

Amaranthus

— Production guideline —



agriculture,
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GENERAL

Classification

Scientific name: *Amaranthus* spp

Family: Amaranthaceae

Common name: Pigweed (English), Hanekam (Afrikaans), Thepe (Sesotho), Imbuya (isiZulu), Vowa (Tshivenda)

Origin and distribution

Amaranth originated in America and is one of the oldest food crops in the world, with evidence of its cultivation reaching back as far as 6700 BC. The genus Amaranth consists of nearly 60 species, several of which are cultivated as leaf vegetables, grains or ornamental plants, while others are weeds. Grain amaranth species have been important in different parts of the world and at various times during the past few thousand years.

At present, amaranth is extensively grown as a green, leafy vegetable in many temperate and tropical regions. The largest area ever grown was during the height of the Aztec civilisation in Mexico during the 1400s. After the arrival of the Spanish conquistadors in Mexico in the early 1500s, amaranth almost disappeared in the Americas as a crop until research began on it in the US in the 1970s. Meanwhile, amaranth had spread around the world and had become established for food use (the grain or leaves) in places such as Africa, India and Nepal. During the past two centuries, grain amaranth has been grown in scattered locations, including Mexico, Central America, India and Nepal. Although it is also used as a grain, Amaranth is more widely used as a pot herb and in some instances supplies a substantial part of the protein, minerals and vitamins in the diet. This makes it an easy crop to cultivate and domesticate.

Production levels

South Africa

Amaranth is not usually planted in South Africa but occurs as a volunteer crop after the first rains; it is harvested from the wild. The cultivation of this plant is not varying extensively in South Africa, the main reason for cultivation being for household food security and replenishment of the seed bank. The production levels of amaranth are not known. However, recent research indicates that under cultivated conditions, amaranth produces fresh leaf yields of up to 40 t/ha. The yield of grain amaranth is highly variable with 1 000 kg/ha considered a good yield.

Internationally

Introduction of amaranth as a human food has been slow, but today it is produced and used as a grain or leafy vegetable in India, China, Southeast Asia, Mexico, the Andean highlands in South America and the United States. The Nebraska panhandle has become the most concentrated area of production of grain amaranth in the US.

Major production areas

The main producing areas of amaranth in South Africa are Limpopo, North West, Mpumalanga and KwaZulu-Natal provinces.

Cultivars

Amaranthus cruentus

A. hybridus

A. spinosus

A. caudatus

A. thunbergii, which are all indigenous to the country



Description of the plant

Mature plant

Amaranth species are erect or spreading annuals with a rough or prickly appearance. Grain amaranths vary in flower, leaf and stem colour, but maroon or crimson colouring is common in all three plant parts. Some varieties have green flowers and some are more golden. Some of the deep crimson varieties can be very striking when in full bloom. The height of the plant varies between 0,3 m and 2 m, depending on the species, growth habitat and environment.

Stems: Stems are usually longitudinally grooved. Grain amaranth plants are about 1,524 m to 2,134 m tall when mature and are dicots (broadleaf) plants with thick, tough stems similar to those of sunflowers.



Leaves: The leaves are variable in size, green or purple, with slender stalks. These are alternate, usually simple, with entire margins and distinct markings, depending on species.

Flowers: Tiny green flowers are borne in dense, elongated clusters, usually on the tips of the branches. They are borne in spikes or plumes and are white, green, pink or purplish in colour.



Seed: The small seeds are usually shiny black in colour, in contrast to those of grain types which are cream-coloured. There are up to 3 000 seeds per gram. The tiny, lens-shaped seeds are usually pale in colour.

Essential parts

Leaves and grain are the essential parts of the amaranth crop.

Climatic requirements

Temperature



Amaranth is highly tolerant of an arid environment. Amaranth seeds need soil temperatures of between 18 °C and 25 °C to germinate and an air temperature above 25 °C for optimum growth. The growth ceases at temperatures below 18 °C. The number of growing degree days during the growing season is a major determinant of amaranth plant growth. Lower temperatures and shorter days will induce flowering with a subsequent reduction in leaf yield.

