We Effect was created by the Swedish Cooperative Movement in 1958. It is an international NGO with its HQ in Stockholm Sweden. Its development cooperation is founded on the principle of help for self-help and thrives towards the vision of a world free from poverty and injustice. We Effect works with partners of mostly member based organizations to ensure members empower themselves with knowledge and skills to alleviate poverty and injustice. We Effect works in various countries globally with Regional offices in Southern Africa, East Africa, Latin America, Asia and Eastern Europe and Sweden, it works in the sectors of sustainable rural development, habitat and rural finance.

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Study Circle Material

Vegetable Production and Marketing for Smallholder Farmers in Zimbabwe

A study guide to help farmers increase production and generate more income from their vegetable enterprise

WE EFFECT

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Equality First Programme – Civil Society Programme for Sustainable Development (CSPSD)

The Equality First Programme – Civil Society Programme for Sustainable Development (CSPSD) is a 3 year programme that seeks to contribute to reduction in poverty and injustice in Zimbabwe. The programme objective is to empower women, men and youths with equal rights and opportunities actively participating in inclusive development processes to sustainably improve their livelihoods in targeted communities of Zimbabwe. The programme is funded by Sida and being implemented by We Effect through the following partner organisations: Zimbabwe Farmers Union (ZFU); Zimbabwe Association of Dairy Farmers (ZADF); Women and Land in Zimbabwe (WLZ); Women and Law in Southern Africa (WLSA); and Southern Africa Confederation of Agricultural Unions (SACAU).

Disclaimer

The views expressed in this information product are those of the authors and do not necessarily reflect the views of or policies of Sida, We Effect or any of the CSPSD partners whose logos are displayed below:

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This study circle material: **Vegetable Production and Marketing for Smallholder Farmers in Zimbabwe** is compiled by We Effect to improve crop productivity in Zimbabwe. The material is part of a programme to enable men and women living in poverty to improve their living conditions, defend their rights and contribute to a just society under the Equality First Programme – Civil Society Programme for Sustainable Development (CSPSD) funded by Sida. The material addresses all aspects of Vegetable production and marketing. Farmers can use the material as part of the study circle methodology where small groups of 7-16 adults or youths meet regularly and carry out planned studies under the leadership of an accepted leader. The material is built around the participants' search for knowledge according to their own needs and interests. The participants want to learn about a topic to help them solve problems affecting their daily lives.

This study circle material is aimed at increasing farmer groups' access to production and marketing information and knowledge in a participatory manner. Special thanks go to Sida who funded the development and printing of this study circle material. This study material has been improved from earlier versions and if you have any suggestions to improve it please contact the undersigned.

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Göran Forssen
Zimbabwe Country Representative
Regional Office for Southern Africa

How to use this study circle material

This guide is divided into 11 sessions. Each session begins with the learning objectives. There is an introduction, and content topics. At the end of each session there is a summary of the main topics covered in the session

Instructions for the study circle leader are given in blue. Discussions are for the whole group to answer questions. Self-reflection is for individual group members to think about questions. There are also exercises when the whole group has to do an activity together. At the end of some of the sessions suggestions for homework are given. There is a glossary at the end of the guide to define technical terms used in the book

Table of Contents

SESSION 1: Introduction to study circles

1.1 Introduction

Greet each other and review the learning objectives for this session

Learning objectives

By the end of this session, you will be able to explain:

- What a study circle is;
- Why and how adults learn;
- The use of study circles;
- The need for a study circle leader;
- The role of your study circle leader and your role as participants.

1.2 What is a study circle?

Talk about what a study circle is. Then read the following …

A study circle is a group of 8-16 people who meet regularly to learn about a topic together. During the meetings, group members share ideas, and learn new things to improve their skills and knowledge. At the meetings, everyone in the group is encouraged to participate on an equal basis. The group meets once or twice per week for 8-16 weeks, to study a selected topic for about two hours.

