



Amaranth

— Production guidelines —



agriculture,
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GENERAL

Classification

Scientific name: *Amaranthus* spp

Family: Amaranthaceae

Common name: Amaranth, Pigweed, Hanekam, Thepe, Imbuya, Vowa, Umfino, Isheke

Origin and distribution

Amaranth is reported to have originated from Central America and Mexico and distributed in many areas in Africa, in particular Benin, Côte d'Ivoire, Nigeria, Tanzania, Zimbabwe and Zambia. However, other studies indicate that the different species have originated from different countries i.e. *spinosus* and *thunbergia* are native to Africa while *hybridus* and *caudatus* are reported to have originated from America.

Production level

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 the Limpopo, North West, Mpumalanga and KwaZulu-Natal provinces.

Cultivars

Amaranthus cruentus

A. hybridus (Africa)

A. spinosus (Africa)

A. caudatus (America)

A. thunbergii (America)

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: Often tingled reddish, erect, occasionally ascending, branched, with linear marks on the surface, and hairless to moderately pubescent with multicellular hairs.



Leaves: The leaves are variable in size, green or purplish, 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 gramme. 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.

Rainfall

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 a 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 5,5 and 7,5. 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.

Soil preparation

Prepare the soil well and mix with cattle or chicken manure or compost at a rate of one bucketful 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

Sow seeds in seedbeds or sow directly in rows in the field. Nurseries should be in flat areas, with fertile soil and near to the water source but not in shaded areas. Mix the seed with sand at a ratio of 1: 2 and sow at

a depth of 0,5 to 1 cm in rows or broadcast directly in the field. Cover the seeds with a thin layer of soil, followed by watering; be careful not to wash seed available. Alternatively, water first, then spread the seed and cover with a thin layer of dry soil. Optimal spacing is 20 x 20 cm to 50 x 50 cm, depending on the size of the plants. If transplanting, seedlings will be ready after 3 to 5 weeks when they have four true leaves (15 cm).

Fertilisation

When using a chemical fertiliser, purchase a 3:2: 3 or 3:2: 1 (NPK) mixture. Using a hoe, open up a furrow and apply the fertiliser mixture in the bottom of the furrow at the rate of 40 g/m. A normal-size teacup takes about 200 g of chemical fertiliser and would cover 5 m. After spreading the fertiliser evenly in the furrow, use a stick to mix the fertiliser with the soil. Water the furrow and then make the holes for the transplants. For really good growth, add limestone ammonium nitrate (LAN) at the rate of 20 g/m when the plants have about 5 to 6 leaves. One teacupful of LAN should be spread along a row of 10 m. When applying LAN to the growing crop, open up a furrow with a hoe about 10 to 15 cm away from the row of plants, mix the fertiliser with the soil, using a stick, water the furrow and then close it.

When using poultry or pig manure, apply a 10-ℓ bucket in a band of about 20 cm wide over a length of 15 m, work the manure into the topsoil, water the band thoroughly and wait 1 or 2 weeks before transplanting. When you use kraal manure, use the same procedure but apply a 10-ℓ bucket over a length of 5 m.

Irrigation

Water plants regularly because plants that suffer from drought will begin to flower and stop producing leaves. Water requirements vary with the crops' growth stage, soil type and weather condition (hot or cold). Frequent irrigation will be required for sandy soils as these drain quickly. Clay soils, on the other hand, drain quite slowly and hold more water than sandy soils. There are few 'rules of thumb' to use as a starting point for irrigation frequency and volume. First, sandy soil should be irrigated three times a week. Second, sandy loam should be irrigated twice a week. Third, clay, clay loam and loam soils should be irrigated once a week. For the first 30 to 35 days after transplanting, irrigate 4 ℓ per day for a 1 m x 1 m size plot (20 ℓ a week for 1m x 1m). Thereafter, irrigate between 5 and 6 ℓ per day for a 1 m x 1 m size plot. Sprinkler and drip irrigation can be used to irrigate amaranth; however, water savings with drip are substantial and roughly

half as much water can be just effective as a sprinkler system. If a sprinkler irrigation system has to be used, avoid late afternoon irrigation to prevent foliar diseases. Excess water application leaches nutrients away from the roots of the plants, therefore careful planning of irrigation volume and frequency is required to prevent crop stress and produce large, healthy vegetable amaranth.

Weed control

Weeds are the biggest pest in amaranth production. This includes lambs-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 3 or 4 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 and disease control

Amaranth is susceptible to a number of insects although the plants are able to recover after feeding by most leaf-chewing insects. Tarnished plant bug, leafminers, flea beetle, grasshopper, caterpillars and amaranth weevil, are potentially significant insect pests of amaranth. Flea beetles damage 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. Not many diseases are observed. Disease problems may develop in large monoculture production systems. Damping-off of young seedlings caused by *Pythium* can be a problem under some environmental conditions, as well as *Rhizoctonia* and stem canker, caused by *Phoma* or *Rhizoctonia*. *A. tricolor* also seems to be very susceptible to *Phomopsis*, which colonises leaves and stems and causes a dieback.

Control of pests and diseases can be done by practising good weed control. The weeds can act as a host for pests and diseases. Neem products

might help. Damping-off can be controlled by using clean seed and establishing sterilised soils before sowing seeds. Seed trays should be washed with a commercial bleach. Establish seedlings in well-drained soil in an area with good ventilation.

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 maize 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. Young plants can be pulled up or cut 6 to 8 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 8 weeks after sowing or 4 weeks after transplanting. Small quantities of leaves can be harvested on a daily basis. In the case of large quantities, intervals of 2 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.

Seed harvesting

Seeds can be harvested from plants when the leaves start to lighten or yellow. Amaranths with a terminal inflorescence are harvested once. The harvested seed heads are placed on a clean tarpaulin or plastic sheet and allowed to dry in the shade. Seeds are easily threshed by hand and cleaned by winnowing. Keep properly dried seeds in a closed container to avoid damage by insects.



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 easily removed. 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 to introduce of indigenous crops. As a result, indigenous crops such as amaranth, remain largely crops 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 about R5,00 to R6,50 per kilogramme. The price hawkers receive for amaranthus and other leafy vegetable depends 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 this 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 marketplace. However, the valuable characteristics of amaranth grain and 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 maize silage yields are low owing to moisture limitations, grain amaranth may become a suitable silage alternative depending on 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.

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