Frost damage should not be a problem because the crop grows during summer with the start of the rains. However, frost plays an important role in the harvesting of the crop. Because amaranth is an annual crop, it does not mature completely in areas with a short growing season. Frost is necessary to terminate the crop's growth.

Water

Grain amaranth is reported to be drought-tolerant compared to most vegetables. Although amaranth is regarded as being drought-tolerant, the precise mechanism involved is not well understood. One trait that helps it in extremely dry conditions is an ability to wilt temporarily and then revive after rainfall occurs. The crop cannot withstand waterlogging as it has a relatively low capacity for water consumption. The exposure of the plant to severe drought induces early flowering and halts the production of leaves.

Soil requirements

It is a crop that is adapted to a variety of soil types, including marginal soils, but will do best on fertile, well-drained soils and deeper soils. Loose and friable soils with high organic matter content are ideal for an early and heavy yield. Selecting soils that are lower in clay and managing the seedbed to minimise the possibility of crusting can help ensure good stands. Amaranth requires good seed-soil contact for rapid germination and emergence and adequate soil moisture must be maintained at the seeding depth throughout initial establishment. The growth of vegetable amaranth is adversely affected by a soil pH of between 4,7 and 5,3. A soil with a pH of 6,4 could produce high yields. If the plants are treated correctly, it should be possible to harvest leaves every two weeks.

CULTIVATION PRACTICES

Propagation

Amaranth grows naturally but can also be propagated from seed. The seedlings are fragile, so it is important to have a fine, firm seedbed. Amaranth seedlings can easily be blocked from emergence by a thin crust on the soil which forms after rain.

Soil preparation

Prepare the soil well and mix with cattle, chicken or compost manure at a rate of one bucket per 1 m² or one to two teaspoonfuls of mineral compound fertilisers per metre row. It is important to have a fine, firm seedbed. Seedbed preparation can be done with a disc or spike-tooth harrow, followed by cult packing and planting, preferably using a planter with press wheels. Seeds should be planted not more than 1,25 cm deep, depending on soil texture and surface moisture at planting time. Crusting can be a

serious problem, although no solutions have been researched and rotary hoeing may be helpful.

Field layout and design

An optimum plant population has not been established, but approximately 272 kg of seed per hectare is considered suitable. Row widths of 762 mm have been reported to be the standard with amaranth trials. At this row spacing, the crop provides good shade for the ground and the wide rows allow access to a row crop cultivator for controlling weeds. This is important, given the lack of labelled herbicides for amaranth.

There appears to be excessive competition among amaranth plants when a narrower spacing is used. This results in shorter, less vigorous plants and smaller grain heads. On the positive side, planting only 0,9 kg of seed per acre, the recommended rate, produces so many seedlings that a large number can be lost with plenty left over for an adequate stand. Plants are spaced in rows about 1 m apart.

Planting

Planting is done when the soil temperature is at least 18 °C and after early weed growth has been controlled by tillage or a contact herbicide. When planted early, amaranth will start flowering after it has accumulated enough growth and heat units; when planted later, flowering is triggered by photoperiod (day length). There are three ways to plant amaranth:

- Seeds are sown directly into the soil. Loosen the soil as deep as possible and prepare a fine and firm seedbed. The seeds are very small and should be mixed with sand and broadcast in the seedbed to ensure even distribution. After broadcasting, lightly cover the seeds with soil, using a rake.
- Seeds are sown in shallow rows. These rows should be 1, 5 m apart. Cover lightly, using a rake. The seeds must be watered twice daily until the seedlings emerge.
- Seeds can be planted in seed trays. Transplant them after approximately four weeks when the plants should be about 15 cm tall. Transplant into rows 1, 5 m apart and with a spacing of 30 cm in the row.