Study circle guidelines

All group member (participants) wish to learn more about a subject to improve their own daily lives;

- All participants are equal and have respect for one another;
- Participants sit in a circle, facing each other to promote effective communication,
- Discussions are encouraged to share and analyse individual experiences;
- Study materials are used to provide information that is relevant to the participants;
- Participants are involved in planning and implementation of their work;
- A study plan is developed to guide the participant to achieve their study objectives.

Answer the following questions

- Why did you join this study circle?
- How do you, as an adult, want to learn?
- Talk about how adult learning is different from the way children learn.

Then read the following…

1.3 How do adults learn?

Unlike children, adults learn because they want to and their learning has a purpose. For instance, they might want to find out how to improve their livestock production in order to get more milk or they may want to find out how to attract more customers to their shops.

Adults learn best when:

- the content is useful and relevant to their lives;
- they are respected and appreciated for what they already know and not proved wrong in front of others;
- they can choose what to learn at their own pace, at a convenient time and place;
- they are given an opportunity to share their knowledge and experiences;
- topics are practical and they can practice what they learn;
- they learn from their peers through exchange visits.

Think about what advice have you recently sought from a neighbour that proved to be very useful? Share your thoughts with the group

1.4 Choosing a study circle leader

In order to start a study circle, the participants need to elect a leader. The leader should be reliable and must have leadership qualities. The study circle leader should be trained in how to facilitate a study circle session. The leader requires continuous support during study circle work. The study circle leader must be able to:

- Bring people together and motivate them to learn;
- Help set goals for each session; and
- Help other participants achieve their learning goals.

What are the important qualities for a study circle leader? You can include the following…

- A good study circle leader can:
- encourage the inclusion of members from different backgrounds;
- be honest and open;
- be equal (not superior) to other participants;
- control their temper and be tolerant;
- remain friendly and diffuse any disagreements within the group;
- encourage all participants and open-up discussions;
- encourage participants to share their ideas;
- listen to others (ask questions and avoid lecturing others);
- prepare, study ahead and be familiar with the study material;
- summarise discussions or key lessons;
- be approachable and be interested in other group members.

Talk about the roles and responsibilities of a study circle leader? You can include the following…

A study circle leader should be able to:

- motivate and encourage the participants to actively look for knowledge;
- work in cooperation with the fellow participants;
- put the participants' own development in focus and ask stimulating questions.
- develop dialogue between the participants and encourage them to ask questions and come up with solutions;
- develop team spirit so that the participants feel secure;
- strengthen the participants' self-confidence;
- enable participants to arrive at common decisions and apply what they have learnt in every day situations;
- make different options clear and act as a guide;
- encourage cooperation among the participants and discourage competition;
- be a resource person in organising the studies but not an expert in the subject;
- guide members in discussing the questions and ensure that answers are put down.

Exercise

Now elect your study circle leader.

1.5 Role of participants

The study circle participants also have roles and responsibilities.
Discussion
Talk about the roles of the participants in the study circle. Then read the following…

Study circle participants help each other to search for knowledge and cooperate on how to solve problems together. All participants must use their knowledge and experience to benefit others in the group. Once a participant has put forward an idea, it becomes a group idea. This improves group knowledge and allows each member to contribute. All study circle participants should encourage cooperation and discourage competition. The participants should share the responsibility for the success or failure of the study circle.
Work in a study circle is made up of:

- The study material;
- The skill of the study circle leader;
- Knowledge and experiences of the members.

1.6 Making the study learning plan

The next step in setting up your study circle is to develop a study circle plan.
Discussion

- Discuss and agree on the following…
- What topic will we study?
- Where shall we meet?
- How often and for how long shall we meet?
- What day and time?
- Responsibilities - who shall do what in our group?
- Who could provide extra guidance if we get stuck and for which topics or session will we need an external resource person?
- Assessment - how shall we test our understanding and whether we have met our study objectives?
- Where can we find more information on our study topic?

What is a study plan?

The success of the study circle will depend on good planning and preparation in order to achieve goals in an effective manner. A study plan is the way learning sessions will be run, how the group will work together. A study plan includes:
Objectives of the study circle;

- Dividing the topic into suitable steps;
- Providing information on the issue (s) under study;
- Providing advice to the group on how their learning sessions can be effective;
- Setting the time frame: During the planning session, the group should agree on the how much time will be spent on a topic(s).

