvested within a period of a week to a fortnight from the first plants being harvested.

Plants are usually lifted by hand, but machine harvesting may be used. A knife is used to separate roots from the butt, or base of the stem, and for trimming off older, outer stalks, and topping the heads, to remove the upper portion of leaves. Under very hot conditions, plants should be removed from the field as soon as possible to reduce wilting, and trimming can proceed in a shady structure. In most operations, washing to remove all traces of soil is necessary.

Wilting is an important factor. Washing should assist in cooling the harvested celery, especially if the water is pre-cooled. Unless the marketing outlet is close to the production area, cooling facilities should be available. Cold-room temperatures should be as low as 2°C, with high humidity, for prolonged holding of the celery.

In South Africa, a common method of marketing is the use of perforated plastic sleeves, which reduces loss of moisture and delays onset of wilting of stalks. If the produce display shelves of sales outlets have a misting facility, paper-coated wire ties may be used to hold the petioles together. A fresh appearance is very important in celery marketing.

The average yield attained in South Africa of 25 to 30 t of celery per ha is only half the average yield of growers in the U.S.A., where a good yield is considered to be 80 t per ha, so cultural improvements can be used by producers here to attain better yields without significant cost increases.

NUTRITIONAL ASPECTS AND USES

Celery stalks have only moderate levels of vitamins, but have a low percentage of carbohydrates and negligible fat. It is popular with dieters because it is 94 percent water and has only 21 calories per 100 g portion consumed (comparable to energy stored in cucumber slices and lettuce).

The leaves are hardly ever used, except in soups. Sliced stalks are also used as an ingredient in soup or stews.

The main use of celery is as a salad dish. It is presented either diced or cut into small lengths. It is also served with other raw vegetables, such as carrot slices and broccoli florets, on a plate with various dips, as an appetizer at cocktail parties and other functions.

Table 20.

Total tonnages sold on Durban National Market per year from 1993 to 1997, and mean annual prices (R per ton obtained).

	1993	1994	1995	1996	1997
Tons sold p.a.	107	48	101	120	72
Ave. R/ton	1371	2306	2454	2602	2809