HORTICULTURAL PRODUCTION MANUAL

BULB ONION PRODUCTION

FEBRUARY 2008

MELAKU TEDLA

This publication was made possible by the assistance provided by the Commerce, Environment, and Agriculture Office of the United States Agency for International Development (USAID). It was prepared by Fintrac Inc. under IQC #EDH-I-00-05-0007-00, Task Order 01 (663-T-06-001). The opinions expressed here are those of the authors and do not necessarily reflect the opinions of the United States Agency for International Development or the Government of the United States.

Please note: The use of company, pesticide names and brand names in this publication is for reference only and does't imply any support or preference given to the product mentioned or a criticism to other products correctly labeled that are not mentioned. Please refer to the labels of pesticide products for information on restrictions, personal protective equipment, re-entry, days of harvest and other instructions for their application. While the manual follows the guidelines found in this project’s PERSUAP, it is recommended that you seek up-to-date information on any changes to pesticide regulations and legislation, which may have affected pesticide use, registration, and restrictions (such as MRLs).

USAID-ATEP promotes the use of Integrated Pest Management and good agricultural practices. Please refer to other technical publications and the project's PERSUAP for further guidance.
Content

1. INTRODUCTION .......................................................................................................................... 1
2. VARIETIES ...................................................................................................................................... 1
3. SOIL & CLIMATE .......................................................................................................................... 2
4. PLANTING METHODS .................................................................................................................. 2
5. NURSERY PREPARATION ............................................................................................................ 2
6. FIELD PREPARATION & PLANT SPACING .................................................................................. 3
7. TRANSPLANTING .......................................................................................................................... 6
8. IRRIGATION ................................................................................................................................... 7
9. PLANT NUTRITION ...................................................................................................................... 7
10. WEED CONTROL .......................................................................................................................... 8
11. DISEASE MANAGEMENT ............................................................................................................ 8
    11.1 Purple blotch (Alternaria porri) .............................................................................................. 8
    11.2 Downy mildew (Peronospora destructor) ................................................................................. 9
    11.3 Botrytis leaf blight (Botrytis spp.) ....................................................................................... 9
12. PEST MANAGEMENT .................................................................................................................. 10
    12.1 Thrips (Thrips tabaci) ............................................................................................................. 10
13. HARVEST .................................................................................................................................... 11
1. INTRODUCTION

Onion (*Allium cepa*) is a popular vegetable grown all over the world. The subterranean bulb is composed of concentric, fleshy, enlarged, leaf bases or scales. The onion root system is fibrous, spreading just beneath the soil surface to a depth of 30 – 60 cm. There are few lateral roots and this allows onions to tolerate crowding.

At a certain point during plant development, bulb formation begins and the plant begins to direct nutrients to the developing bulb for storage. High onion bulb yields depend on healthy, vigorous plants. The point at which the plant starts bulbing depends on day length and temperature. Onion varieties are categorized by the amount of day length they require to initiate bulbing:

- **Short day types**: day length of 12 hours and below triggers bulbing. These varieties produce mild, soft fleshted onions that cannot be stored for a long time.
- **Intermediate day types**: 12 - 13 hour day length required to trigger bulbing.
- **Long day types**: day length of at least 14½ hours required to trigger bulbing. These varieties are very pungent; firm flesh and have good storage.

It is important to choose the right variety. If a long-day onion variety is planted at a time of year when the days are short, the plants may fail to produce bulbs. If, on the other hand, a short-day onion variety is chosen and planted during days with many hours of sunshine, the plant may start producing a bulb before the roots and foliage have fully developed. This leads to smaller onions and lower yields. In all varieties, bulbing is accelerated with increasing temperature. Temperature extremes not only affect rate of bulbing but also bulb shape. Thick and elongated necks are common when temperature goes below 6°C.

2. VARIETIES

At one time all onion varieties were open pollinated. There are still many open pollinated varieties offered by seed companies but the discovery of male sterility led to a rapid adoption of F1 hybrids. Hybrids have high yields, and produce larger, more uniform bulbs compared to open pollinated ones.
In addition to day length, bulb color, bulb shape and resistance/tolerance to diseases are all characteristics that need to be taken into consideration when choosing a variety. Market requirements, time of year and the farmer’s personal experience will determine which variety is eventually chosen.

3. **SOIL & CLIMATE**

Onions can be grown on any fertile soil that is well drained and non-crusting. The optimum pH range regardless of soil type, ranges from 6 – 6.8, although more alkaline soils are also suitable.

Onion is a cool season biennial and is tolerant of frost. Cooler temperatures are preferred, because they allow the plant to develop a mature foliage and extensive root system before bulbing. High temperatures favor bulbing and curing. Optimum temperatures for plant growth are between 13 & 24 °C. Range for seedling growth is narrow 20 – 25 °C.