Study plan for Vegetable Production

For the topic, Vegetable Production, the initial study circle activities can include:

- Sharing experiences on goat production for small-scale producers;
- Familiarising study circle participants with the study material;
- Comparing content of the study material with the study circle group members' expectations;
- Ensuring the study plan meets the wishes and needs of the participants.

A study can be a session-by-session outline on the issues you intend to study during the study circle. An example:

Session 1: Overview of vegetable production
Session 2: Starting a vegetable production project
Session 3: Soil management
Session 4: .....

What can you expect to learn?

Vegetable Production for smallholder farmers in Zimbabwe is a practical manual aimed at enhancing knowledge, increase productivity and commercialization of vegetable production. The topics contained in this book include: an overview of vegetable production, starting a vegetable production project, soil management, crop protection and production of traditional vegetables, cabbage, rape and kales, tomatoes, onions and carrots.

Review what you have learned in this session then read the summary to check that you have remembered everything.

Summary

- A study circle is a group of 8-16 people who meet regularly to learn about a topic
- Adults learn differently from children and their learning has a purpose
- A study circle needs a reliable leader with strong leadership qualities.
- The study circle participants help each other to search for knowledge and cooperate on how to solve problems together
- A study circle needs a study plan for each topic studied.

SESSION 2 Overview of vegetable production

2.1 Introduction

Greet each other and review the learning objectives for this session:

Learning objectives

By the end of this session, you will be able to:

- Understand the importance of vegetables
- Group vegetables into different classes
- Understand the growing conditions that vegetables need

Vegetables are plant products that are eaten either raw or cooked as an accompaniment to our staple food.

Discuss

Talk about the following:

- List the vegetables which you grow and eat.
- Are there any other vegetables that you are interested in growing or eating?
- Why is growing and eating vegetables beneficial?

Now read the next section…

Health benefits of vegetables

Vegetables are the main source of minerals and vitamins in our diet as shown in table 2.1. Our bodies need these substances for us to remain healthy. They help to protect us from disease by strengthening our body and immune system. Vegetables also contain large amounts of fibre which help our digestive system to work properly. The more vegetables that are consumed by a person, the less likely that person is to be affected by diabetes, high blood pressure, heart problems and some types of cancer. Absence of vegetables in a diet causes serious health problems. Below is a table which lists some examples of good vegetable sources of various vitamins.

Table 2.1 Vegetable sources for vitamins and minerals

Vitamin	Sources
A	Bush green amaranthus (*mowa; imbuya)*, carrot, pepper, peas, yellow Vegetable , tomato and all dark green leafed vegetables.
B	Beans, dried peas and spinach
C	Uncooked cabbage, lettuce, sweet pepper, tomato,
D	All green vegetables
E	Lettuce, green-leafed vegetables
K	Green-leafed vegetables
Mineral	**Sources**
Calcium	Beans, green vegetables, *nyevhe, mowa, derere regusha, nyemba* and peas.
Iodine	Carrot, green beans, spinach
Iron	*Nyevhe, derere regusha,* cauliflower, dried beans, green vegetables both traditional and exotic, tomato and spinach
Magnesium	Beans, peas and spinach
Potassium	Beans, potato, Vegetable and spinach
Phosphorus	Beans, tsunga and *chembere dzagumhana*
Sodium	Celery, beetroot, spinach.

Other benefits of vegetables

- Vegetable production can be a very good source of regular household income as vegetables fetch a good market price. Vegetables can also be processed into high value products such as dried foods, juices or soup powders.
- Vegetables sold to other countries bring in foreign currency which Zimbabwe needs to buy goods it does not produce from other countries.
- Most vegetables have a relatively quick production cycle, making it possible to sell them in short spaces of time.
- You do not need large pieces of land in order to grow vegetables.
- Vegetable production can provide employment to many people since it is labour-intensive.

