CASSAVA

Manihot esculenta Crantz

Plant symbol = MAES

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Alternate Names

Synonyms: Jatropha manihot L., Janipha manihot (L.) Kunth, Manihot utilissima Poh, Manihot aipi Poh, Manihot manihot (L.) Cockerell, Manihot melanobasis Muell. Arg.

Common names: cassada, cassava, manioc, yuca, tapioca, mandioca, shushu, muk shue, cassave, maniok, tapioka, imanoka, maniba, kasaba, katela boodin, manioc, manihot, yucca, mandioca, sweet potato tree, and tapioca plant

Caution: The root of the bitter variety is very poisonous when raw. Cooking destroys the hydrocyanic acid making it safe to eat; the cooking water must be discarded.

Uses

Ethnobotanic: In Samoa, cassava was used to induce abortion. American Indians use the brown juice, obtained during processing, for burns.

Food products: There are hydrocyanic glucosides (HCN) in all parts of the plant; these glucosides are removed by peeling the roots and boiling in water.

The young tender leaves are used as a potherb, containing high levels of protein and vitamins C and A. The leaves are prepared in a similar manner as spinach, while eliminating toxic compounds during the cooking process.

Cassava flour is used to make cookies, quick breads, loaf breads, pancakes, doughnuts, dumplings, muffins, and bagels.

Cassava extracted juice is fermented into a strong liquor called kasiri. It also can be concentrated and sweetened until it becomes dark viscous syrup called kasripo (casareep). This syrup has antiseptic properties and is used for flavoring.

The peeled roots of the sweet variety are usually eaten cooked or baked.

Livestock: Cassava leaves and stem meal are used for feeding dairy cattle. Both fresh and dried cassava roots are consumed by ruminants in different forms (chopped, sliced, or ground). Cassava bushes three to four months old are harvested as forage for cattle and other ruminants.

Ornamental: One clone with variegated leaves is planted as an ornamental.

Commercial: Cassava starch is used in the production of paper, textiles, and as monosodium glutamate (MSG), an important flavoring agent in Asian cooking. In Africa, cassava is used as partial substitution for wheat flour.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description

General: Family (Euphorbiaceae), Cassava is one of the leading food and feed plants of the world. It ranks fourth among staple crops, with a global production of about 160 million tons per year. Most of this is grown in three regions: West Africa and the adjoining Congo basin, tropical South America and south and Southeast Asia.

Cassava is a tall semi-woody perennial shrub or tree, up to 7 m high, dbh up to 20 cm, single to few stems, sparingly branching; branchlets light green to tinged reddish, nodes reddish. The outer bark is smooth, light brown to yellowish grey; inner bark cream-green; exudate thin, watery; wood soft, creamy straw.

Leaves: petiole light greenish to red; blade basally attached or slightly (up to 2 mm) peltate, dark green above, pale light greenish grayish underneath, sometimes variegated; lobes narrow, 2.9-12.5 times as long as wide; central unlobed part usually short, lobes 15-21 times as long. Inflorescences lax, with 3-5 together in fascicles; pedicels light green to red.

Staminate flowers: calyx divided to halfway or more, green to white to lobes white to reddish with white median band inside to red purple, glabrous except for apex of calyx tube and inner side of segments finely hairy; filaments white, anthers yellow; disc yellow to light orange.

Pistillate flowers: calyx green with red margin and midrib, hairy along the margin and on the midrib inside; disc pink; ovary with 6 longitudinal ridges, green (with pinkish stripes) to orange; pistil and stigmas white.

Fruit: subglobose, green (to light yellow, white, dark brown), rather smooth, with 6 longitudinal wings.

Seeds: Up to 12 mm long.

Root: The tuberous edible root, grow in clusters of 4-8 at the stem base. Roots are from 1-4 inches in diameter and 8-15 inches long, although roots up to 3 feet long have been found. The pure white interior is firmer than potatoes and contains high starch content. The roots are covered with a thin reddish brown fibrous bark that is removed by scraping and peeling. The bark is reported to contain toxic hydrocyanic (prussic) acid, which must be removed by washing, scraping and heating.