4. **PLANTING METHODS**

Three ways of planting systems may be used:-

1. Direct planting: - is preferred where the season is very long and provides early prebulbing growth.
2. Transplants: - normally have 3-5 well formed leaves at time of transplanting. Transplanted leaves are pruned prior to transplant or field setting, thereby facilitating handling and increasing plant hardiness. Seedlings can be produced in trays in covered nurseries (see photo) or can be produced in field nurseries.
3. Sets are used in some areas to ensure large bulb size and uniformity. Sets are small dry bulbs grown the previous season with size of 12 mm in diameter.

5. **NURSERY PREPARATION**

When selecting a site for a nursery there are some important factors to consider. Ideally, the site should be on flat, accessible land that is free of shade; there should be easy access to water, good drainage and the soil should be loose and rich in nutrients and organic matter. The nursery site must be plowed and harrowed one month before planting, to clear weeds and prepare the soil. Beds are formed to a height of 30 cm, with a width of 1 meter leaving a pathway of 50-80 cm.
Before sowing, the soil should be watered. Seeds are sown 16-18 mm deep on heavy soils and deeper in sandy soils. The seeds should be sown on the top of the bed and then covered with an extra layer of soil until the seeds are at the required depth. Care has to be taken not to bury the seeds too deep as this will affect the uniform and timely emergence of the seedlings. After planting the seeds, the nursery has to be watered with a watering can and then covered with a dry mulch or black plastic to accelerate germination. The beds should be checked for germination after the first few days. At the first signs of seedling emergence, the shade (dry mulch or plastic) should be removed. If the seedlings are in shade too long, they begin to stretch making them vulnerable to damage. The seedlings should be watered twice daily as needed.

Water management is important and the nursery soil should never be too wet or too dry. One week before transplanting, reduce water in order to harden the plants.

6. FIELD PREPARATION & PLANT SPACING

Prior to planting, the field should be plowed to a sufficient depth (at least 20 cm) & then harrowed to eliminate plant debris & soil clods. This should be done around 45 days before harvest. Weed control is very important in onion production and early field preparation helps this task.

Further field preparation will depend on what irrigation system is used and whether raised beds are prepared. These considerations will affect plant density and final yields. Fields that are furrow irrigated can either be ridged with a spacing of 30 cm between the ridges (as in the photo to the right) or can be prepared into sunken beds, that are divided into 1 meter wide and 5 meters long sections (see photo below). If bulb onions are being produced, there should be a spacing of 7.5 cm between plants. For pickling onions, there should be a space of 2.5 cm between plants.
Furrow-irrigated beds of onion

If drip irrigation is available, the use of raised beds is recommended. Beds have a number of agronomic advantages:

- Good drainage - onions are easily damaged by water logging
- Good aeration (roots need oxygen – plants absorb 90% of their oxygen through the roots)
- Good soil structure to allow proper root growth and development
- Cultural practices such as weeding, scouting, application of pesticides and harvest are all easier
- People are forced to walk in the rows and not on the beds, avoiding soil compaction

The recommended density for onion production under drip irrigation is from 200,000 plants per hectare to 500,000 plants per hectare. The final density will depend on what size of the bulb the market requires. The consumer may prefer a medium (50 mm), large (76 mm) or extra large (95+ mm) sized onion.

Generally, the beds are 1m wide, with 50cm between beds. The exact plant population will depend on the number of rows of plants per bed and distance between each plant. The number of rows of plants on the beds will affect the number of drip lines required. The following table gives plant densities for different number of plant rows and plant spacing arrangements.

### Number of plants per hectare based on number of plant rows/bed and plant spacing

<table>
<thead>
<tr>
<th>No. plant rows/bed</th>
<th>Plant spacing</th>
<th>No. of drip lines</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(8 cm)</td>
<td>(10 cm)</td>
</tr>
<tr>
<td>4</td>
<td>333,333</td>
<td>266,667</td>
</tr>
<tr>
<td>5</td>
<td>416,669</td>
<td>333,333</td>
</tr>
<tr>
<td>6</td>
<td>500,002</td>
<td>400,002</td>
</tr>
</tbody>
</table>
The planting arrangement of 5 rows of plants with 2 drip lines is not ideal because the row in the center always produces bulbs a little smaller than those in the other rows. Even so, this arrangement does give a 20-25% yield improvement over the 4 rows of plants with 2 drip lines and so may be worth the slightly higher cost in seedlings and labor for transplanting the extra row. To maximize yields, the ideal arrangement is 6 rows of plants with 3 drip lines. To accomplish this, a slight modification to the 2 drip line system is needed. To guarantee proper planting densities, rigid frames with fixed planting spaces can be used to make the planting holes.
7. TRANSPLANTING

Transplant seedlings when they have 3-5 well-formed leaves. Depending on temperatures this can be from 50-80 days from the sowing of seeds. Water the land before transplanting and transplant early in the morning or late afternoon to avoid plant heat stress.

