

Production Guidelines for African Leafy Vegetables

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Report to the
**Water Research Commission &
Department of Agriculture, Forestry & Fisheries**

by

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WRC Report No. TT 536/12

SEPTEMBER 2012



Obtainable from

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South Africa

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The publication of this report emanates from a project titled *Nutritional value and water use of indigenous crops for improved rural livelihoods* (WRC Project No. K5/1579).

This report forms part of a series of three reports. The other reports are:-

Nutritional value and water use of African leafy vegetables for improved livelihoods
(WRC Report No. TT 535/12), and
Nutritional status of South Africans: Links to agriculture and water
(WRC Report No. TT 362/P/08)

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ISBN 978-1-4312-0324-6
Set No. 978-1-4312-0325-3

Printed in the Republic of South Africa

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ACKNOWLEDGEMENTS

These guidelines are an output of the research project (Project No K5/1579//4) entitled **“Nutritional value and water use of indigenous crops for improved livelihoods”**.

1. The solicited project was initiated and managed by Water Research Commission (WRC) of South Africa. The WRC, together with the Department of Agriculture, Forestry and Fisheries, provided co-funding for the project. The members of the Reference Group contributed greatly in supporting and guiding the project team.
2. The Reference Group was comprised of the following members:

Dr AJ Sanewe	Water Research Commission (Chairman)
Dr GR Backeberg	Water Research Commission
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Prof AT Modi	University of KwaZulu-Natal
Mr TC Ramashala	Department of Agriculture, Forestry and Fisheries
Dr A Minnie	Mangosuthu University of Technology
Dr A Mnkeni	University of Fort hare
2. We would also like to acknowledge the invaluable contribution of technical and support staff of the Department of Crop Sciences, Tshwane University of Technology and the Agricultural Research Council Vegetable and Ornamental Plant Institute.
3. The contribution of each project team member was invaluable to the project and would like to give acknowledgements to:

Prof A Oelofse	University of Pretoria (Project Leader)
Dr F Wenhold	University of Pretoria
Dr M Faber	Medical Research Council
Dr PJ van Jaarsveld	Medical Research Council
Dr MM Slabbert	Tshwane University of Technology
Prof W van Averbek	Tshwane University of Technology
Dr YG Beletse	Agricultural Research Council
Dr I van Heerden	Agricultural Research Council
Mr WS J v Rensburg	Agricultural Research Council
4. All photos by courtesy of Dr YG Beletse, Dr D Visser and Mr WS Jansen van Rensburg from ARC-VOPI.
5. We would also like to acknowledge the contribution of Mrs HJ Vorster and SP Ntombela as well as various community members throughout South Africa in compiling the list of names in the official languages. We acknowledge that it is not an exhaustive list.

1. Introduction	1
2. General Considerations	1
2.1 Seedling production.....	2
2.2 Land preparation and Fertilising your garden or field soil	4
2.3 Irrigation water use.....	7
2.4 Seed production	8
2.5 Harvesting if Leafy vegetables	8
2.6 Pest and disease management.....	9
Cultural Control.....	9
Amendments and extracts	9
2.7 Recipes for some amendmets and extracts	11
2.8 Some pests and diseases of African Leafy vegetables.....	13
3. Amaranth (<i>Amaranthus</i> spp.).....	16
4. Spider plant or Cat's whiskers (<i>Cleome gynandra</i>).....	18
5. Jute mallow (<i>Corchorus olitorius</i>).....	20
6. Cowpeas (<i>Vigna unguiculata</i>)	22
7. Bitter watermelon (<i>Citrillus lanatus</i>)	25
8. Pumpkin (<i>Cucurbita maxima</i>).....	27
9. Black nightshade (<i>Solanum retroflexum</i>)	29
10. Chinese cabbage (non-heading) (<i>Brassica rapa</i> L. subsp. <i>chinensis</i>).....	31
11. Picture pamphlet on Growing amaranth	33
12. Guide to the common names of African Leafy Vegetables.....	35

1. Introduction

Traditional African Leafy Vegetables (ALVs) refer to the collective of plant species whose leaves and petioles are consumed as leafy vegetables. The ALVs are referred to as *Morogo* or *Imifino* by African people. The term ALVs also include indigenous, indigenized and recently introduced leafy vegetable species.

ALVs have long been known in South African rural communities as an essential food that is consumed with starch staples. These vegetables have high nutritional value that could play an important role in the prevention of malnutrition. The recent trends in addressing malnutrition in many developing countries have focused towards optimal utilization of the underutilized ALVs at a household level. In East African countries, the consumption of traditional African vegetables at household level has more than doubled in the last five years and it is expected that this trend will also occur in South Africa. The National Department of Agriculture, Forestry and Fisheries (DAFF) and the Department of Science and Technology (DST) have already acknowledged the potential role of traditional African leafy vegetables in the livelihoods of the South African people. However, these vegetables are still mainly harvested from the wild and traded informally in South Africa. This manual intends to bring together some of the latest research findings in guiding farmers to produce these nutritionally important traditional African leafy vegetables.

2. General Considerations

Producing traditional African leafy vegetables is based on two main agronomic practices. The first practice is that growth limiting factors of the vegetables must be optimised and the second is that the vegetables must be protected against pest and disease damages.

Water, nutrients and light are the three important growth limiting factors for traditional African leafy vegetables. Temperature and frost are also additional important factors that limit growth of these vegetables in which the grower must give attention during the growing period. Vegetables grow only within certain temperature ranges, that is why we see some vegetables are planted only in winter whilst others in summer in a natural environment. The occurrence of frost is also important, because it can injure or kill the vegetables. Most summer crops, such as Amaranth and Spider plant (spider flower) die when they are exposed to frost. Others, such as kale, rape or mustard can withstand frost.

Pests and diseases cause damage to vegetables. This damage can be so severe that the vegetables either completely die or cause a reduction in yield, both quantitatively (less produce) and qualitatively (reduction in the quality). Poor quality vegetable produce can prevent or diminish the profitability from the sale of produce.

In this guideline, we present guidelines for the production of selected popular African leafy vegetables in South Africa. This information should enable you to grow these vegetables successfully and protect them reasonably well against damage by pests and diseases. The guidelines were compiled with the rural homestead in mind and the emphasis is on the use of resources that are locally available.

The guidelines commence by providing you with some general information, which is arranged in the logical sequence of crop growth, starting with seedling preparation, planting,

harvesting and seed collection. Young leaves can be harvested after four weeks after transplanting. Harvesting can take place four to five times during the season, depending on the season and vegetables. If the seed is required for future planting, one can leave the vegetables to produce flowers, when the plant has reached maturity seeds can be collected.

2.1 Seedling production

African vegetable seedlings are not commercially available, but you can produce your own seedlings or sow directly in the field. To establish your seedling nursery, choose a place that has good quality soil and is closer to a water source. The nursery can be partially shaded or you can erect shade, using shade net, old grain bags, thatch grass or reeds, to protect young seedlings from full exposure to the sun.



An inexpensive cover for seedling production used by farmers at Thandinhlabathi (eDumbe). The seed bed is covered with thatch grass raised by a wooden frame from local branches (left). A semi-permanent structure by gardeners in Maphumolo (right)

The soil in the nursery should be well prepared into a fine seedbed. Regular addition of organic material, particularly compost, to your nursery soil is the best way to develop perfect soil conditions, characterised by a loose, stable and crumb structure.



A permanent vegetable seedling production structure

Seed should be sown directly into the seedbeds. Look out for any pest and diseases such as damping off and cutworms. Damping off is diseased condition of seedlings due to excessive water application and sowing seeds too closely to each other. Damping off results in wilting and death of seedlings.. Over watering and thinning out seedlings after emergence should avoid damping off from occurring. When seedlings appear to have been cut off above soil level, cutworm is the problem. Cutworms can be removed by hand but application of cutworm bait can be used as a preventative measure.



Cutworm and the damage caused (Photo: Dr D Visser, ARC)

Transplant the seedlings to the garden or field when they have become strong and grew well (typically when they have three leaves). Seedlings that are too young struggle to take root after transplanting. Seedlings that are too old have developed quite extensive root system in the nursery soil and when they are lifted from the nursery soil, many of the roots are damaged. This damage causes stress in the plant from which it might not recover.

The best time to transplant seedlings is in the late afternoon on a cool day, because this provides the plants opportunity to establish themselves in the new conditions without being exposed to excessive heat and strong light.



African Leafy vegetable seedlings, two weeks after emergence (left) and ready to be transplanted (right)

First water the seedbed and then dig up the seedlings very carefully from the nursery bed with a small spade or digging stick. The trick is to avoid damaging the roots of the seedlings

as much as possible. After the seedlings have been dug up, keep seedlings in a shade to protect them against sunlight and do not let the roots dry out.