Habitat: In general, the crop requires a warm humid climate. Temperature is important, as all growth stops at about 10ºC. Typically the crop is grown in areas that are frost free the year round. The highest root production can be expected in the tropical lowlands, below 150 m altitude, where temperatures average 25-27°C, but some varieties grow at altitudes of up to 1 500 m. The plant produces best when rainfall is fairly abundant, but it can be grown where annual rainfall is as low as 500 mm or where it is as high as 5,000 mm. The plant can stand prolonged periods of drought in which most other food crops would perish. This makes it valuable in regions where annual rainfall is low or where seasonal distribution is irregular. In tropical climates the dry season has about the same effect on Cassava as low temperature has on deciduous perennials in other parts of the world. The period of dormancy lasts two to three months and growth resumes when the rains begin again.

Cassava is one of the most efficient producers of carbohydrates and energy among all food crops. Its root constitutes one of the world's largest stock crops for starch. It is mainly used for human consumption, less for animal consumption and for industrial purposes, though this may vary by country.

The roots are rarely eaten fresh but are usually cooked, steamed, fried or roasted when fresh or after drying or fermenting. It is advisable to peel, boil, grind or cut, and dry the roots in order to diminish the contents of cyanogenic glucosides. Cassava is famous for the presence of free and bound cyanogenic glucosides, linamarin and lotaustralin that converts HCN in the presence of linamarase, a naturally occurring enzyme. Linamarase acts on the glucosides when the cells are ruptured. All plant parts contain cyanogenic glucosides with the leaves having the highest concentrations. In the roots, the peel has a higher concentration than the interior.

In the past, cassava was categorized as either sweet or bitter, signifying the absence or presence of toxic levels of cyanogenic glucosides. Sweet cultivars can produce as little as 20 mg of HCN per kg of fresh roots, while bitter ones may produce more than 50 times as much. The bitterness is identified through taste and smell. This is not a totally valid system, since sweetness is not absolutely correlated with HCN producing ability. In cases of human malnutrition, where the diet lacks protein and iodine, underprocessed roots of high HCN cultivars may result in serious health problems.

Cassava provides a major source of calories for poor families, because of its high starch content. With minimum maintenance, the farmers can dig up the starchy root of the cassava and eat it 6 months to 3 years after planting. In Africa, people also eat the leaves of the cassava as a green vegetable, which provide a cheap and rich source of protein and vitamins A and B. In Southeast Asia and Latin America, cassava has also taken on an economic role. Various industries use it as a binding agent, because it is an inexpensive source of starch.

Distribution: Cassava can be found from the United States to Africa, Asia, Europe, and the South Pacific. For current distribution, please consult the Plant profile page for this species on the PLANTS Web site.

Establishment

Adaptation: Cassava is a tropical root crop, requiring at least 8 months of warm weather to produce a crop. However, under adverse conditions such as cool or dry weather it can take 18 or more months to produce a crop. Cassava is traditionally grown in a savanna climate, but can be grown in extremes of rainfall; however, it does not tolerate flooding. In droughty areas it looses its leaves to conserve moisture, producing new leaves when rains resume. Cassava does not tolerate freezing conditions, but does tolerate a wide range of soil pH 4.0 to 8.0 and is most productive in full sun.

Propagation by seed: For agricultural purposes, cassava is propagated exclusively from cuttings because seed germination is usually less than 50 percent. Seedlings are raised from seed only for the purpose of selecting seedlings with fewer and smaller roots than those of the parents. Botanically seeds are used only for breeding purposes.

Propagation by cuttings: Propagate cassava by planting segments of the stem. Cut stems into 9-30 cm lengths; be sure to include at least one node. Segments can be buried vertically with 8-15 cm in the ground. The selection of healthy, pest-free cuttings is essential. Stem cuttings are sometimes referred to as 'stakes'. In areas where freezing temperatures are possible, plant cuttings as soon as the danger of frost has past. Cuttings can be planted by hand or by planting machines. Hand planting is done in one of three ways: vertical, flat below the soil surface or tilted. Under low rainfall conditions, vertical planting may result in the desiccation of the cuttings, while in areas of higher rainfall; flat-planted cuttings may rot. In general, flat planting 5-10 cm below the soil surface is recommended in dry climates and when mechanical planting is used. Germination seems to be higher; tubers tend to originate from a great number of points and grow closer to the surface of the soil, making better use of fertilizers applied on the surface and also making harvesting easier.

