

Production guidelines for Garlic



**agriculture,
forestry & fisheries**

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Production guidelines for Garlic

DEPARTMENT OF AGRICULTURE, FORESTRY AND FISHERIES

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For further information please contact

Directorate Plant Production, Division Vegetable Crops

Tel: 012 319 6072

Fax: 012 319 6372

E-mail: DPP@daff.gov.za

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Part i: General aspects

1. Classification

Scientific name: *Allium sativum*

Common name: Garlic

2. Origin and distribution

Garlic is native to Europe and is said to have been disliked by the Romans because of its strong odour but was fed to their labourers and soldiers. It was used in England by the first half of the 16th century. Garlic has been used as food, a condiment, and for medicinal purposes for over 5 000 years. More recently, sales to speciality processors for medicinal or health food use have increased. Garlic is now spread throughout the world as a vegetable crop but mostly classified as a herb or a medicinal plant.

3. Production levels and areas

3.1 South Africa

Garlic is native to Europe and is said to have been disliked by the Romans because of its strong odour but was fed to their labourers and soldiers. It was used in England by the first half of the 16th century. Garlic has been used as food, a condiment, and for medicinal purposes for over 5 000 years. More recently, sales to specialty processors for medicinal or health food use have increased. Garlic is now spread throughout the world as both a vegetable crop but mostly classified as a herb or a medicinal plant.

4. Description of the plant

4.1 Roots

Garlic has a shallow adventitious root system at the bottom of the bulb.

4.2 Stem

The stem is approximately 5.0 to 6.5 cm tall.

4.3 Leaves

Garlic leaves can be confused for other alliums, but it has flat leaves whereas chives and onions have round leaves. In addition to being flat, the leaves are long and grass-like and smell like garlic or onion when crushed. They are blue-green in colour and grow in a form of a dense clump. Leaves on flowering plants are alternate and are larger near the base of the stem. The leaves may also be triangular in shape and approximately 2.54 cm long and 5.0 to 7.5 cm wide.

4.4 Flower

First-year rosettes extend to 10 cm high. The flowers are placed at the end of a stalk rising direct from the bulb and are whitish, grouped together in the form of a globular head with an enclosing kind of leaf and among them are small bulb-like structures. Each flower has four white petals that are 0,5 cm or 0,2. Garlic blooms in spring.

4.5 Fruit

The fruit is a long 2.5 to 6.3 cm green capsule called a silique and it contains many seeds. The capsules burst open when mature and disperse seeds several meters from the plant.

4.6 Seeds

Small, black seeds grow in a row inside the silique. Seeds may remain viable for up to 5 years. Plants can produce up to ± 800 seeds depending on the environmental conditions, the cultivar type and the population density of the plants. Garlic seeds can be distributed by humans, animals or even by running water. The seeds are mainly utilised for breeding purposes by plant breeders than for planting of garlic aimed for consumption.

5. Cultivars

The selection of the cultivar should take into consideration several different factors and characteristics, some of which include the adaptability of the cultivar to the climate of the growing area, the market demand of the particular cultivar and the resistance or tolerance of the cultivar to various diseases and pests. There are actually many different cultivar strains of garlic. They may differ in taste, length of storage, colour, size, number of cloves per bulb, hardiness, and suitability for cooking. Some even store longer, some are more gourmets in flavour, and some mature earlier and others later.

There are five basic types of garlic from which cultivars can be derived or classified:

5.1 Artichoke

Artichoke types were named after artichoke plants because their heads are characterised by layers of overlapping cloves, which look similar to an actual artichoke. Artichoke types are typically vigorous, productive and adaptable. They are long storing and some of the easiest types to grow.

5.2 Silverskin

Silverskin garlic types need better soil than Artichoke garlic types and prefer mild winter climates for best characteristics. Silverskin types are characterized by tallish and sometimes pinkish cloves. They typically stored for about 8 to 10 months, the longest of any of the garlics. They are the best for braiding, but are usually the most difficult to peel of all garlic.