Bare rooted seedlings packed in wet newspaper to keep the roots moist

When transplanting seedlings to a garden or field seed bed, you should prepare the soil by making small holes using the desired spacing between plants. In each hole you should pour a cup of water and let the water drain away. Gently place one seedling in each hole and cover the roots of the seedling with soil. Press the soil down around the roots. When it is hot, cover the young newly transplanted seedlings with mulch like straw or dried grass. Water the newly planted seedlings immediately after planting and regularly to avoid seedlings from drying out. Take care when watering, not to wash away the soil around the roots.

2.2 Land preparation and fertilising your garden or field soil

ALVs need well prepared land to get a good start. Prepare the land with a tractor or by hand before the ALVs are planted. This is done in order to loosen the soil so that: 1) the roots can grow and water can penetrate more easily, 2) to work organic matter (and sometimes manure or fertilizer) into the soil, 3) to control the growth of weeds and 4) to shape the seedbed (into ridges, beds, or mounds) and to destroy hibernating pest & disease organisms and facilitate proper soil chemical and microbial activity.



Land preparations can be done with a tractor or by hand.

Just like all living organisms, plants need food to grow. We refer to plant food as nutrients. Fertilisers contain nutrients and that is why we apply fertilisers to the soil for crop production.

We need to apply fertilisers regularly to these soils, because plants take up nutrients from the soil and when we harvest our crops we remove the nutrients that were taken up. In nature, when plants get old they die and the nutrients taken up whilst growing are returned into the soil as the dead plant material is decomposed.

There are two main types of fertilisers. The first consists of chemicals. They are very concentrated but they are expensive. Among the chemical fertilisers there are two types, mixed fertilisers and single source fertilisers.



Commercially available chemical fertilizer: 2:3:2 on the left and LAN on the right.

The most important plant nutrients are nitrogen (N), phosphorus (P) and potassium (K). Mixed fertilisers contain all three of these nutrients. Bags of mixed fertilisers have a formula written on them which shows the concentration of nutrients and also the proportion of nitrogen (N), phosphorus (P) and potassium (K). For example, the formula on the bag reads 2:3:2 (22). The last number in brackets is the concentration of nutrients expressed as a percentage. The (22) means that in 100 kilogram of the fertiliser mixture; 22 kilogram (22%) consists of a combination of pure nitrogen (N), phosphorus (P) and potassium (K). The higher the concentration, the more expensive the fertiliser will be. The 2:3:2 refers to the proportion of nitrogen (N), phosphorus (P) and potassium (K) contained, in this order. The 22 kilogram NPK is divided as follows: 2 parts is nitrogen (N), 3 parts is phosphorus (P) and 2 parts is potassium (K) and the percentage of N, P and K is calculated as follows: $N = (2 \div 7) \times 22 = 6.29\%$; $P = (3 \div 7) \times 22 = 9.43\%$; $K = (2 \div 7) \times 22 = 6.28\%$.

Chemical fertiliser mixtures are very convenient to use because they contain all three important nutrients. The only way to make an accurate fertilizer recommendation is to have your soil analysed. In this way you can only add what is needed and will obviously save money. If no soil analysis is available, a fertilizer mixture can be used. The fertiliser mixture 2:3:4 is probably your best choice, when this will be the only fertiliser you will apply to your garden or field soil. The reason for choice for this fertilizer is that most non cultivated lands in South African soils has low levels of P whereas cultivated soils in home gardens are often depleted from K as well as P. K also seems to have an effect on nutritional value of ALVs. ALV respond very well to additional N applications as top dressings during the growth season. The reason is that plants need more nitrogen (3) than phosphorus (2) and potassium (1). If you intend to apply additional nitrogen to your crop, whilst it is growing, the mixture 2:3:4 is probably your best choice.

Often zinc (Zn) is added to chemical fertiliser mixtures. This is also shown in the formula. The presence of zinc is shown when the formula reads as follows: 2:3:4 (22) + 0.5% Zn. The last part of the formula (+ 0.5% Zn) indicates the presence of zinc. Zinc is also an important plant nutrient but it is only needed in small quantities. Most South African soils lack zinc and adding it to your soil is a good idea. Applying zinc will ensure that your plants grow better and that they contain zinc. Zinc is also an important nutrient for human beings and many South Africans suffer from zinc deficiency, which makes them unhealthy. Applying zinc to your soil ensures that your vegetables are rich in zinc and eating these vegetables will provide you with all the zinc you and your family need to stay healthy.

Single fertilisers contain only one plant nutrient. Super-phosphate contains only phosphorus (P), limestone ammonium nitrate (LAN) contains nitrogen (N), Ca and Mg; and potassium chloride (KCL) contains potassium (K) and Chloride (CL). LAN and KCL or KNO_3 are usually recommended for low pH or sandy soils and NH_4SO_4 and K_2SO_4 or KNO_3 for high pH clay soils.

If you make use of a chemical fertiliser mixture rich in phosphorus (P) such as the mixture 2:3:4 mentioned earlier, it will pay you to add nitrogen (N) at a later stage, when the plants start growing fast (five to six leaves). Application of limestone ammonium nitrate (LAN) as side dressing is recommended.



Making compost in home garden in Maphumolo (left) and spreading manure evenly in trial at ARC-VOPI (right)

Organic materials, such as animal manure and compost, are the second type of fertiliser. They have two main advantages over chemical fertilisers. Unlike chemical fertilisers they contain all plant nutrients and as a farmer or gardener you can generate organic fertilisers on your farm, saving you money. The main disadvantage of organic fertilisers is that they contain nutrients in small quantities in a bulk of material as a result, you have to apply a lot of organic fertilisers to your soil to get the same effect as chemical fertilisers. The availability potential of salt and weed seed hazards, and expense per kg of nutrient is high. The value of manures and organic concentrates, therefore, does not lie in their nutrient value, but rather in the fact that they improve the soil's physical properties. The general belief that organic materials are better sources of plant nutrients than inorganic forms is not correct. Plants respond equally well to organic or inorganic (chemical) forms of fertilizer. For both sources to

be beneficial to plants, their nutrients must be changed into chemical forms that plants can absorb and use.

Animal manure is the most commonly used organic fertiliser in rural human gardens. Be sure to differentiate between poultry (and pig) manure and ruminant manure, which is the manure found in kraals where cattle, goats and sheep are kept at night. Poultry and pig manure are more concentrated than kraal manure and should be applied at lower rates than kraal manure.

When you have plenty kraal manure or poultry manure and your garden or field soil has not received much fertiliser in the past, it is recommended that you broadcast manure. This means that you spread the manure over the full area of your land and then work it into the soil with a spade or a plough. Then you should either irrigate the soil or wait for the rain to thoroughly wet the topsoil containing the manure and then wait about one month before you plant your crop, or transplant your seedlings.

When you use poultry or pig manure you should aim at applying one 10 litre bucket on every 3 square metre (1 meter x 3 meter) of land. This represents an application rate of about 10 tons per hectare. When you use kraal manure, you should aim at applying one 10 litre bucket on every square metre (1 meter x 1 meter) of land. This represents an application rate of about 30 tons per hectare. Note that the kraal manure must dry good enough before used.

Once you have raised the fertility of your soil in this way, you can limit subsequent applications of manure to the strip in which you will place the transplants. When using poultry or pig manure, apply one 10 litre bucket in a band of about 20 cm wide over a length of 15 m, work the manure into the top soil, water the band thoroughly and wait one to two weeks before transplanting. When you use kraal manure, use the same procedure but apply one 10 litre bucket over a length of 5 m.

2.3 Irrigation water use

Before irrigating your ALVs, knowing and understanding your type of soil is critical. Most soils are mixture of three textural classes: sand, clay and loam, therefore, identify what dominates your soil before planting. This will help you determine how fast your water infiltrates into the soil, how often your plants should be irrigated and how much volume of water you need to apply. As a general rule of thumb, sandy soils absorb water very quickly and the water infiltrates deep below the root zone. In sandy soils don't apply so much water so that it does not drain below the root zone without stopping. In clay soils water infiltrates slowly than sandy soils and dries out slowly; therefore stretch the time between your irrigation times. Loamy soil is characterised as medium absorption which is between sand and clay.

Buckets, hosepipe, sprinkler or drip irrigation system can be used to irrigate ALVs; however, water savings with drip are substantial compared to a sprinkler system. Drip irrigation is a method of irrigation popular for its potential to increase yields while decreasing water requirements and labour input. If sprinkler irrigation system is utilized, stay away from windy days for uniform applications and late afternoon irrigations to avoid foliar diseases. Excess water application leaches nutrients away from the roots of the plants, therefore careful

irrigation amount and frequency is required to prevent crop stress and to help produce marketable healthy vegetable.

2.4 Seed production

African leafy vegetable seed is not commercially available except for Muchaina/Mustard, pumpkin and cowpea. The ARC-VOPI, however, has seed nursery and produces ALVs seeds at small scale. However, you can produce your own seed. Look for healthy disease free plants in the field. You can also look for features you like in the crop and select these plants. Mark the plants and do not harvest leaves from them.