Vertical planting is used in rainy areas and tilted planting in semi-rainy areas. Observing the polarity of the cutting is essential in successful establishment of the planting. The top of the cutting must be placed upright. Typical plant spacing is 1m by 1m.

Cuttings produce roots within a few days and new shoots soon appear at old leaf petiole axes on the stem. Early growth is relatively slow, thus weeds must be controlled during the first few months. Although cassava can produce a crop with minimal inputs, optimal yields are recorded from fields with average soil fertility levels for food crop production and regular moisture availability.

Responses to macro-nutrients vary, with cassava responding most to P and K fertilization. *Vesicular-arbuscular* mycorrhizae benefit cassava by scavenging for phosphorus and supplying it to the roots. High N fertilization, more than 100 kg of actual N/ha, may result in excessive foliage production at the expense of storage root development. Fertilizer should only be applied during the first few months of growth.

There is no mature stage for cassava; because plants are ready for harvest as soon as there are storage roots large enough to meet the requirements of the consumer. Under the most favorable conditions, yields of fresh roots can reach 90 t/ha while average world yields from mostly subsistence agricultural systems average 10 t/ha. Typically harvesting can begin as soon as eight months after planting. In the tropics, plants can remain un-harvested for more than one growing season, allowing the storage roots to enlarge further. However, as the roots age and enlarge, the central portion becomes woody and inedible.

Cassava is either planted as a single crop or intercropped with maize, legumes, vegetables, rubber, oil palm or other economic important plants. Mixed planting reduces the danger of loss caused by unfavorable weather and pests by spreading the risk over plants with different susceptibilities.

Management

General: Cassava grows best on light sandy loams or on loamy sands which are moist, fertile and deep. It grows well on soils ranging in texture from the sands to the clays and on soils of relatively low fertility. Cassava can produce an economic crop on soils so depleted by repeated cultivation that they have become unsuitable for other crops. On very rich soils the plant may produce stems and leaves at the expense of roots. Cassava will grow on a wide range of soils, provided the soil texture is friable enough to allow the development of the tubers.

When cassava is grown as the first crop in forest land no further preparation is required than the clearing of the forest growth. When it is grown after other crops

it often can be planted without further preparation of the soil, once the preceding crop has been harvested or the soil has been plowed two or three times until free from grass and other plants.

Cassava is frequently cultivated as a temporary shade plant in young plantations of cocoa, coffee, rubber or oil palm. When cultivated as a temporary shade plant, no special attention is given to the cassava plant. When grown alone, the plants require little maintenance after planting. Irrigation may be required if there is no rain, and hoeing of the earth helps preserve the subsoil humidity, especially in dry sandy soils. The chief problem is weed control which may be desirable to weed the crop two or three times until the plants are well developed and their shade prevents the growth of weeds.

In moist soil, sprouting takes place within the first week after planting. Within a month of the beginning of planting, the substitution of new cuttings to replace those that did not sprout is still possible. Cassava is grown mainly as a cash crop and farmers may for ten years or more grow cassava on the same land. However, if the price of cassava roots drops, the farmers may shift to another crop (e.g., sugarcane, maize or sorghum) until cassava again becomes the more profitable crop.

No fertilization is required when the land is freshly cleared or when there is enough land to enable grower to substitute new land for old when yields fall. Like all rapidly growing plants yielding carbohydrates, cassava has high nutrient requirements and exhausts the soil very rapidly. When cassava is grown on the land for a number of years in succession or in rotation the soil nutrients are reduced and must therefore be returned to the soil by fertilization. Large commercial farmers replaced the nutrients lost by applying artificial fertilizers that are usually too costly for the small farmer. Small farmers replace the nutrient loss by using different kinds of organic manures, such as cattle or duck manure or garbage to replace the nutrients taken from the soil.

Maturity differs from one variety to another, but for food the tubers can be harvested at almost any age below 12 months. From the standpoint of maximum starch production, the optimum age for harvest is 18-20 months. During this growth period both root and starch production increase rapidly to their maximum value, after which root production decreases slowly and starch production much more rapidly on account of the declining starch content of the tubers.