5.3 Porcelain

This is one of the most impressive looking types of garlic which can be mistaken for Elephant garlic. They are similar in that they both have very large clove sizes, but Porcelains have a superior, rich flavour and are full-bodied. Bulbs are smooth and symmetrical with snow white wrappers enclosing 4 to 8 off-white coloured cloves, often with rose-red or purple coloured stripes. This type is easy to clean and can be stored longer than the other hardnecks.

5.4 Purple stripe

This type of garlic is most suitable for cooks who enjoy roasting since it maintains its flavour well after being roasted. Purple stripe garlic types are characterized by very attractive bulbs with beautiful purple lines and stripes, and they usually have about 8 to 12 cloves per bulb. Their cloves are tall and elongated with partial red-purple streaks over an off-white coloured background.

5.5 Rocambole

This is the most widely grown of the hardnecks. Characterised by rich flavour that is highly sought by chefs. Bulb wrappers are often blotched with purple. The cloves are brownish with varying reddish colours. There is about an average of 6 to 11 cloves which are very easy to peel per bulb. This type has the storage life that averages 3 to 4 months when well grown and well cured. The stalks of this types has a different behaviour as compared to other types in that, shortly after their stalks appear they coil into tight loops, and for this rea-

son they are also termed serpent garlies. They later lose their coils and the stalks turn woody.

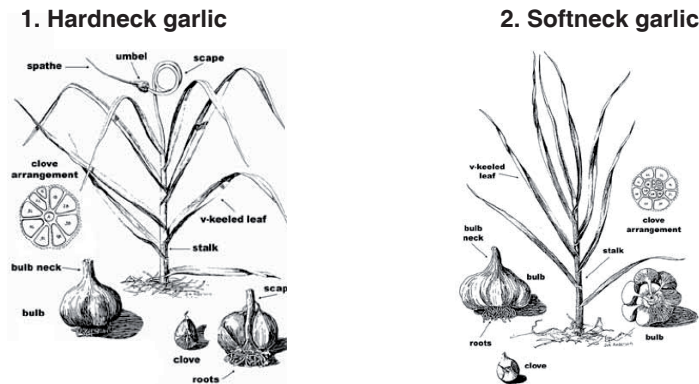
The five basic cultivars of garlic are further divided into softneck garlic and hardneck garlic as follows:

1. Softneck garlic

Artichoke and Silverskin variety garlies are considered to be the softneck garlies also known as the common garlies. Softneck garlic is primarily the one found in most grocery stores.

2. Hardneck garlic

Porcelain, Purple Stripe, and Rocambole types are hardneck garlies. They are considered to have more flavour and to be more gourmet tasting than softnecks. However, hardnecks typically do not store as long as softnecks. The picture of their differences is shown below:



Source: Sterling, S. January 2000. Garlic. www.dpi.vic.gov.au.

6. Climatic requirements

6.1 Temperature

Garlic thrives well in warm climates but it can survive winter temperatures. Most of the conditions that are suitable for the production of onions are also suitable for garlic. The suitable growth temperature for garlic is 13 to 24 °C. The plants are also influenced by temperature and day length but to a lesser

extent than onions. Long days and high temperatures during the growing season encourage bulb formation. Early cultivars are more likely to react to changes in temperature than late cultivars.

6.2 Rainfall

Garlic is sensitive to moisture stress throughout the growing season. Any periods of dry soil conditions, especially during bulbing will result in yield reductions. Where enough rainfall is not available, then irrigation is a requirement for this crop to provide satisfactory yields.

7. Soil requirements

Garlic grows best in well drained fertile soils that are high in organic matter. Incorporating compost or well-rotted manure into heavy soils will result in the soil being friable and suitable for production. Malformation and difficulty when harvesting bulbs may result when garlic has been planted in heavy, clay soils. The optimum soil pH for garlic is between 6 and 7. Before planting, the soils should be well tilled to provide a loose growing bed for bulb development. The soil must be kept evenly moist because dry soil will cause irregularly shaped bulbs.

Part ii: Cultivation practices

1. Propagation

Garlic is propagated by cloves.

2. Soil preparation

The soil should be prepared far enough in advance in order to eliminate perennial weeds, adjust pH, nutrient and organic matter levels if needed, and remove any soil obstructions. Ploughing should be to the depth of 15 to 20 cm. It can then be harrowed and left in good tilth. The surface should be well worked and smooth. If the area of production will be under irrigation, then the soil should be levelled to allow proper and effective irrigation.