2.2 Vegetable crop groups

It is useful to group vegetables into classes in order to understand the growth requirements of similar vegetables.

Discuss

Talk about the following:

- How can we group vegetables? Which vegetables have similar growing requirements?

Now read the next section…

Vegetable families

Vegetables can be grouped according to the family which they come from. Each family is given a name that usually describes a common feature of its members. Members of the same family often have the same growing requirements. Members of the same family often share the same pests and diseases. Therefore, grouping vegetables into families helps with planning crop rotation. Table 2.3 shows the common vegetable families and examples of vegetables in each family.

Table 2.2 Common vegetable families

Family	Examples of members
Cabbage family	Cabbage, *tsunga,* cauliflower, rape, broccoli, covo, chomoulier and *rugare.*
Tomato family	Tomato, potato, eggplant, tobacco, pepper.
Legume family	Pea, beans, cowpea, soya beans.
Pumpkin family	Cucumber, butternut, pumpkin, squash
Onion family	Bulb onion, shallots, garlic, leeks
Carrot family	Carrot, celery, parsley

Vegetable product groups

We can group vegetables according to the part of the plant that we eat (leaf crops, root crops, fruit crops and legumes). Grouping vegetable crops in this way also helps us with crop management because crops with similar products have similar requirements. Table 2.3 shows these types of groups:

Table 2.3 Vegetable groups according to products

LEAF CROPS	Requirements	ROOT CROPS	Requirements
Cabbage family: cabbage, tsunga, rape, covo, choumolier etc. Spinach	Heavy feeders, need regular water, prefer cool times of year. Lighter feeders, can grow all year	Onion family: onion, garlic, shallots/ spring onions, leeks. Carrot	Light feeders, lower water requirements, onions and garlic must be grown at cool times of year. Can grow all year
FRUIT CROPS		**LEGUMES**	
Tomato family: tomato, chillies, peppers, paprika (and potatoes) Pumpkin family: pumpkins, squash cucumber, melons	Heavy feeders, need regular water, prefer warm times of year. Heavy feeders, need regular water, prefer warm times of year	Sugar beans, butter beans, cowpeas, groundnuts, roundnuts, Peas	Help put nitrogen back into the soil. Grow best at warm times of year. Grow best at cool times of year.

2.3 Water requirements

Plants need large quantities of water to survive. Water carries nutrients such as those from manures and fertilizers from the soil into the plant roots. Water carries the nutrients through the plant and finally leaves the plant through openings into the air. This movement of water is faster during hot and dry periods. To be a successful vegetable producer there should be a good and reliable water source.

Discuss

Talk about the following

- How can we reduce water loss from plants and the soil surface?

Now read the next section

Irrigation

If water is inadequate we need to irrigate to meet the crops requirements for water. In Zimbabwe, all production in winter must be under irrigation since we do not have rains during this period.
Table 2.4 compares different irrigation methods.

Table 2.4 Advantages and disadvantages of different irrigation methods

Type of irrigation	Advantages	Disadvantages
Hand bucket	• Cheap • Not complicated	• Very hard work • Water distribution poor • Only suitable for small • areas
Furrow Irrigation	• Lower pumping costs than with sprinkler • Lower initial investment costs in equipment	• Increased erosion risk • Difficult to apply water uniformly in the furrows • Need for expensive levelling of field • Difficult to move machinery across the furrows
Sprinkler (water is applied under pressure over the crop)	• No need for expensive levelling of field • Uniform water distribution	• High cost of pumping • Evaporation losses during irrigation • Wetting the crop leaves may increase disease problems
Drip irrigation (water drips slowly to the roots via some pipes and emitters)	• Saves water • Lower running costs compared to sprinkler • Waters plant station only with almost no water made available to weeds • Improved infiltration in heavy soils • Low water evaporation losses • Low labour costs	• Problems of pipe blockages • High initial costs • The sun and animals can damage the pipes.

Mulching

Water in the soil can be conserved through mulching. Mulching means covering the soil with material such as dried grass, dried leaves, stover or compost. The mulch acts as a barrier to evaporation from the soil surface. Mulching also reduces soil erosion, and it can add organic matter and nutrients to the soil.