When transplanting seedlings, pour water into the furrow or hole into which the plant is to be placed. Wait a few moments for some of the water to seep into the soil. Plant the small plant with its roots in the mud-water mixture and cover the hole. Fertiliser should not be placed with a plant in the same hole; rather place it approximately 10 cm away to avoid scorching.

Other approaches that have proven successful in planting amaranth include: using a vegetable planter with a small plate appropriate for carrots or celery; installing special amaranth seed plates in a sugar beet planter; using the insecticide application box as a planter; or using a standard grain drill.

Grain drills are not recommended owing to problems in controlling seeding rate and depth, but one can be used if the amaranth seeds are diluted with a “carrier” such as ground corn. A mixture suitable for drilling consists of 0,226 kg of amaranth with 2,04 kg of ground corn. Set the drill for a seeding rate of 2,3 kg per acre. A variety of planters have been successfully used with amaranth. Some farmers with row crop planters will put the amaranth into the insecticide box rather than the main seed box, running a tube down between the double disc openers to deliver the seed. Grain drills have been used by stopping the appropriate number of seed holes to get the desired row width. Vegetable planters can be used with a celery plate. Sometimes it is helpful to leave the soil a little loose over the amaranth seed to help prevent crust formation.

Fertilisation

One of the essential elements, and one which participates directly as an indispensable requirement for normal plant growth, is nitrogen. High levels of nitrogen are essential for the regrowth of leaves after harvesting. To promote better regrowth, a top dressing of LAN (limestone ammonium nitrate, 28 kg) can be given at monthly intervals. Nitrogen will be the most limiting nutrient in most environments. Nitrogen requirements may vary from 50 to 200 kg N/ha and the requirement also differs, depending on the species.

Plants can be fertilised by using cow manure at 6 t/ha as well as commercial fertilisers with a high nitrogen content. Higher yields are also obtained from plots fertilised with composted chicken manure, which has considerable quantities of nitrogen, a mineral that plays a key role in the development of the plant (especially leaf growth).

A side dressing of compost is sometimes applied during active growth, especially if plants are allowed to go to seed. If nitrogen is used, around 18 to 36 kg/acre, with the lower figure used after soya-beans or other legumes in a crop rotation system, the growth of vegetable amaranth is adversely affected by a soil pH of 5,3 and 4,7. A soil with a pH of 6, 4 could produce high yields and if the plants are treated correctly it should be possible to harvest leaves every two weeks. Phosphorus and potassium can be applied at soil-test-recommended levels.

Irrigation

Although the plant is drought resistant, it performs optimally under irrigation. Under irrigation, amaranth yields a harvest of leaves every two weeks during summer. In sandy soils, an irrigation frequency of four to five days is maintained in the summer season, while in the rainy season the irrigation frequency is based on soil moisture level.

Weed control

Weeds are the biggest pest in amaranth production. This includes lamb-quarter, redroot pigweed, kochia, cheatgrass and various other grasses. Early weeds are controlled by tillage or a contact herbicide prior to planting the amaranth. Amaranth grows slowly during the first several weeks, so three or four cultivations may be needed during this period to control weeds (no selective herbicides are labelled for use with amaranth). Grain amaranth seeds do not undergo dormancy and their growth is not vigorous early in the season. Therefore, it is unlikely that amaranth would be a weed problem in succeeding crops.

Although cover crops and no-till planting can help prevent weed seeds from starting, amaranth seedlings grow slowly the first few weeks and are easily overtaken by early weeds. Once amaranth gets to be 6 to 10 inches tall, it will begin growing rapidly, and its shade can outperform late-emerging weeds.

Pest control

There is a wide range of insects that attack amaranthus in South Africa; various snout beetles, moth larvae, fleas, stinkbugs and blowflies. Tarnished plant bug and amaranth weevil are regarded as potentially significant insect pests of amaranth. The insect most likely to affect yields is the tarnished plant bug, a sucking insect which often reaches high populations in the seed head during the critical seed-fill stage. Flea beetles damage the young leaf tissue.