3. Planting

3.1 Slope

The field of production should be flat and this can be achieved through the use of machinery. The slope is mostly important when irrigation is used, it is also important in avoiding wet patches where water will settle during rainy conditions.

3.2 Planting density/spacing

Spacing between rows will depend on the method of planting and available equipment for cultivation. Single or multiple rows of plants are commonly used. However, the general recommendation for spacing the divided cloves is 8 to 15 cm with row spacing of 30 to 40 cm.

3.3 Design

A tractor is used to draw two or three small furrows, depending on the track width. They must be approximately 50 mm deep, with 200 to 300 mm between the rows. The "seed" pieces are planted or sown either manually or mechanically about 80 mm apart in the row. The cloves should be sown root end down, standing erect below the soil surface. Garlic can be successfully planted and grown on double plant-row raised beds, in single rows on the flat or level soil surface.

If the distance between the rows is slightly wider while the planting distance in the row remains the same, less planting material is used and mechanical ridging is facilitated. The first priority when determining planting distance is to plant at least 4 to 7 t of material/ha. Rows must be wide enough apart to be ridged mechanically or manually from the time the plants are approximately 200 mm high. Instead of cultivating the land, it can later be ridged two or three times.

3.4 Planting date

The suitable planting time differ from one area to another in South Africa and this is due to different climatic conditions but planting can start from February to May.

3.5 Planting depth

The cloves are planted to the depth of about 50 mm on raised beds or on the flat ground.

4. Fertilisation

Garlic is a heavy feeder, but the fertiliser recommendation should be guided by soil test results. There are also general recommendations that can be used. The first thing that should be done sometime before planting is to incorporate the compost into the soil as it does not only improve the soil fertility but also the soil structure. Then at planting, about 125 g of 3:2:3 can be applied per m² using the broadcasting method.

A light side dressing of 40 g of 3:2:3 can be applied per m² during the growing period, which can be 6 to 8 weeks after planting. However, if the compost has not been applied on the field, then a further supplement of nitrogen as a fertiliser will be required. A solution of ammonium sulphate at the concentration of a heaped teaspoon in 5 ℓ of water can be used, but it is only practical for garlic garden production.

Nitrogen can be applied through irrigation, although care must be taken to avoid foliar burn. The preferred sources of nitrogen are calcium or ammonium nitrate. Applications of urea should be avoided due to potential plant injury.

5. Irrigation

Garlic can be successfully grown using furrow, sprinkler, or drip irrigation. Garlic has a relatively shallow root system and it is therefore sensitive to moisture stress throughout the growing season. The quantity of water that should be applied depends on the weather and the soil conditions. Furthermore, there will be increased water demand during hot, dry weather conditions. Where the conditions like this prevail, mulching is recommended to reduce the rate of moisture loss from the soil surface.

The frequency and the rate of irrigation can also be determined by using the moisture determining devices such as neutron probe around the field. The preferred time of irrigation is morning to mid-afternoon, thus allowing sufficient time for the plant foliage to dry before nightfall. As garlic becomes mature at harvest, irrigation should cease. This increases harvesting ease and reduces the potential deterioration and staining of exterior bulb sheath leaves.

6. Weed control

Weed control can be achieved by cultivation, hand-hoeing or by applying registered herbicides. Deep cultivation close to the plants should be avoided as root damage with subsequent yield losses may occur. Each method of weed control may be effective but the best way is to integrate these methods to ensure a weed free garlic field.

7. Pest control

7.1 Cutworms

CONTROL

Land must be kept free of weeds for at least 6 weeks before garlic is planted so that the cutworms in the ground may die of starvation. After the garlic has germinated, it is important to apply weed control to reduce the number of sites where moths can lay their eggs.

WINTER PLOUGHING

By ploughing the lands in winter, cutworms occurring in the ground are exposed to natural enemies such as birds.

CHEMICAL CONTROL

Before or after emergence the soil may be sprayed with the registered chemicals, following the prescribed application guidelines. The cutworm bait which is in a granular form can also be used, broadcast over the field of garlic production or directly on the rows.