2.4 Soil requirements

Soils hold the plant upright and supply water and minerals. Soil contains nutrients, water, organic matter, air and living things. The proportions of these things differ in different soils and thus different soils need different management methods. Vegetable crops need soils with high levels of fertility and a fine texture. To have a successful vegetable production project a farmer must work hard to improve the soil.

2.5 Temperature, light and wind

Crops are very sensitive to temperatures and the amount of light which they receive.

Temperature

Temperature is a measurement of hotness or coldness. Each plant has a temperature at which it grows best. Vegetable plants which are native to Zimbabwe are better adapted to our climate than those brought in from other countries. In order to have success with vegetable production you must take note of the temperature requirements of the crop that you want to grow. So, when choosing crops to grow, select those that can grow well in the particular season.

Talk about the following

- Which vegetables grow better during the hot rainy season?
- Which vegetables grow better during

Now read the next section…

Table 2.5 Cold season and warm season vegetables

Cool season vegetables	Warm season vegetables
Broccoli, cabbage, rape, onion, potato, pea, garlic.	Cowpea, cucumber, tomato, eggplant, okra,

Light intensity

Plants use sunlight in order to make their food. Some crops can grow in the shade or with partial shade. Leaf crops such as spinach, covo and lettuce may tolerate some shade. Many vegetable crops need full sun in order to grow particularly tomatoes and onions.

Day-length

Some plants need more hours of sunlight during the day than others. During winter in Zimbabwe, the sun sets earlier while in summer we get longer days. In the countries where many of our vegetable seeds come from the summer day length is longer than ours. When buying seeds, you should make sure that the variety is adapted to our short-day region.

Onions for example, have short and long-day varieties. Long day onions from the temperate regions can only bulb if a minimum of about 16 hours of day-length are available. If a farmer in Zimbabwe grows such an onion variety it will not produce a bulb.

Wind

Plants are very sensitive to wind because it can cause chilling, drying out and can bring dust and pests and diseases to a crop growing area. Use of wind breaks will minimise the effect of strong winds.

Discussion

Review what you have learnt in this session then read the summary to check that you have remembered everything.

Summary

- Vegetable crops have many benefits including improving the health of people who eat them, and improving household income. They can be grown in a small area, have a short growing cycle.
- Vegetables can be grouped according to their families or the products which they produce. These groupings help the vegetable farmer to improve crop management.
- Vegetables require adequate water supply, fertile soils and adequate temperatures and light. Vegetable growing areas should be protected from wind.

SESSION 3 Starting a vegetable production project

3.1 Introduction

Greet each other and review the learning objectives for this session:

Learning objectives

By the end of this session participants will be able to:

- appreciate the importance of carefully choosing which vegetable crops to produce
- choose the best site for their vegetable production project'
- prepare their site for vegetable production
- explain the best methods for vegetable propagation

Talk about the following

- What do you need to think about when choosing the best crops for your vegetable production project?

Now read the next section…

3.2 Choosing the crops

The first step in starting a garden is to plan what you are going to produce during the year. If you are growing vegetables for market then you need to find out what vegetables are popular you're your customers and what kinds of prices you can expect for the vegetables at different times of year. It is also important for you to know who you are going to market to. Will you be selling to friends and neighbours from your home? Will you be setting up a stall on the roadside? Will you be selling to a stallholder or vendor at a market? Will you be selling to a supermarket? Before choosing your crop, you must think about:

- How long the crop takes to mature – this will help you know what time of year you are likely to be selling the crop and you can inform your customers.
- What inputs (seed, fertilisers, irrigation equipment etc.) will be required to produce the crop – this will help you know how much you are going to spend on the crop. If you compare this with the price you expect from selling the crop you will be able to see whether producing this crop is viable or not.
- How perishable the crop is (how long it will keep before you must sell it. Leaf crops need to be sold the day of harvesting, carrots and onions last a few days if stored correctly, but onions and pumpkins can last for many months before they need to be sold.