Harvest seed when the pods/seed heads are fully dry, just before they open naturally in the field. Fruit should be harvested when they are mature and fully ripe. Choose good quality fruit.

Extract the seed from the pods manually. Seeds can be removed by hand-beating or rubbing between hands. Winnow to clean. Dry seeds in the shade for 3-5 days. Put the seed on a cloth and not corrugated iron as it will become too hot and kill the seed.

When extracting seed from fruit, separate seed from fruit pulp. Wash these seeds thoroughly and dry in the shade for 3-5 days. It is easy to separate fruit pulp and seed for fruit like pumpkin but more difficult with nightshade. Small fruit can be squashed and placed in water. Leave the water and seed mixture for one to two days and separate the seed from the pulp. Good seed will sink and bad seed will float. Wash these seeds thoroughly and dry in the shade for 3-5 days.

Properly dried seeds should be kept in a closed container to avoid damage by insects. Any container that seals properly can be used. Ash can be added to prevent insect damage. Store containers in a cool dry place. Charcoal will also help to dry the air in the container and preserve the seed for longer. Certain seeds like spider plant and Jute mallow do not germinate when fresh and should be stored for at least three to four months. Soaking in water and heat treatment also helps with germination.

2.5 Harvesting Leafy vegetables

Harvesting can be done by uprooting whole plants, cutting back (\pm 20 cm above ground) or picking the leaves. Once plants are growing well, frequent harvesting of leaves or shoots can take place. When possible, harvest early in the morning or late in the afternoon when it is cool. Shoots and leaves can be wrapped in wet cloth or placed without water in well-ventilated bags overnight. Water can be sprinkled on, but sparingly to avoid rotting. Dip shoots in water for about 30 minutes the next morning to revive it.



Two ways of harvesting. Cutting back to about 20-30 cm (left) and picking leaves and growth tips (right)

Don't cook your leafy vegetables too long. It will destroy all the nutrients in them. Avoid changing the cooking water whilst cooking because it contains nutrients.

2.6 Pest and disease management

Various pests and diseases attacks African Leafy Vegetables. Unfortunately, no agro-chemicals are registered for the control of these pest and diseases. It is therefore necessary to use cultural control methods as well as amendments, extracts or home-made remedies.

Cultural Control:

- Use good quality seed/plant material
- Weed control – some weeds may harbour pests and diseases that may spread to the crop plants. Weed competition will also weaken the crop plants, making them more susceptible to pest and diseases.
- Keeping the fields clean of plants or materials that may harbour pests. Remove dead and diseased plants as soon as possible. That can harbour pests and diseases that can attack the crop plants.
- Keep implements (spades, hoes, ploughs, etc.) clean. Soil and other dirt on the implements can spread pests and diseases.
- Scout for pests and diseases regularly. Look out for leaf damage, discolouration such as yellowing, leaf spots, stunting, fruit rot, misshaped leaves, wilting, cankers and stem damage or rotting. If you detect only a small amount of disease, removal of infected foliage or plant will help reduce the spread. Remove all harmful insects and destroy them. Ants are often an indication of aphid or mealy bug infestation.
- Use specific cropping systems to reduce pests and diseases. Crop rotation works very well. Don't plant the same plants in the same place every year. Mixed cropping can also limit the spread of pests and diseases. Trap crops (plants preferred by the insects or disease) planted around the fields might help to reduce pests and diseases. Push crops, like garlic and marigolds, can discourage insects by their smell.

Amendments and extracts

Plant extracts can control or combat insects upon contact or through ingestion, as a repellent or they can be used to lure insects into a trap. Garlic is an example of a safe plant extract

with a wide application in pest and disease control. Pepper dusts and sprays contain a compound that repels insects. Nicotine has been one of the most popular insecticides since the 1880s, and is still widely used. However home-made nicotine tea only retains its toxicity for a few hours after spraying, making it less effective . Sprays made from the leaves of *Cleome gynandra* (lerotho) are known for their insecticidal and insect repellent characteristics, and may cause reduction in aphid and thrips populations considerably.

Home-made sprays may be stored safely for up to one month, providing they are in sterile, glass, screw top containers. Glass bottles or jars may be sterilised by placing them in cold water and bringing them to the boil, then allowing them to simmer for 30 minutes. Allow the bottle or jar to cool in the water before using. Correct labelling is essential. Include the date of making the spray and the ingredients on the container and keep them in a safe place out of the reach of children and animals

The following basic spraying principles should be followed for best results:

- Spray early in the morning or in the evening when it is cooler. Spraying in the heat of the day can cause burning of the leaves, or the plant can react negatively to the botanical spray (known as phytotoxicity);
- always perform a test on a small portion of the plants first, wait 24 hours for any negative reaction, and proceed if there was no plant damage; and
- always protect your skin and face when applying plant extracts since some of these ingredients can be irritating to your skin and mucous membranes.

2.7 Recipes for some amendments and extracts

Recipe	Methods of Preparation	How to use	Target pests and diseases
Garlic bulb extract (Prakash & Rao, 1997; Richardson, 2005; Vijayalakshmi et al., 1999) 85 grams of chopped garlic 50 ml of mineral oil (kerosene or vegetable oil) 10 ml of soap 950 ml of water Strainer Bottle container	Add garlic to vegetable oil. Allow mixture to stand for 24 hours. Add water and stir in the soap. Store in bottle/container.	Dilute 1 part of the emulsion with 19 parts of water (for example, 50 ml of emulsion to 950 ml of water). Shake well before spraying. Spray thoroughly on the infested plant, preferably early in the morning. Not poisonous, but if sprayed frequently it can be harmful to beneficial insects such as lady beetles	American bollworm Armyworm Thrips Potato tuber moth Root knot nematode Shoot borer Bacterial diseases Anthracnose Downy mildew Whiteflies
Herbal sprays (Richardson, 2005) Rosemary Sage Thyme White clover Liquid soap	Mash or blend 1 to 2 cups of fresh leaves with 2-4 cups of water and soak overnight. Or pour boiling water 2-4 cups fresh or 1-2 cups dry leaves and leave until cooled down. Strain through cheesecloth and dilute with another 2-4 cups of water. Add a few drops liquid soap (approx. ¼ teaspoon) to help spray stick to leaves	Spray plants thoroughly, especially on the underside of the leaves, and repeat weekly if they persist appearing	Cutworms Caterpillars Cabbageworm Aphids Many other leaf-eating pests
Pepper dusts (Richardson, 2005) Black pepper Chilli pepper Dill Ginger Paprika Red pepper	The cheapest will be to grow and dry your own peppers. The dry pepper must be grinded to a fine powder.	Sprinkle along seeded rows of vegetables, in a band at least 15 cm. wider than the row or planting bed. To protect plants from ants, sprinkle around the base of the plant in an area as wide as the canopy. A fine layer will be sufficient, and after rain or irrigation the treatment has to be repeated.	Maggots Ants
Pepper sprays (Richardson, 2005)	Mash 2 large peppers, strain and add water to	Shake well before spraying. Renew after	Maggots Ants

Recipe	Methods of Preparation	How to use	Target pests and diseases
Chilli pepper Paprika Red pepper	bring the volume to 5 litres of concentrate. Dilute spray at rate of ¼ cup of concentrate per 5 litres water. Add ¼ tbs. of liquid soap to make mixture stick to leaves	rain or irrigation.	
Nicotine (Richardson, 2005) Tobacco leaves water	Soak 1 cup of crushed tobacco leaves or cigarette butts in 5 litres of warm water for 30 minutes, with ¼ teaspoon liquid soap added. Strain the mixture through cheesecloth. This solution can be kept for several weeks if stored in a tightly closed container.	For soil pests the mixture should be sprayed onto the soil at the stem base or root zone area. For leaf pests the spray leaves thoroughly, especially the undersides. Nicotine can be absorbed by plant leaves and remain active for several weeks. For this reason, it should be applied sparingly on edible parts of the plant.	Soil pests such as root aphids and fungus knats Leaf chewing insects Aphids Immature scales Leafhoppers Thrips Leaf miners Beetle larvae
Baking soda (http://organicgardening.about.com/) Baking soda Water Vegetable oil Dishwashing liquid	4 litres of water 1 tablespoon of baking soda 1 tablespoon of vegetable oil 1 tablespoon of dishwashing liquid	Apply weekly	Powdery mildew
Sulphur water (Alternative Field Crops Manual, 2000).	Mix finely ground sulphur with water at the rate of 85 g per 13.5 litres of water	Spray plant thoroughly or dust on an even coat over plant surfaces. Sulphur is easily removed from plants during rain, and frequent applications may be needed to provide an adequate level of disease protection. To avoid plant injury, do not use when temperature is 32°C or above.	Rusts Powdery mildew Leaf spots

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2.8 Some pests and diseases of African Leafy vegetables

Insects:



Damage on amaranth leaves caused by chewing insects



Blister beetle on amaranth leaves. Be careful to handle this beetle with your bare hands.