Classify the seedlings by size as they are removed from the nursery (small, medium & large). Throw out diseased or damaged seedlings. Plant the same-sized seedlings together. If this is done, you will find that there will be little difference in bulb size at harvest - the small onions will develop normally due to the lack of competition from larger plants. When removing seedlings from the nursery, only take out enough plants for that day’s planting. Never leave seedlings to be planted for the next day.

Seedlings are delicate and so large quantities should not be carried around by hand as they may be squeezed and damaged during transplant. It is best to leave them in the field crate or box that they came in from the nursery. Planting depth is important and care should be taken to not plant the seedlings too deep (where the white portion is completely covered). If the part that goes on to form the bulb is completely covered by soil, the bulb may become deformed. It is also important to ensure that no air pockets remain after transplant.

One way to prevent air pockets is to use a starter solution. This is made by dissolving 10kg of DAP in 200 liters of water. A cup of this solution is added to each planting hole at transplant. This ensures that a good seal is made between the surrounding soil and the transplant.
8. **IRRIGATION**

Onions require a well managed irrigation program. The planting area should be well watered before transplant. After transplant, access to water should be curtailed for a few days until the plants show signs of wilting in the middle of the day (takes between 3-12 days). A lack of water stimulates root growth, which results in the development of an extensive root system. For the rest of the growing period, onions need a steady supply of water. Plants feed by absorbing nutrients dissolved in the soil water. If water is scarce, plants will not reach their full potential because of a lack of water AND nutrients. If there is insufficient watering during bulb formation, there is the risk of low yields, splitting and forced maturity. Overwatering should also be avoided because this will result in the loss of nutrients from the rooting zone.

9. **PLANT NUTRITION**

Onions respond well to organic matter, which helps obtain high bulb yields. Soils differ widely in their nutritional status. Fertilizer needs will depend on production history, soil type and analyses results. A general fertilizer recommendation for onions is 160kg of N, 90kg of P and 40kg of K per hectare.

Fertilizer is applied either as a broadcast treatment or is incorporated at a depth of 5-10cm for the base application. One or two side dressings of N are applied during the season. Nitrogen (N) rates are important for proper plant growth. Insufficient N will induce early maturity and reduce bulb size, whereas high N will cause large necks and soft bulbs with low storage quality.

### General fertilizer recommendation

<table>
<thead>
<tr>
<th>Fertilizer</th>
<th>Base</th>
<th>1st side dress</th>
<th>2nd side dress</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>80</td>
<td>40</td>
<td>40</td>
<td>160</td>
</tr>
<tr>
<td>P</td>
<td>90</td>
<td></td>
<td></td>
<td>90</td>
</tr>
<tr>
<td>K</td>
<td>40</td>
<td></td>
<td></td>
<td>40</td>
</tr>
</tbody>
</table>
If a drip system has been installed, it can be used to deliver the necessary plant nutrients. This is called ‘fertigation’. Fertigation is the most efficient way of fertilizing a crop because the crop gets the right quantity and mix of nutrients for all stages of its growth. It also cuts down on the amount of nutrients lost to leaching and the negative impact on the environment that this can cause.

10. WEED CONTROL
Onions have shallow root systems, are slow growing and provide little shade to out-compete weed species. Weed control is a very important cultural task in onion production. Mechanical weed control should avoid damaging the onion roots and so shallow cultivation (2-5 cm deep) should be practiced. Depending on weed pressure, weeding may be required several times during the cropping cycle. At present, there are no registered herbicides for onion production.

11. DISEASE MANAGEMENT

11.1 Purple blotch (*Alternaria porri*)
Purple blotch is a fungal disease that is one of the most serious diseases of onion in the world. Early infection causes white, sunken lesions in the leaves that enlarge to form an elongated target-like spot with a yellow halo and a purplish center. Under humid conditions, the middle of the lesion can be black or coffee colored, caused by the fungal spores. Older leaves are most affected, but all parts of the plant can be infected. Late infection of the bulbs can occur via neck wounds. Humid conditions and optimum temperatures (21-30°C) favors this disease’s development.

The fungus is transmitted from old crop debris and seeds. It is disseminated by splashing water and wind. It is also important to note that thrips damage greatly enhances the disease’s ability to infect the plant. For this reason, control of thrips should be an important part of purple blotch management. Lowering density of transplanted crops will reduce infection (better ventilation) as will application of high potassium fertilizer. Routine field sprays with dithiocarbamate fungicides such as mancozeb will be effective, although it is critical to treat the disease at the early stages of infection – this requires a good scouting program. Fields should be scouted twice a week and sprayed at the first sign of infection.
11.2 **Downy mildew (Peronospora destructor)**

This fungal disease normally develops under cool, humid conditions, with the symptoms appearing in the older leaves. The infected leaves are covered by masses of fungal spores, which turn the leaves a grey to purple color (not to be confused with purple blotch disease). The dead leaf tip is a characteristic symptom of this disease. Eventually the lesions work their way down and cover all the leaf, which then collapses and dies.