If the roots are left in the ground, starch content increases with age until, at a certain point; lignifications takes place, causing the roots to become tough and woody, so that they are harder to prepare for consumption and other uses.

Harvesting of cassava can be done throughout the year when the roots reach maturity. In regions with seasonal rains, harvesting is usually done in the dry season, during the dormant period of the plant; where rain prevails all year round, cassava is harvested throughout the year.

Harvesting is still generally a manual operation, although equipment to facilitate this operation is being considered. The day before harvest, the plants are "topped" the stalks are cut off 40-60 cm above ground by hand, machete or machine and piled at the side of the field. This length of stalk is left as a handle for pulling. Material required for the next planting is selected and the rest is burned. In light soils the roots are slowly drawn from the soil simply by pulling the stems or with the help of a kind of crowbar and the tubers are cut off the stock. In heavier soils a hoe may be required to dig up the roots before the plant is pulled out. It must be noted that once the plants have been topped, lifting of the roots must not be delayed, as sprouting and a drastic fall in the starch content of the tubers will result.

Once the roots are harvested, they begin to deteriorate within about 48 hours, initially owing to enzymatic changes in the roots and then to rot and decay. The roots may be kept refrigerated for up to a week or stored in the ground for longer periods if they are not detached from the plant.

Mechanization

In most of the tropical world cassava is grown on small plots; however, in some countries (e.g., Mexico. Brazil and Nigeria) large plantations have been established. The degree of mechanization depends on the amount of land, available labor in the area and general policy regarding the use of manual labor.

The use of machinery for land preparation is preferable to manual labor to ensure the best possible seed bed for tuber development. Subsequent operations of planting, weeding, topping and harvesting can be done by hand as well as by machinery.

The following is an outline of the present use of machinery in cassava cultivation:

(a) The hoe remains the principal implement for cultivating, weeding and harvesting.

(b)Plowing and harrowing, are usually done by tractor.

(c) A mechanical two row planter using a tractor driver and two men on the machine to feed cuttings from the reserve bins into the rotating planting turntable. In operation, the cuttings fall in succession through a hole into a furrow opened by a simple furrower. A pair of disks throws dirt into the furrow and floats pulled by chains pack the soil over the cuttings. The planter is able to cover about 5 hectares per day.

(d) A gasoline-powered table saw is used to prepare the cuttings for planting. The machine has the advantage of speed and regularity of produced cuttings.

(e) A topping machine consisting of a heavy screen mounted on the front of a tractor has been developed to push down the tops: then a rotary mower on the back of the same tractor can cut the downed top to make harvesting by hand possible. The height at which the tops are cut back can be easily regulated with any rotary mower.

(f) Cassava is not a crop that lends itself readily to mechanical harvesting because of the way the tubers grow. They may spread over 1 m and penetrate 50 60 cm. Careless use of machinery for harvesting can damage tubers, resulting in a darkening due to oxidation that will lower the value of the flour. The mould-board plow has been used to make hand harvesting less tedious. Stalks can be cut successfully by a mid-mounted mower or a topping machine, and the roots are lifted mechanically with a mid-mounted disk terrace.

Pests and Potential Problems

In many regions, the cassava plant is not normally affected by diseases or pests. However, in others it may be attacked by the following:

(a) Viruses. Mosaic, the brown streak and leaf curl of tobacco may attack leaves, stems and branches. Many parts of Africa harbor these diseases and attempts are being made to select resistant varieties.

(b) Bacterial disease. Bacteria such as Phytomonas manihotis (in Brazil), Bacterium cassava (in Africa) and Bacterium solanacearum (in Indonesia) may attack roots, stems or leaves of cassava plants.

(c) Mycoses. There are kinds which attack roots, stems, or leaves of cassava plants and cause various diseases.

(d) Insects. Some insects affect the plant directly (locusts, beetles and ants); others affect the plant indirectly by the transfer of virus (aphids).

(e) Animals. Rats, goats and wild pigs are probably the most troublesome; they feed on the roots, especially in areas adjacent to forests.

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