Galling caused by developing insect larva in cowpea stem



Aphids



Cutting of Amaranth leaves due to aphid infestation



Aphids on the underside of the curled Amaranth leaves



Insect damage on spider plant leaves, possibly caused by bragada bug



Plant eating ladybird larvae on pumpkin leaves



Entrance hole of the stem borer on a Amaranth stems



Stem borer eating out the centre of an Amaranth stem



Red spider mite on the underside of a nightshade leaf. The small red crawling mites can be seen.



Red spider mite on the upperside of a nightshade leaf. The leaves are covered in a fine web and the leaves started to look yellow.

Viruses:



Mottle symptoms in cowpea leaves



Deformed fruit in pumpkins due to severe virus infection

Diseases:



Powdery mildew on pumpkin



Blight symptoms



Blight symptoms on Amaranth leaf



Secondary infection on Amaranth stems due to stem borer infestation

3. Amaranth (*Amaranthus spp.*)



Seeds: Seed 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.

Soil preparation: Prepare the soil by hand or mechanically.

Fertilizer: When using chemical fertiliser, purchase 2:3:4 mixtures. Using a hoe, open a furrow and apply the fertiliser mixture in the bottom of the furrow at the rate of 40 grams per m. A normal-size teacup takes about 200 gram 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 LAN at the rate of 20 gram per metre when the plants have about 5 to 6 leaves. One teacup of LAN should be spread along a row of 10 m. When applying LAN to the growing crop, open 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 one 10 litre bucket in a band of about 20 cm wide over a length of 15 m, work the manure into the top soil, water the band thoroughly and wait one to two weeks before transplanting. When you use kraal manure, use the same procedure but apply one 10 litre bucket over a length of 5 m.

Sowing: Usually grows in October when the temperature is above 27°C. Sow seeds in seedbeds or sow directly in rows in the field. Nurseries should be in flat areas, with fertile soils and near the water sources but not in shaded areas. Mix seed with sand at a ratio of 1: 2 and sow at a depth of 1/2 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 away seed. Alternatively, water first, then spread the seed and cover with a thin layer of dry soil.



Mixing seed with sand (left) and sowing the seed and sand mixture (right)

Transplanting: The seedlings will be ready for transplanting after 3-5 weeks when they have four true leaves (15 cm).

Crop management: Amaranths grows for 3 months and best growing season is between October and February. Optimal spacing is 20 cm x 20 cm to 50 cm X 50 cm depending on the size of the plants. Weed whenever necessary. Farmers may grow either a sole crop or a mixed stand with other crops.



Amaranth under commercial production

Water requirements: Water plants regularly because plants that suffer from drought will begin to flower and stop producing leaves. Amaranth grows well in summer when the temperature is above 27°C. Water requirement varies with crop growth stage, soil type and weather condition (hot or cold). Amaranth needs to be transplanted in a wet soil (not dry) to keep the transplanted plant roots moist. The frequency of irrigation depends on the type of soil. Frequent irrigation will be required for sandy soils as they are poor in holding soil water. 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 amount. First, a sandy soil should be irrigated three times a week. Second, sandy loam soils should be irrigated twice a week. Third, clay, clay loam and loam soils should be irrigated once a week. Amaranths require 413 mm water during its growing period. For the first 30-35 days after transplanting, irrigate 4 litres per day for a 1 m x 1 m size plot (20 litres a week for a 1 m x 1 m). Thereafter, irrigate between 5 to 6 litres per day for a 1 m x 1 m size plot.

Harvest: Individual leaves and growth tips can be harvested or the whole plant can be cut back.

Pest and disease: Amaranth is susceptible to a number of leaf chewing insects but can recover quickly. Tarnished plant bug, leaf miners, 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 it bore into the central tissue of roots and occasionally stems, causing rotting and potentially 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 and *Rhizoctonia* and stem canker, caused by *Phoma* or *Rhizoctonia*. *A. tricolor* also seems to be very susceptible to *Phomopsis*, which colonizes leaves and stems and causes dieback.

Control of pest and diseases can be done by practicing good weed control. The weeds can act as a host for pests and diseases. Damping off can be controlled by using clean seed and establishing the seedlings in sterilized soils (steam or dry heat before sowing seeds). Wash used seed trays with commercial bleach. Establish seedlings in well-drained soil in an area with good ventilation.

4. Spider plant or Cat's whiskers (*Cleome gynandra*)



Seeds: Seed can be harvested when pods are fully ripe and yellow but before they open naturally to prevent shattering. The harvested leaves are placed on a clean tarpaulin or plastic sheet and allowed to dry in the shade. Seeds are threshed by hand and cleaned by winnowing. Keep dried seed in a cool dry place. Store seed for three months or more because fresh seed will germinate very unevenly.

Soil preparation: Prepare the soil by hand or mechanically.

Fertilizer: When using chemical fertiliser, purchase 2:3:4 mixtures. Using a hoe, open a furrow and apply the fertiliser mixture in the bottom of the furrow at the rate of 40 grams per m. A normal-size teacup takes about 200 gram 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 LAN at the rate of 20 gram per metre when the plants have about 5 to 6 leaves. One teacup of LAN should be spread along a row of 10 m. When applying LAN to the growing crop, open 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 one 10 litre bucket in a band of about 20 cm wide over a length of 15 m, work the manure into the top soil, water the band thoroughly and wait one to two weeks before transplanting. When you use kraal manure, use the same procedure but apply one 10 litre bucket over a length of 5 m.

Sowing: Sow seeds in seedbeds or sow directly in rows in the field. Mix seed 1:10 with sand or dry soil before sowing.

Transplant/thinning: Germination of Spider plant is uneven. Take care during transplanting not to injure the taproots of the seedlings. Desired spacing is 25-50 cm between rows and 15 cm between plants. .

Management: Spider plant grows well during the warm season under irrigation. It is sensitive to cold and does not grow well when temperatures drop below 15°C. Spider plant prefers sandy loam soils, rich in organic matter and responds well to well-decomposed manure. Flowering is delayed when adequate manure is available, allowing more, larger leaves to develop. Weed only in the open space between the rows.

Water requirements: Spider plant grows well in summer when the temperature is above 27°C and favours a range of soils from sandy loam to clay loam soils. Spider plant needs to be transplanted into a wet soil (not dry) to keep the transplanted plant roots intact. Water requirement varies with crop growth stage, soil type and weather condition (hot or cold). The frequency of irrigation depends on the type of soil. Frequent irrigation will be required for sandy soils as they drain quickly and do not hold a great deal of water. 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 amount. First, a sandy soil should be irrigated three times a week. Second, sandy loam soils should be irrigated twice a week. Third, clay, clay loam and loam soils should be irrigated once a week. Spider plant requires 414 mm for its growing period. Spider plant favours water throughout its growing

period and one can irrigate 6 litres of water per day for a plot size of 1 m x 1 m. Irrigation can be applied using drip and sprinkler irrigation systems.



Commercial production of Spider plant under drip irrigation

Harvesting: Individual leaves and growth tips can be harvested or the whole plant can be cut back. Cut back the shoots 10-40 cm from the ground to form new side shoots. The harvest can be repeated 2 to 4 times and even more during the season, depending on the soil fertility and moisture conditions. The harvested shoots should be kept in a bag without water during the night. Dip the shoots in water for about 30 minutes the next morning.

Pest and disease: A number of pests infest *Spider plant*. The most important are beetles and hurricane bugs (also known as bagrada or painted bugs) (*Bagrada hilaris*). The hurricane bug can render establishment virtually impossible. Other pests are: pentatomids (*Acrosternumgramineum* and *Agonoselis nubilis*) and their parasitoids; locusts (*Schistocera gregaria*); nematodes (*Meloidogyne* spp.); flea beetles (*Phyllotreta mashonana* Jacq.); green vegetable bugs (*Nezara* spp.); cabbage sawfly (*Athalia* spp.); cotton jassids (*Empoasca* spp.) and aphids that cause leaf damage.

Bagrada bugs (*Bagrada hilaris*) damage plants by feeding on young leaves. Both adults and nymphs suck sap from leaves, which may wilt and later dry. Considerable damage is caused to young plants, which may die or have the growth points severely damaged. Significant damage may also be caused to older plants. The bugs, especially in the early stages of development, gather in masses and suck the sap from plants. Feeding by the bugs causes small puncture marks visible as white patches starting on the edges of leaves. Eventually the leaves wilt and dry. Heavily attacked plants may have a scorched appearance. *Spider plant* is host to the mildew fungus (powdery mildews *Sphaerotheca fuliginea*, *Oidiopsis taurica* and *Cercospora uramensis*).