The adult amaranth weevil feeds on leaves, but the larval stage is more damaging because they bore into the central tissue of roots and occasionally stems, causing rotting and potential lodging.

There are no synthetic insecticides labelled for amaranth, but various organic insecticides can be used, including certain pyrethrum and BT products.

There are no fungicides labelled for amaranth.

Disease control

No significant disease problems have been conclusively identified for grain amaranth. One possible problem is a damping-off fungus, which can kill seedlings. Therefore use disease-free seeds and avoid both overwatering and dense planting. Leaf amaranth suffers damage from the armyworm and the curly top virus disease, which is transmitted by the beet leafhoppers (*Circulifer femellus*).

Other cultivation practices

Amaranth can work well as a double crop after wheat or canola. Amaranth should be placed into at least a two-year rotation with another crop; it works well in rotation with corn and soya-beans.

Harvesting

Harvest maturity

Most amaranth cultivars grow rapidly and may be harvested from 30 to 55 days from sowing, when they reach a height of 0,6 m.

Timing of harvest is not as straightforward as with the commodity crops. Management during harvest is a most critical stage in grain amaranth production. Without careful harvest techniques it is possible to lose most of the seed. Before harvesting can begin a killing frost must occur, followed by a week of good drying weather to make the crop drier for harvest (there are no approved desiccants for amaranth).



Harvesting methods

The plants are harvested by hand only. Young plants can be pulled up or cut six to eight weeks after sowing when they are about 20 cm tall. This is done in cases where seeds were broadcasted. Plants may be cut back to 15 cm to encourage lateral growth for successive harvesting.

When the plants are harvested at regular intervals, start picking the leaves eight weeks after sowing or four weeks after transplanting. Small quantities of

leaves can be harvested on a daily basis. In the case of large quantities, intervals of two weeks are recommended. Leaf production can be sustained by the removal of flowers.

Leaves can be harvested in two ways:

- Picking of individual leaves when these are the size of the palm of your hand.
- Breaking off the leaves around the terminal growth tips of the stems. This is done by pulling one hand up towards the growth tip and breaking off the leaves with the other hand.

Though amaranth can be harvested by hand, combine harvesters are also commonly used. A regular combine can be used if fitted with appropriately-sized separator screens. When reel heads are used it may be helpful to remove several reel bats or raise the height of the reel. Row headers perform better at harvesting amaranth than reel heads do for combining amaranth.

During harvest, if the stems and leaves are too wet, the seeds become sticky and adhere to the inside of the combine as well as the straw discharge. Shattering during the cutting process can also cause losses, so adjustment should be made to minimise shattering of the hands. Care should also be taken to balance against getting it combined before pre-harvest losses from lodging or seed shatter from wind occurrence.

Grain harvesting

Harvesting amaranth seeds is a basic process. Cut the seed heads just before these become dry and brittle. Lay the seed heads on a cloth or place them inside paper or cloth bags with the heads down and leave in the shade to finish drying. When the seed heads are dry, the seeds can be removed in several ways:

- by rubbing gently with your hands (wearing gloves is recommended);
- by enclosing the seed heads between two cloths and treading on them without shoes on;
- by beating the seed heads off a bag; or by beating them together over cloth.

POST-HARVEST HANDLING

Thorough planning in terms of handling, grading, packing and storage of products should be done.

Screening

Once the dry seeds are removed they can be placed in a shallow bowl and swirled around until the large pieces of flowers rise to the top where they are easy to remove. By tipping the bowl you can rake out much of the chaff that is left. Remove any small particles of flowers or dirt that remain by shaking the seed through a small mesh screen about the size of a window screen. Winnowing the seed in a light breeze will also remove the flowers and chaff effectively. The seeds are very light so it is important to winnow carefully in a light breeze only.

Grading

A gravity table can be used to separate particles of the same size but of different weight, such as the dark pigweed seeds.