7.2 Pink stalk borer

Larvae of the moth *Sesamia calamistis* are known as pink stalk borers. They attack the stems of different crops. When the larvae hatch, they bore into the stems of the garlic plants. This causes yellowing of the leaf tips and the central leaves eventually die off.

CONTROL

The numbers of this pest are reduced by cultural practices such as weed control and removal of alternative host plants in the vicinity of garlic fields. Natural enemies of the pink stalkborer include the parasitic wasps of the families *Braconidae* and *Ichneumonidae*.

8. Disease control

8.1 Brown rust (*Puccinia alli fungus*)

SYMPTOMS

The rust pustules which are bright orange, slightly raised and elongated appear on the leaves. The leaf is also covered with powdery spores, and turns to a yellow colour as time goes on. This leaf disease can be responsible for serious losses under prolonged moist conditions.

CONTROL

No chemicals are registered to control this disease however, the disease can often be avoided by not planting too early.

8.2 White bulb rot (*Sclerotium cepivorus fungus*)

SYMPTOMS

This disease attacks the crop at all the stages of growth in the field, the leaves of both partly and fully developed plants turn yellow and wilt. There is also a snow white mycelia on the bulb surface or at the crown of seedlings. The small rounded shape sclerotium also develops on the mycelia. The root system of the crops is destroyed completely and the crop leaves also turn yellow and wilt. The disease is more destructive during the early spring and the autumn seasons.

CONTROL

There are registered chemical for this disease in South Africa. However, it is more advisable to prevent the disease rather that to control it. Crop rotation and thorough destruction of infected material is the best control measure. The soil can also be treated before planting and it should also be well drained. Farm equipment such as the ploughs that work on the infected land, should also be treated to avoid spreading the disease to the clean field areas.

The bulbs may rot in the ground or carry the infection throughout the storage period. As the fungus can survive in the soil for as long as 10 years, it is best to destroy the infected bulbs in the fields.

8.3 Pink root (*Pyrenochaeta terrestris* fungus)

SYMPTOMS

The disease can survive on roots of different vegetable crops. The infected crop becomes poorly defined and the plants become stunted as compared to the other healthy plants. The roots become pink and rot. The length and the number of the leaves are also reduced and it also results in smaller bulbs that will be harvested.

CONTROL

This fungal disease which occurs on many different kinds of plants can be carried over in the bulbs. Therefore, bulbs from infected fields should not be used for planting. The field of production that is infected can be flooded with water to control this disease. The bulbs suspected of being diseased should be treated with a registered chemical prior to planting, and a sound crop-rotation system should be used. There are also resistant cultivars that can be planted.

8.4 Stemphylium leaf blight (*Stemphylium vasicarium* fungus)

SYMPTOMS

It affects the flower stalks of the garlic crop and its symptoms are similar to those of Alternaria blotch. The small pale yellow lesions are found on the leaves or the flowers. The lesions can get bigger and be surrounded by pinkish coloured margins. Lesions later become dark brown or black in colour and they look like pimples or raised spots on the affected area.

CONTROL

The proper sanitation should be maintained around the farm, and this includes the removal of all the diseased plant material. There are no registered chemicals for the control of this disease in South Africa.

8.5 Neck rot

This disease is fortunately not common. It is a wound parasite that enters the plants through wounds. Much can therefore be done to prevent it, by cultivating and harvesting carefully so as not to damage the plants. For the same reason, the growing garlic should not be tramped down in an effort to speed up the ripening process.

9. Other cultivation practices

9.1. Mulching

Mulching is the process of covering the soil surface with straw or any other available mulching material to suppress the weeds and to conserve the soil moisture. Grain straw is not recommended because it can host several pests that might attack garlic. The soil temperature can also be modified by the mulch to be very suitable for the crop. The mulching practice can increase the yield of garlic significantly.

9.2. Topping

Some types of garlic produce flower stalks with small aerial bulbils. Removal of these stalks enhances crop maturity and yield. Research work indicates that crop yields (average bulb weights) can be dramatically increased to about 70% by removing the flower stalks soon after their development.