Control pests and diseases by regular monitoring of the crop. It is important to detect bagrada bug before they cause damage to the crop. Crop hygiene is very important, in particular removal of old crops and destruction of weeds. Handpicking and destruction of the bugs helps to reduce damage. This is particularly important in the early stages of the crop. Growing strong smelling plants such as garlic, onion or parsley near the crop are reported to reduce infestations. Encourage natural enemies: Eggs of Bagrada bugs are parasitized by tiny wasps. A mixture of chilli, soap, garlic and paraffin has shown to be an effective control method in trials in Namibia or spraying plants with a soapy solution (bar soap) has been found effective against Bagrada bugs. It helps to wash off young bugs.

5. Jute mallow (*Corchorus olitorius*)



Seeds: Collect seed from yellow or brown, almost mature, pods and leave to dry on a sheet in the shade. Seeds are dormant and should be sown only after 4 months. Keep properly dried seeds in a closed container to avoid damage by insects.

Soil preparation: Prepare the soil by hand or mechanically.

Fertilizer: When using chemical fertilisers, purchase 2:3:2 or 3:2:1 mixtures. Using a hoe, open a furrow and apply the fertiliser mixture at the bottom of the furrow at the rate of 40 grams per m. A normal-size teacup takes

about 200 gram 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 LAN at the rate of 20 gram per m when the plants have about 5 to 6 leaves. One teacup of LAN should be spread along a row of 10 m. When applying LAN to the growing crop, open 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 one 10 litre bucket in a band of about 20 cm wide over a length of 15 m, work the manure into the top soil, water the band thoroughly and wait one to two weeks before transplanting. When you use kraal manure, use the same procedure but apply one 10 litre bucket over a length of 5 m.

Sowing and Transplanting: Mix seed 1:10 with sand or dry soil. Sow in rows or broadcast. Thin the seedlings out (1-2 cm apart) to ensure that you have stronger seedlings. Transplant seedlings when they are about 7-10 cm tall, as older plants will not grow well.

Management: Spacing for tall varieties is 10 cm in the row by 30-50 cm between rows. Broad varieties with many side shoots require a spacing of 30 x 50 cm. Plant Jute mallow at an interval of two weeks to spread the marketing period. Plants can be topped to give stronger side shoots. Frequent watering is needed for a good leaf yield.

Water requirements: Jute mallow grows well in summer when temperature is above 27°C and performs better in well drained sandy clay loam soils, but also grows in a wide range of soils. Jute prefers to be transplanted into a wet soil (not dry) to keep the transplanted plant roots intact. Water requirement varies with crop growth stage, soil type and weather condition (hot or cold). The frequency of irrigation depends on the type of soil. Frequent irrigation will be required for sandy soils as it drains quickly and do not hold a great deal of water. 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 amount. First, a sandy soil should be irrigated three times a week. Second, sandy loam soils should be irrigated twice a week. Third, clay, clay loam and loam soils should be irrigated once a week. Jute mallow requires 448 mm of water during its growing period and can be irrigated using sprinklers and drip irrigation systems. One can irrigate 4.5 litres of water per day for a size 1 m x 1 m plot (4.5 litres per m² per day).

Harvesting: Harvest Jute mallow by picking the tops or cut young growth back at about 15 cm above the ground level. New side shoots will develop and harvesting can be repeated 3 or 4 times. More frequent and intense harvesting of leaves tends to prolong the leaf growth

phase. Jute perishes quickly after harvest, especially when left in the sun. Wrap leaves in a wet cloth, leaving plenty of room for air to circulate and keep moist. Water may be sprinkled on produce but not too often since this will stimulate rotting.

Pest and disease: Pests and diseases are rarely a big problem. Jute mallow is susceptible to red spider mites (*Tetranychus urticae*), yellow mites, leaf beetles (*Podagrica sjostedji*), sweet potato butterfly (*Acræa acerata* and *A terpsichore*) and root-knot nematode (*Meloidogyne* spp). Leaf-eating grasshoppers and armyworm (*Spodoptera* sp.) flea beetles (*Podagrica* spp.) and black beetles (*Epithrix torvi*) can cause crop losses. Major diseases include wilting by *Sclerotium rolfsii* and leaf spot by *Cercospora corchori*. Others diseases reported to occasional cause disease are black leaf spot (*Curvularia* sp.) and stem blight (*Macrophomina phaseoli*). Powdery mildew (*Erysiphe* sp.) can be more serious during the dry season.

Pests, like armyworm, can be controlled by removing weeds and plant residue to help reduce egg-laying sites. Tilling before planting helps to expose and kill overwintering larvae. Tilling also removes plant residue, which helps to discourage egg laying. Beneficial insects kill certain pests; parasitic wasps feed on armyworms, so gardeners should attract these predators with nectar-rich plantings such as yarrow or sweet alyssum. Ladybugs and lacewing insects also feed on armyworm eggs and young larvae. Handpick certain pests like cutworms, by forcing them out of their hiding place by watering the soil with a solution of a spoonful of insecticide soap and about a can full of water. Neem is an effective organic spray for certain pests.

Sanitation, that is removal of diseased material, will prevent fungal disease from spreading fast. Weekly applications of sulphur dust or spray or baking soda makes an inexpensive control for powdery mildew on plants. The baking soda fungicide is mostly effective as a preventative measure; offering only minimal benefits after your plants have become infected.

6. Cowpeas (*Vigna unguiculata*)



Seeds: Pods are harvested from healthy, disease-free plants when they have turned yellow but are not yet completely dry. The seeds will be firm, well developed, and beginning to loosen inside the pods. Dry the pods and then place in a shelter for 1-2 weeks of curing. Pods are threshed by hand, however be careful not to injure or split the seeds. Seed is further cleaned and dried after threshing. Keep properly dried seed in a closed container to avoid damage by insects.

Soil preparation: Prepare the soil by hand or mechanically.

Fertilizer: Cowpeas need nitrogen, phosphorus and potassium to grow well. Using a hoe, open a furrow and apply 40 gram of super-phosphate in the bottom of the furrow at the rate of 40 grams per m or one teacup per 5 m row. If you prefer working with chemical fertiliser mixtures, purchase 2:3:2 and also apply at the rate of 40 grams per m or one teacup per 5 m. After spreading the fertiliser evenly in the furrow, use a stick to mix the fertiliser with the soil. Water the furrow and plant directly.

When using poultry or pig manure, apply one 10 litre bucket in a band of about 20 cm wide over a length of 15 m, work the manure into the top soil, water the band thoroughly and wait one to two weeks before transplanting. When you use kraal manure, use the same procedure but apply one 10 litre bucket over a length of 5 m.

Sowing and transplanting: Preferably sow directly in the fields when the soil is wet. Choice of a good sowing date can help minimize pod rot caused by excess moisture during maturation. Plant manually using two to three seeds per hill or use a mechanical planter.

Management: The recommended spacing is 50-75 cm between rows and 50-75 cm between plants for spreading varieties. The recommended spacing for erect and semi-erect varieties are 50 cm between rows and 15-25 cm between the plants..

Water requirements: Cow pea grows in summer between October and February when the temperature is above 25°C. Cowpea seeds can be planted directly to the soil. Cowpea can grow in a wide range of soils. Water requirement varies with crop growth stage, soil type and weather condition (hot or cold). Cowpea tolerates drought, however water it regularly if it is grown as a leafy vegetable. The frequency of irrigation depends on the type of soil. Frequent irrigation will be required for sandy soils as it drains quickly and do not hold a great deal of water. 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 amount. First, a sandy soil should be irrigated three times a week. Second, sandy loam soils should be irrigated twice a week. Third, clay, clay loam and loam soils should be irrigated once a week. Cowpea needs 446 mm of water for its growing period. Irrigate up to 4 litres per day for a plot size of 1 m x1 m (4 litres per m²).



Cowpea in a commercial planting (left). Harvesting cowpea leaves in a commercial planting (right).

Harvesting: Harvesting of young tender leaves for vegetables can be done as soon as 2-3 weeks from sowing. Cowpea leaves tend to be quite coarse when old and are not always palatable. Young green pods can be harvested and prepared like green beans. The seeds are harvested when the pods started to dry but before they shatter.

Pest and Diseases: Insects attacking cowpeas are Mexican bean beetle, bean leaf beetles, cowpea curculio, aphids, green stink bug, maize stalk borer (and maybe others), and weevils (when in storage). Other important pests also include the cowpea aphid (*Aphis craccivora*), various leaf hoppers, the Egyptian leaf worm (*Spodoptera littoralis*), larvae of the African bollworm (*Heliothis armigera*) and the cowpea leaf beetle (*Oothea mutabilis*).