Packing

After harvesting, the leaves are kept in a bag and usually sold on the day of harvest to avoid quality loss. However, where there is cooling storage the leaves can be kept in such containers.

Storage

Maximum moisture for storing the grain is approximately 11 %. Dry small quantities of grain by blowing air across the amaranth; heated air may be necessary at certain times. The optimum way to store the grain after cleaning and drying is in wooden storage bins or in heavy duty (4- or 5-ply) paper bags. It is important to keep properly dried seeds in a closed container to avoid contamination.

Preserving methods

Washed leaves may be dried in the shade and stored for up to a year for consumption during winter. Cooked leaves may be dried and stored. Fresh leaves may be kept in the refrigerator.

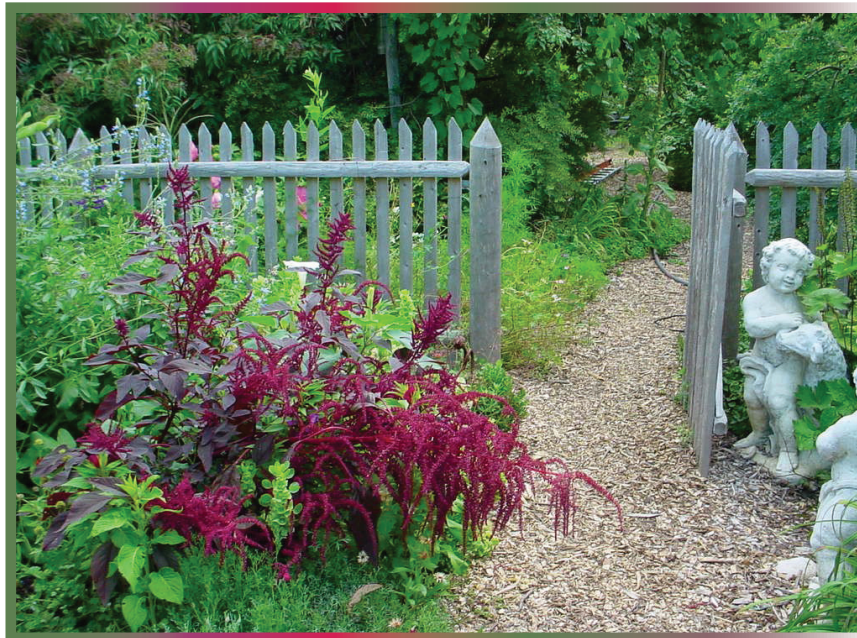
Transport

Amaranth requires refrigerated transport to retain the turgidity of the leaves.

Marketing

Both local and export markets are flooded by exotic crops, making it difficult for the introduction of indigenous crops. As a result, indigenous crops such as amaranth remain largely a crop of small producers, consumed largely in areas where these are produced. The leaves of the crops are sold by street hawkers in Mpumalanga, KwaZulu-Natal and the Eastern Cape. Farmers who grow amaranth have marketed their crop in a number of ways. Some sell small bags of the entire grain or flour mail-order to consumers. Many of these purchasers are allergic to wheat products. Other growers sell to the local market or regional health food stores or restaurants. There are also a few middlemen who buy grain from the farmers and market it to the larger health food companies.

The leaves are sold for around R5.00 to R6.50 per kilogram. The price hawkers receive for amaranthus and other leafy vegetable depend on whether they take the vegetable to market themselves or sell them through an intermediary. The advantage of the latter practice is, of course, that the women get their money all at once rather than in instalments and they save on time and transport costs. However, it also means that they are not able to determine a price according to supply and demand and, because they



tend to sell their crop at irregular intervals to meet incidental expense, they are in a weak position when it comes to price negotiation.