10. Harvesting

10.1. Harvesting maturity

Harvesting begins when the leaf tops begin to dry, discolour and bend towards the ground. Another indication of bulb maturity is the reduced thickness of the sheath leaves surrounding the bulb. Early harvest results in bulbs which are immature and tend to shrivel when cured, while late harvest may result in bulbs which have stained, and have partially decayed wrapper leaves and exposed cloves.

10.2. Harvesting methods

With small plantings of garlic, the bulbs are usually harvested by hand pulling, using a fork to loosen the soil and facilitate lifting. On larger plantings, the potato digger or a small onion plough can be used to lift the garlic crops. After lifting, the crops can be left on the field, using their leaves to protect the bulbs from sunburn. The process is also termed curing and it is very important for the quality of the garlic crop.

Part iii: Post-harvest handling

1. Curing

Curing is often accomplished in several ways. One is curing the bulbs indoors using forced air to dry them or by either placing them in slotted bins, on wired racks or on open trays in a well-ventilated building.

2. Sorting and grading

After curing, the garlic tops and the roots should be trimmed. Topping and root trimming can be done mechanically or by hand. Brushing to remove the loose outer sheath is the final step before marketing. Garlic is usually graded by size, with the larger-sized bulbs commanding a higher price. The grading process can also be done manually or mechanically.

3. Packing

Garlic can be packed in a mesh bag or in a well ventilated crate. The quantity when packed, should be taken into great consideration because if too much is packed, there is a lot of heat released and this can result in loss of quality of the garlic bulbs.

4. Storage

For maximum storage life, garlic should be properly cured and stored at -0°C with a 60 to 70% relative humidity. Higher humidity provides suitable conditions for the development of penicillin mould and root growth, which is undesirable. Adequate air circulation and proper storage containers are important to remove transpired heat and moisture. As storage temperatures are increased above 0°C , the rate of bulb weight loss also increases. Storage life under the mentioned suitable conditions is 6-7 months depending on the strain of garlic. Controlled atmosphere with 0.5% of O_2 and 5 to 10% of CO_2 can also increase the storage life of the garlic bulb.

5. Transport

The bulbs must be thoroughly dried before being shipped or transported. The moisture content is very important before transportation as it greatly affects the quality of the bulb. It is also advisable to have refrigerated transport vehicles if the garlic bulbs are to be transported to distant destinations.

6. Marketing

Presently, the majority of garlic is marketed as fresh product to the fresh produce markets throughout the year. The market prices are greatly influenced by the supply. When the garlic crop is scarce then the prices are high. Some producers have contracts with processing industries to which they supply all their produce after harvest.

Part iv: Productive schedules

ACTIVITIES	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
Soil sampling	X											
Soil preparation	X											
Planting		X	X	X	X							
Fertilisation		X	X	X	X		X					
Irrigation		X	X	X	X	X	X					
Pest control		X	X	X	X	X	X	X	X			
Disease control		X	X	X	X	X	X	X	X			
Weed control		X	X	X	X	X	X					
Leaf sampling												
Harvesting								X	X			
Marketing								X	X	X	X	X

Part v: Utilisation

Garlic is used as a condiment for flavouring in soups, stews, pickles and salads. Studies have supported the idea that the regular consumption of garlic can reduce blood pressure, blood cholesterol levels, act as an inhibitor to the overgrowth of pathogenic organisms in the body, such as *Candida albicans* and can be useful as a worm medicine.

REFERENCES

- Cantwell, M. 2001. *Properties and recommended conditions for long term storage of fresh fruits and vegetables*. Unpublished.
- Conway, D. 1973. *The magic of herbs*. Jonathan Cape publishers. Britain
- FAOstat. <http://faostat.fao.org/faostat/servelet/Xteservlet3?Areas>
- Immelman, D. 2006. Garlic farming. www.garlic.org.za
- Olivier, O.L. 1974. *The cultivation of garlic; the cultivation of garlic, onions and leeks in South Africa*. Horticultural research Institute. Pretoria.
- Sterling, S. January 2000. Garlic. www.dpi.vic.gov.au.
- www.garlicfarm.ca/garli_production.htm

Notes

A series of 25 horizontal dotted lines for writing notes.