Cowpea leaves attacked by aphids (left) and healthy leaves (right)

Diseases reported are fusarium wilt, bacterial canker, southern stem blight, cowpea mosaic virus (and several other less prominent viruses), Cercospora leaf spot, rust and powdery mildew. The root knot nematode and damping off can also be a problem. Other diseases reported are brown blotch (*Colletotrichum capsici*), Septoria leaf spot (*Septoria vignae*), stem cancer (*Macrophomina phaseolina*) and bacterial blight (*Xanthomonas campestris*), scab (*Sphaceloma* sp.), brown rust (*Uromyces appendiculatus*) and web blight (*Rhizoctonia solani*)

Pests can be controlled by cultural practices like crop rotation (This has limited value because the adults can easily fly between fields). In big, commercial plantings, the use of specific pheromone lures, this will confuse the males and keep them from mating with the

females. Sanitation is important – get rid of infected leaves, branches etc. that might harbour eggs over winter.

Some diseases can be controlled by using disease-free seed. Hot water seed treatment at 50°C for 25-30 minutes is recommended. Strictly follow time and temperature recommendations to minimize damage to seed germination and vigour. Hot water treatment can also eliminate fungal pathogens on the seed. Chlorine treatment of seed is also effective: use one part household bleach to 4 parts water plus a half teaspoon of surfactant (liquid soap) per four litres of solution, agitate seed for one minute, then rinse in running water for 5 minutes. Dry seed thoroughly.

Spraying with a copper compound can be effective in controlling bacterial blight.

7. Bitter watermelon (*Citrillus lanatus* subsp. *lanatus*)



Seeds: The fruits should be left to fully ripen and turn colour before harvesting for seed production. Keep the fruits in a shed for a couple of weeks to allow the seed to ripen. Cut the fruit lengthwise and scrape fruit pulp out. Leave the seed and pulp in a container at room temperature for 12 days. Stir daily. Good seeds will sink to bottom while remaining debris and immature seeds can be rinsed away. Spread seeds on a paper towel or screen until dry. Properly dried seeds should be kept in a closed container to avoid damage by insects.

Soil preparation: Prepare the soil by hand

or mechanically.

Fertilizer: When using chemical fertiliser, purchase 2:3:2 or 3:2:1 mixtures. Using a hoe, open a furrow and apply the fertiliser mixture in the bottom of the furrow at the rate of 40 grams per metre. A normal-size teacup takes about 200 gram 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 to plant the seeds. For really good growth, add LAN at the rate of 20 gram per m when the plants have about 5 to 6 leaves. One teacup of LAN should be spread along a row of 10 m. When applying LAN to the growing crop, open 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 one 10 litre bucket in a band of about 20 cm wide over a length of 15 m, work the manure into the top soil, water the band thoroughly and wait one to two weeks before transplanting. When you use kraal manure, use the same procedure but apply one 10 litre bucket over a length of 5 m.

Sowing: Bitter watermelon is usually direct-seeded when all danger of frost has passed. Bitter watermelon is planted in rows 2-2.5 meter apart, with plants spaced 0.5-0.6 meter to 2 meter between plants. Pumpkins are often intercropped with maize or other taller crops.

Management: Control weeds through hand-weeding and hoeing. Bees and other insects are important for good fruit harvest.

Water requirements: Bitter watermelon grows in summer when temperature is above 27°C. Irrigate regularly to avoid water stress and have optimum growth and yield. Bitter watermelon needs plenty of water in the first two months of its growing period but later in the growing period water application can be reduced. Bitter water melon requires up to 389 mm of irrigation water during its growing period. Irrigate at least 4.5-5 litres of water per day for a plot size of 1 m x 1 m for the first two months and once the fruits set one can apply up to 2 litres of water per day for a plot size of 1 m x 1 m until harvest.



Large scale planting of bitter watermelon for fruit production

Harvesting: Tender leaves and stems can be harvested once plants are established.

Pest and Diseases: Some of the most important pests mentioned for related species of the watermelon family are aphids, blister beetles pickleworm, spider mites, spotted and striped cucumber beetle and thrips. The melon fly (*Daucus* sp.) affects young fruit, and the major pests of stored seeds are *Trilobium castaneum*.

Watermelon in general is susceptible to a wide range of diseases: *Cercospora* leaf spot (*Cercospora citrullina*), Downy mildew (*Pseudoperonospora cubensis*) and *Alternaria* leaf blight (*Alternaria cucumerina*), Viruses usually result in no necrosis (death) of leaf tissue. Pimples and ring spots (circles of darker coloration) or raised, brown, concentric rings can be caused by the tobacco ring spot virus. Symptoms of physiological diseases includes blossom end rot caused by a calcium deficiency, misshapen fruit can be caused by pollination problems or fluctuations in watering. Splitting of the fruit is caused by an excessive watering pattern. Damping off (*Marcrophomina phaseolina*) can cause serious seedling losses, while Anthracnose (*Colletotrichum*), which is seed transmissible, must be controlled.

Natural predators, such as tachnid flies, soldier beetles, parasitic nematodes, braconid wasps, lacewings and ladybugs will eat the eggs or adults of some pests. Repellent plants like broccoli, calendula, catnip, goldenrod, nasturtiums, radish, and marigolds can be planted with the crop to repel pests like the cucumber beetle. Mix a spray of 30 gram wood ashes, 30 gram hydrated lime and four litres water, sprayed on upper and lower leaf surfaces can control some pests. Alternatively a spray of hot peppers, water and garlic can be used. Neem oil can be used as a soil drench to treat eggs and larvae. It does seem to help with control of the adults as a repellent and antifeedant.

Diseases can be controlled by planting disease-free seed. Hot water seed treatment at 50°C for 25 minutes is recommended for seed. A three year crop rotation away from potato, tomato and pepper will also help. Mulching can reduce the severity of infection as well as improved air circulation amongst plants. Avoid overhead irrigation or use it such that plant wetness is minimized.

8. Pumpkin (*Cucurbita maxima*)



Seed: The fruits should be left to fully ripen and turn colour before harvesting for seed production. Keep the fruits in a shed for a couple of weeks to allow the seed to ripen. Cut the fruit lengthwise and scrape seed out. Leave the seed and pulp in a container at room temperature for 1-2 days. Stir daily. Good seeds will sink to bottom while remaining debris and immature seeds can be rinsed away. Spread seeds on a paper towel or screen until dry. Properly dried seeds should be kept in a closed container to avoid damage by insects.

Soil preparation: Prepare the soil by hand or mechanically.

Fertilizer: When using chemical fertiliser, purchase 2:3:2 or 3:2:1 mixtures. Using a hoe, open a furrow and apply the fertiliser mixture in the bottom of the furrow at the rate of 50 grams per m. A normal-size teacup takes about 200 gram chemical fertiliser and would cover 4 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 seed. For really good growth, add LAN at the rate of 20 gram per m when the plants have about 5 to 6 leaves. One teacup of LAN should be spread along a row of 10 m. When applying LAN to the growing crop, open 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 one 10 litre bucket in a band of about 20 cm wide over a length of 15 m, work the manure into the top soil, water the band thoroughly and wait one to two weeks before transplanting. When you use kraal manure, use the same procedure but apply one 10 litre bucket over a length of 5 m.

Management: Pumpkins are usually direct-seeded when all danger of frost has passed. Pumpkins are planted in rows 2-2.5 meter apart, with plants spaced 0.5-0.6 meter to 2 meter between plants. Pumpkins are often intercropped with maize. Reduce irrigations as fruits reach harvest stage. Control weeds through hand-weeding and hoeing. Bees and other insects are important for good fruit harvest.

Water requirements: Irrigate regularly to avoid water stress and have optimum growth and yield. Pumpkin needs plenty of water in the first two months of its growing period but later in the growing period water application can be reduced. The total amount of water required for its growing period is 389 mm. Irrigate at least 4.5 litres of water per day for a plot size of 1 m x 1 m for the first two months and once the fruits sets one can apply 2.5 litres of water per day for a plot size of 1 m x 1 m until harvest. Reduce the frequency and amount of irrigations before the fruits reach its harvest stage.



Large scale planting of pumpkins for leaves and fruit (left) and pumpkins intercropped with maize (right).

Harvesting: Tender leaves and stems can be harvested once plants are established. Young and tender fruits can be harvested or the fruit can be left to mature before harvesting. Fruit should be removed from vines with care to avoid damage. Fruit should be cured at room temperature to increase storability. Curing heals superficial wounds, reduces the high water-content of the fruit, and improves the eating quality.

Pest and Diseases: Major insect pests of the pumpkins includes squash bugs, cucumber beetles, squash vine borers, aphids and spider mites. Some of the major diseases of pumpkin include: Anthracnose, bacterial leaf and fruit spot, bacterial wilt (carried by the striped and spotted cucumber beetle; an effective strategy of controlling this disease is to manage the insect pest) black rot, downy mildew, powdery mildew and *Phytophthora* blight.

Control pests by good sanitation practices. Tilling your pumpkin patch or removing the plants and composting them will bury or kill many of the surviving adult pests. Trap cropping can provide some control as well. Plants that are purported to repel pests like the squash bugs to some degree are catnip, tansy, radishes, nasturtiums, marigolds, bee balm and mint. Handpicking from the underside of the leaves can be very effective.