As in the case of leafy amaranth, the grain market is still the greatest problem facing the development of amaranth as a crop. The relatively high price of amaranth, while good for commercial farmers, is a factor limiting the extent of its current use in the food market place. Still, the valuable characteristics of amaranth grain, combined with its adaptation to a wide range of growing areas, make it a very promising crop for the future. Though the market for amaranths is small it is gradually growing as a food based on its nutritional qualities. Though this physical characteristic of the grain starch has potential value for both food and industrial uses, none has been commercialised to date.

Marketing issues have to be taken into consideration in such initiatives in order to ensure that the communities benefit as much as possible from the efforts they have made to re-establish and propagate underutilised but obviously popular species. A farmer entering the market with grain from several hundred hectares of amaranth could cause a surplus and dramatically lower prices. For this reason amaranth should be grown only after a market has been identified for the crop, and preferably after a contract has been arranged with a buyer.

PRODUCTION SCHEDULES

Activities	January	February	March	April	May	June	July	August	September	October	November	December
Planting												
Harvesting												

UTILISATION

Leaf amaranth is used as a steamed vegetable in soups and stews. One of the reasons there has been recent interest in amaranth is because of its useful nutritional qualities. The grain has some protein (12 % to 17 %) and is high in lysine, an amino acid that is low in other grain crops. The grain is high in fibre and low in saturated fats, factors which contribute to its use

by the health food market. It is an exceptionally rich source of calcium, iron and vitamin C, a very rich source of potassium, vitamin A and riboflavin, a rich source of niacin and an above-average source of protein.

Grain amaranth has been used for food by humans in a number of ways. The ground grain is used in breads, noodles, pancakes, cereals, granola, cookies and other flour-based products. The grain can be popped like popcorn or flaked like oatmeal. More than 40 products containing amaranth are currently on the market.

Little is known about the production and utilisation of amaranth as forage. The leaves stem and head are reportedly high in protein (15 to 24 % on a dry-matter basis). A relative of grain amaranth, redroot pigweed, has been shown to have 24 % crude protein and 79 % in vitro digestible dry matter. Vegetable amaranths, which are closely related, produce 30 to 60 t/ha of silage (80 % moisture). In areas where corn silage yields are low owing to moisture limitations, grain amaranth may become a suitable silage alternative after further research.

There are many species of amaranth in cultivation. Some types of amaranth are grown for their edible seeds, while others are cultivated for their edible greens. Amaranth is widely cultivated in West Africa for its edible greens, particularly in Sierra Leone. The plant is a fast-growing annual which loves high temperatures, to attain its maximum growth of 5 to 6 feet. *Amaranthus tricolor* is the most commonly grown species in Sierra Leone, preferred for its ability to produce high-quality, tasty greens.

REFERENCES

BEN-ERIK VAN WYK, FANIE VAN HEERDEN & BOSCH VAN OUDTSHOORN. 2002. *Poisonous plants of South Africa*. Briza.

BEN-ERIK VAN WYK & NIGAL GERICKE. 2000. *People's plants*. Briza.

DEPARTMENT OF AGRICULTURE, 2009. *The National Agriculture Handbook/directory*.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS. 1988. Traditional Food Plants. FAO, *Food and Nutrition*, p. 2

JANSEN VAN RENSBURG, W.S., VAN AVERBEKE, W., SLABBERT, R., FABER, M., VANJAARSVELD, P., VAN HEERDEN, I., WENHOLD, F. & OELOFSE, A. 2007. African leafy vegetables in South Africa. *Water SA* Vol. 33, No. 3 (Special edition). (Available at websites <http://www.wrc.org.za>.)

<http://www.snakeriver.org/wscpr/LinaryDocs/Amaranth.pdf>.

JONATHAN, GEOFFREY, CAITLIN & RICHARD, 2001, *Problem plants of South Africa*. Briza.
NAZMUL HAQ. 2004. Women reintroducing neglected crops. Agriculture Network,
LEASA Magazine, 20, 1, March 2004.
www.heirloom-organics.com/guide/guidetogrowinggrains.html.
[www.inforst.org/publication/books/documents/chapter 8](http://www.inforst.org/publication/books/documents/chapter8)

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