Initial infection comes from old field residues where spores are carried long distances on the wind. Spores remain viable for 4 days and germinate in free water, which can be provided by rain or morning dew.

For effective control a good field sanitation program prior to planting is required. Fields should be scouted twice a week. Young plants can be treated preventatively with mancozeb (weekly sprays) until bulb formation starts.

![Downy mildew damage and a close up of lesions with spores.](image)

11.3 **Botrytis leaf blight (Botrytis spp.)**

Botrytis leaf blight is caused by a fungal pathogen that is most prevalent when the plant is stressed. Insect damage helps the infection process. The disease first appears as white, sunken specks on leaves expanding to cause die back from the tip of the leaves. The specks are small (no more than 6 mm in length) and oval. Tops may be killed completely within a week and entire field may be affected.

The disease is spread from infected plants, especially bulbs and so good field sanitation and removal of old crops and volunteer plants is critical. The disease can also survive in the soil, which is why rotation with three years between allium crops, is another useful cultural control technique. Scouting twice a week is important and chemical control can be achieved by treating with mancozeb at interval of 7 days. In an IPM program, spraying can be held back until a threshold of one speck per leaf is found.
12. PEST MANAGEMENT

12.1 Thrips (*Thrips tabaci*)

Thrips are tiny insects that damage the epidermis of stems and leaves to feed on the plant sap. This results in small, white/silvery marks on the leaves. The marks can cover large areas of the leaf, cutting down the plant’s ability to photosynthesize. The plant can also become water stressed due to the loss of fluids from thrip feeding. The damage done to the plant also gives easy entrance for diseases. Severe infestations result in collapse of plant and large reductions in yields. Infestation levels are most severe during hot, dry periods.

The thrips’ life cycle can be from 15 to 30 days depending on temperature. Nymphs are a clear yellow color and they hide within the leaves, often in the leaf axils. Adults are slightly bigger (2mm), are a darker color and have wings. They are found in the leaves with the nymphs but can also be found in flowers. These insects have a wide host range, and so will also be found in surrounding weeds. Adult females can produce 80 eggs.

Scouting is an important part of the control program and sticky traps are a good way of monitoring thrips populations. The adults are attracted to yellow or blue surfaces. It is also very important to control weeds both inside and out the crop, especially if weeds are flowering. Insecticides such as Diazinon can be used to control this pest. During dry conditions, they can be sprayed on a 7-10 day rotation. Up to 6 applications of insecticides may be needed.
The key with all insecticide applications is that the pesticide reaches the bottom of the leaves where the thrips are hiding. Often farmers use too little water because they feel that onion doesn’t have many leaves or much surface area. Where a farmer may be happy applying 200-400 liters of water per hectare, the volume of water actually needed, is closer 1,000 liters/hectare, especially when the plant is more mature. It is also important to spray during the cool of the day, when the thrips leave their hiding places at the bottom of the plant and are more active.

13. HARVEST

Onions are ready for harvest when leaves start to dry out and collapse. Bulbs must cured before being harvested. Under dry conditions, bulbs may be left in the field to cure.

Onions are dried and cured for the following reasons:
1. The necks of the bulbs are closed off to prevent water loss. This stops the entry of fungi and bacteria, which normally enter the bulb when the neck is not yet dry.
2. The outer layers that cover the bulb dry out, which gives good protection against internal dehydration and external damage.
3. The dried, external layers give a better color to the onion.

Onion harvesting can be divided between the dry season and the rainy season. In the dry season, temperatures are high, relative humidity is low and there is little chance of hard, frequent rains. This is the best time to harvest onion. When 30-70% of the plants have doubled over, irrigation should be stopped and a barrel passed over the plants to accelerate the drying process. Two days after this, the onion plants can be pulled out of the soil and placed in rows where the foliage of adjacent rows is protecting the onion bulbs. This is done so that the sun does not burn the bulbs. The bulbs should be left until the neck is dried (5-10 days). It is better to dry the bulbs with the foliage attached. In some cases, farmers chose to not use the barrel and selectively harvest only those onion plants where the leaves have doubled over. The harvested onions are dried in an adjacent field. Doing it this way is more work but yields can be increased.

Onion plants ready to harvest

Using a barrel to speed up drying process
In wet conditions, harvesting is made complicated by the threat of disease. The plants are harvested at the same time as before (30-70% of the plants doubled over) but they are kept in the ground for a shorter period after use of the barrel. When the onions are pulled out of the ground, they are dried under cover.