Pests can also be controlled by the use a soap spray that strips pests like aphids of their protective wax coating and by dehydrating them. Mix 1 tablespoon of liquid soap to 4 litres of water, spray. A spray made from a tea of tomato or potato leaves and water can also be used. Neem products and plant and mineral oils can give some control. Garlic oil spray can kill aphids and other soft bodied pests.

9. Nightshade (*Solanum retroflexum*)



Seeds: Allow the black/purple berries to completely ripen on the plant before harvesting for seed. Gently squeeze out the jelly-like substance that contains the seeds from the fruit. Place the jelly and seeds into a small container and add water for fermentation. Loosely cover the container and place in a warm place (around 25-30°C) for 1-2 days. Stir every day. A layer of fungus/mould will begin to appear on the top of the mixture. This fungus eats the gelatinous coat that surrounds each seed and prevents germination and also produces antibiotics that help to control seed-borne diseases.

After fermentation, fill the seed container with water. Let the contents settle and gently pour out the water along with pieces of fruit pulp and immature seeds floating on top. Viable seeds are heavier and settle to the bottom of the container. Repeat this process until water is almost clear. Pour these clean seeds into a fine-mesh strainer/cloth bag and let the excess water drip. Place seed onto paper towel, fine mesh, or newspaper and let the seeds to dry completely in partial shade. Keep properly dried seeds in a closed container to avoid damage by insects

Soil preparation: Prepare the soil by hand or mechanically.

Fertilizer: When using chemical fertiliser, purchase 2:3:2 or 3:2:1 mixtures. Using a hoe, open a furrow and apply the fertiliser mixture in the bottom of the furrow at the rate of 40 grams per metre. A normal-size teacup takes about 200 gram 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.

Add LAN at the rate of 20 gram per metre when the plants have about 5 to 6 leaves. One teacup of LAN should be spread along a row of 10 m. When applying LAN to the growing crop, open 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. After you have harvested the plants for the first time, which you should do by cutting the stem about 5 cm above the soil surface, apply LAN again at the rate of 20 gram per m, using the same procedure as described above. Repeat the application of LAN at the rate of 20 gram per meter after the second harvest. Normally, three harvests can be obtained.

When using poultry or pig manure, apply one 10 litre bucket in a band of about 20 cm wide over a length of 15 m, work the manure into the top soil, water the band thoroughly and wait one to two weeks before transplanting. When you use kraal manure, use the same procedure but apply one 10 litre bucket over a length of 5 m. After the first harvest of the crop, you can apply poultry manure to boost growth. Open a furrow with a hoe about 10 to 15 cm away from the row of plants, apply about one 10 litre bucket per 20 m of row, mix the poultry manure with the soil using a stick, water the furrow and then close it.

Sowing: Seed can be sown in a nursery or direct in the field. Mix seed with sand and sow in rows 15-20 cm apart and 1 cm between seed, or broadcast. Cover seed with a thin layer of soil and then water. The seedbed can be mulched with grass or a similar material to retain moisture. This mulch can be removed once the plants are 3 cm high.

Transplanting: About three weeks after sowing, harden off seedlings by slightly reducing the frequency of watering. The seedlings are ready for transplant in four to six weeks when they have 4-7 true leaves (10-15 cm).

Management: Nightshade will grow in most soil types. It will also grow in partially shaded areas. Spacing of 30 cm by 30 cm is recommended. Weed whenever necessary.

Water requirements: Irrigate regularly to avoid water stress and have optimum growth and yield. The frequency of irrigation depends on the type of soil. Frequent irrigation will be required for sandy soils as they drain quickly and do not hold a great deal of water. 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 amount. First, a sandy soil should be irrigated three times a week. Second, sandy loam soils should be irrigated twice a week. Third, clay, clay loam and loam soils should be irrigated once a week. When nightshade is stressed for water the leaves become smaller size. The total amount of water needed by a nightshade is about 240 mm water. Irrigate the crop 4 litres per day for a plot size of 1 m x 1 m until first harvest. The regrowth of the crop after harvesting is usually slow and therefore can be irrigated 3 litres per day for a plot size of 1 m x 1 m in the first week of the first harvest. Once the second harvest is made the irrigation should be increased to 5 litres per day for a plot size of 1 m x 1 m (5 litres per m²).

Pest and disease: Insect damage by chewing insects is often noticed on the leaves. Ants, black aphids, caterpillars, and occasionally grasshoppers, can cause damage to the leaves. Beetles such as small black beetles (possible flea beetles), as well as *Lagria* sp., *Podagrica* sp. and *Epilachna* sp. are some of the commonly found beetles on nightshade. Early Blight (*Alternaria solani*), Grey Mould (*Cladosporium oxysporum*), Bacterial wilt (*Ralstonia solanacearum*), Leaf blight, rotting caused by *Phytophthora infestans*, powdery mildew (*Leveillula taurica*) while leaf curl virus, and yellow vein virus, the latter transmitted by the whitefly (*Bemisia tabaci*) are the major diseases found on nightshade.

Pests can be controlled by crop rotation, wood ash dusted on leaves. Onion and garlic are natural flea-beetle repellents. Teas can be made from these plants to use a spray on susceptible plants.

Early blight can be seed-borne thus use clean disease free seed. Hot water seed treatment at 50°C for 25 minutes is recommended to control early blight on tomato (related to nightshade) seed. Crop rotations with at least three years of non-host plants (away from susceptible plants like tomato, potato and eggplant) will also control some diseases. Provide optimum growing conditions and fertility. Stressed plants (including drought) are more susceptible to diseases like early blight.

10. Chinese cabbage (non-heading) (*Brassica rapa* L. subsp. *chinensis*)



Seeds: *Brassica* seed shatters easily. Harvest carefully when 60-70% of the pods have turned yellow/brown and most of their inner seeds are light brown and firm. Harvested seed stalks are cured for 1-2 weeks if desired. Pods are then threshed with sticks and sifted by hand. Seed is brittle and should not be crushed when handled. Seed is dried in partial sun, then cleaned and stored. Keep properly dried seeds in a closed container to avoid damage by insects.

Soil preparation: Prepare the soil by hand or mechanically.

Fertilizer: When using chemical fertilisers, purchase 2:3:2 or 3:2:1 mixtures. Using a hoe, open a furrow and apply the fertiliser mixture in the bottom of the furrow at the rate of 50 grams per m. A normal-size teacup takes about 200 gram chemical fertiliser and would cover 4 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. Add LAN at the rate of 20 gram per metre when the plants have about 5 leaves. One teacup of LAN should be spread along a row of 10 m. When applying LAN to the growing crop, open 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. Repeat the same application of LAN about one week later when the plant has eight leaves. At that stage the 5th leaf can be harvested. Harvest subsequent leaves as the plant grows and harvest all leaves as soon as the flower stalk starts to elongate.

When using poultry or pig manure, apply one 10 litre bucket in a band of about 20 cm wide over a length of 15 m, work the manure into the top soil, water the band thoroughly and wait one to two weeks before transplanting. When you use kraal manure, use the same procedure but apply one 10 litre bucket over a length of 5 m.

Sowing: Sow in seedbeds, in rows spaced 15-20 cm apart. Sow seeds 1-2 cm apart within the row. Closer spacing can lead to damping off disease.

Transplant: Transplant when seedlings are 15 cm tall, or sow direct and thin at 5 weeks after germination.

Management: Space plants 35-50 cm in the row, with 50-75 cm between rows. Weed when necessary.

Water requirements: Water Chinese cabbage frequently for good yields. Plants suffering from drought will begin to flower and will stop producing leaves. Chinese cabbage is a cool season vegetable and grows during winter season (May-August); however it needs plenty of water throughout its growth period. Chinese cabbage requires about 190 mm of water during its growing period. The frequency of irrigation depends on the type of soil. Frequent irrigation will be required for sandy soils as they drain quickly and do not hold sufficient water. 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 amount. First, a sandy soil should be irrigated three times a week. Second, sandy loam soils should be irrigated twice a week. Third, clay, clay loam and loam soils should be irrigated once a week. For good quality leaf harvests irrigate 5 litres of water per day for a plot size of 1 m x 1 m right through the growing period..



Chinese cabbage grown under drip irrigation

Harvesting: Harvest leaves once plants are established. Keep harvested leaves cool. Lengthen storage life of leaves by sprinkling some water on the leaves. Avoid using too much watering since this will encourage rot.

Pest and disease: Aphid, root maggot and flea beetles are the most injurious insect pests in the cabbage family. The Brassicaceae family is susceptible to various diseases. Clubroot (*Plasmodiophora brassicae*), TuMV virus and soft rot are the most serious diseases. Other fungi reported to attack Brassicaceae include: *Albugo candida*, *Alternaria brassicae*, *Fusarium oxysporum*, *Pythium ultimum*, *Rhizoctonia* sp., *Sclerotinia sclerotiorum*, and *Streptomyces scabies*. The following bacteria can cause disease: *Agrobacterium tumefaciens* and *Erwinia carotovora*,

Control pests by removing weeds or plough under at least two weeks before you plant a new spring crop of vegetables if your garden area is weedy. Also keep the garden clean and remove affected plants and destroy them.

Diseases can be controlled by using clean seed. Remove all infected plants and destroy them, or plough them in. Remove all weeds, especially cruciferous weeds, as they can be a source of the pathogen and practice three year crop rotation with non-cruciferous plants to reduce the disease.

11. Picture pamphlet on Growing amaranth



**LET'S GROW
AMARANTHUS**

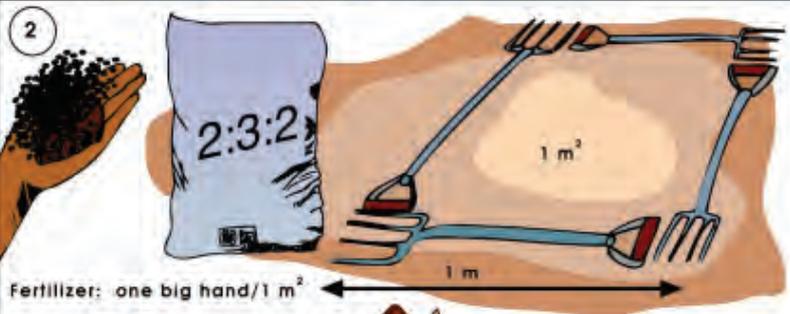
	J	F	M	A	M	J	J	A	S	O	N	D
SOW									x	x	x	
TRANSPLANT									x	x		
HARVEST	x	x	x								x	x

Cultivars to use: Contact the ARC-Roodeplaat Vegetable and Ornamental Plant Institute, Pretoria

1 Soil preparation: deep work soil with fork



2 Fertilizer: one big hand/1 m²



or

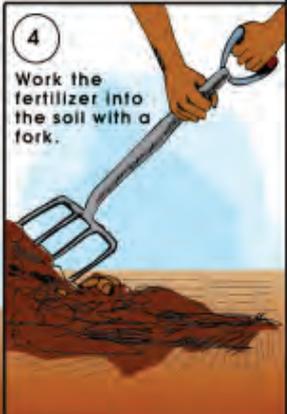
Kraal manure: four big hands full/1 m²



3 Apply fertilizer broadly over the area.



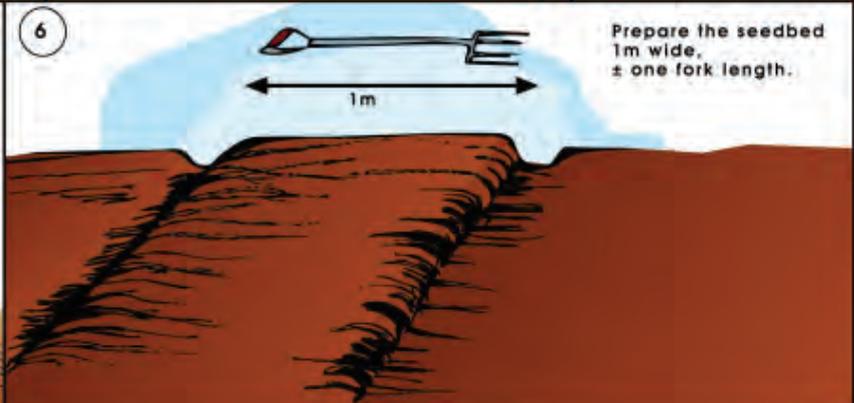
4 Work the fertilizer into the soil with a fork.



5 Rake fine, remove large clods and stones



6 Prepare the seedbed 1m wide, ± one fork length.



Brought to you by ARC-Roodeplaat

7 Space the seedlings 20cm apart (\pm two hand widths), in rows. Space the rows as indicated.

20cm 20cm 20cm 20cm

8 Water regularly

- : First week - twice a day
- : Week two - once a day
- : Week three and on - three times a week.

9 Cut plants at 30cm every 10 days.

10 Apply top dressing after every harvest (i.e. LAN). Work the top dressing lightly into the soil.

11 Scout for insects. Combat pests that damage crops.

12 Remove all the weeds, this will ensure a good crop - no competition for the crop.

13 Spray with organic remedies once pests are noticed. Use crop rotation, but avoid tomatoes. Burn diseased plants.

14 Harvest: pick big leaves weekly.

12. Guide to the common names of African Leafy Vegetables

Language	<i>Amaranthus spp.</i>	<i>Cleome gynandra</i>	<i>Corchorus olitorius</i>	<i>Vigna unguiculata</i>	<i>Citrullus uanatus subsp. lanatus</i>	<i>Cucurbita maxima</i>	<i>Solanum retroflexum</i>	<i>Brassica rapa subsp. chinensis</i>
Afrikaans	Misbredie, Hanekam, Kalkoenslurp, Varkbossie	Oorpeultjie, Palmbossie, Vingerblaartee	Jute, Wilde Jute	Akkerboontjie, Koertjie	Bitterwaatlemoen, Karkoer, Maketaan	Pampoen	Nastergal, Galbessie, Nagskade	Mosterd
English	Pigweed, Cockscorn, Hell's Curse	Spider Flower, Spider Plant, Cats Whiskers, African Cabbage	Jew's Mallow, Jute	Cowpea	Tsamma, Tsamma Melon, Wild Watermelon, Bitter Melon	Pumpkin	Nightshade, Houndsberry, Stubbleberry, Pretty Morel	Rape, Chinese Cabbage
Isindebele		Lude, Ulude, Ulube		Dinawa	Ibotola	Ibobola	Ixabaxaba	
Isixhosa	Unomdlomboyi, Imbuya, Umifino Umtyuthu			limbotyi	Umxoxozi, Ujodo, Ityabontyi	Fruit; Thanga, Cetshana Leaves And Young Fruit: Imithwane	Umsobo, Sheshoa-Bohloko, Umsobo-Sobo	
Isizulu	Imbuya, Isheke, Indwabaza			Imbumba, Indumba, Isihlumanya	Ihbece, Ikhabe	Intanga, Umilba	Umsobo, Isihlalakude, Udoye, Umagqa, Umgwaba, Umsobo-Sobo (Fruit),	

Language	<i>Amaranthus spp.</i>	<i>Cleome gynandra</i>	<i>Corchorus olitorius</i>	<i>Vigna unguiculata</i>	<i>Citrillus uanatus subsp. lanatus</i>	<i>Cucurbita maxima</i>	<i>Solanum retroflexum</i>	<i>Brassica rapa subsp. chinensis</i>
Northern Sotho	Thepe, Theepe			Monawa	Mogapu, Habu, Lethikithi, Lehlikihli, Mathikithi, Lerotse, Matyathya, Matikitiki, Motshatsha, Mochacha	Mphodi, Monyaku, Motshatsha, Mophotse	Lethotho	
Sesotho	Thepe	Lerotho	Thelele, Ligusha	Monawa, Dinawa, Nawa	Lehapu, Makakabane, Tjoto, Thoomo	Mekopu, Maphutse/Lepho tse	Seshoa-Bohloko, Sehloabohloko, Momoli	
Setswana	Imbuya, Thepe			Dinawa, Nawa-Ea-Setswana	Makataan, Kgengwe, Lekatane, Makopuntji	Mekopu, Maphutse/Lepho tse		
Siswati	Umbuya, Isheke						Msobo, Umsobo	
Tshivenda	Vowa, Theebe	Murudi	Delele	Munawa (Plant), Nawa (Beans)	Brani, Gwadi	Phuri, Thanga	Muxe	Mutshaini, Murodishia, Larhodisa
Xitsonga	Theyke, Cheke	Rirhudzu, Bangala	Guxe, Ligushe	Dinaba, Munaoa, Tinyawa		Tinwembe	Kophe	
Other	Mohwa (Shona), Imbuya, Tyutu	Nyere, Tsuna	Guxe, Ligushe	Murowi We	T'samma (Khoisan),	Bowara, Majoda, Manhanga,	Musaka (Shona)	

Language	<i>Amaranthus</i> <i>spp.</i>	<i>Cleome</i> <i>gynandra</i>	<i>Corchorus</i> <i>olitorius</i>	<i>Vigna</i> <i>unguiculata</i>	<i>Citrillus</i> <i>uanatus</i> subsp. <i>lanatus</i>	<i>Cucurbita</i> <i>maxima</i>	<i>Solanum</i> <i>retroflexum</i>	<i>Brassica rapa</i> subsp. <i>chinensis</i>
	(Pondo)	(Shona)	(Sjangaan)	Nyemba (Shona)	Bawora, Majoda, Manwiwi (Shona)	Muborora (Shona)		