Talk about the following

- What is the ideal site for vegetable production?
- Which areas should you avoid?

Now read the next section…

3.3 Choosing the site

Choose a suitable area for your vegetable production project based on the requirements of the different crops. Ideally you should find an area that has fertile, well-drained, loam soils (not too heavy and not too light). The site should be close to your water source but not closer than 30m to a river or wetland because of the danger of soil erosion.

The area should be large enough for your beds as well as having an area for: the nursery or seedbed, compost and harvesting/ curing. If you do not have a flat area you may need to make contour ridges or terraces if it is very steep. Avoid sites in low-lying areas as they may be affected by frost in winter.

Sun and shelter

The area should be in a sunny position but should be sheltered from wind. If it is not sheltered then you will have to make a windbreak. This can be a fence made from dry grass which can eventually be replaced by plants such as bananas or sugar cane. It should be made at least 6m away from the nearest crop. The area should be protected from livestock. If it is not protected then you will have to make a fence. The windbreak can double up as a fence.

Making a map

Once you have chosen your area it is a good idea to draw a map of the area and work out how many beds you can fit in, which direction the beds are going to face and where you are going to locate other activities such as the nursery, seedbed and compost area.

3.4 Site clearance and preparation

All large plants should be removed from the area where you want to make your beds however you should leave some trees around the edge of the area to make a windbreak. You can also leave trees to provide shade in the compost area and the nursery area.

Use trees that you have chopped down to make a strong fence around the garden that can keep out all livestock including chickens. Use any small plants, weeds or leaves to make compost.

Remove any stones and level land where it is not flat. You should also level termite mounds. The soil from these mounds is rich in minerals and can be spread on the vegetable beds to improve fertility.

Preparing beds

Beds should be laid out using pegs and string to ensure that space is not wasted. A good size for a bed is 1.2m wide by 5m long with 50cm paths in between. The soil of the bed should be loosened to 20cm depth with a fork or hoe. Try to avoid turning the soil or mixing the layers. The soil can then be levelled using a rake. Make ridges at the edges of the beds to define them and contain the soil and water. Add one and a half buckets of well-rotted compost per 1m of bed to the surface of beds at least two weeks before planting.

Row layout

Depending on the type of crop you have two options for row layout:

For large, heavy feeder crop (such as tomatoes, spinach, covo or okra) crops make two rows, 60cm apart in each bed with 30cm to the edge of the bed.

For smaller light feeder crops (such as onions, garlic, carrots or bush beans) make four rows per bed: If using a drip kit mark each row 15cms each side of each dripline.

The nursery and compost area

Compost is going to be a very important part of your vegetable production project. Choose a site with enough space to make three compost heaps, each 2m x 2m square with 1m paths in between. This will give you enough space for collecting compost materials and turning the compost heaps.

Most vegetable growers use wither a nursery or a seedbed system. A nursery is a special place (usually a raised structure with a roof) where we raise small plants (seedlings) before they are transplanted to the beds. The advantage of a nursery is that seedlings can be given all of the nutrients and protection that they need until they are strong enough to be planted in the main beds. This increases their productivity and saves you money because most seeds that you plant will survive and turn into adult plants. A nursery or seedbed area should be shaded, protected from wind and must be close to the sources of water and compost.

Discuss

Talk about the following:

- How have you raised vegetables before?
- Have you used a seed bed or nursery method?
- What successes or challenges did you face?

Now read the next section…

3.5 Vegetable propagation

In order to grow well, young plants need cool, moist conditions and protection from pests and diseases until they become strong enough to survive on their own. Some vegetable types should be planted in containers in a nursery. Others such as peas, beans, pumpkins, cucumber and squash cannot be grown in containers and must be planted directly into beds.

Some vegetable seeds (such as those of carrots and onions) are small so be careful not to plant them too deep. The best way to avoid this is to sprinkle the seeds onto the surface of the soil and then cover with a 15mm layer of soil followed by a thin layer of grass or leaf mulch.

Planting seeds

In order to germinate successfully, seedlings need soft, fertile soil. Make soil for seedlings by mixing four buckets of loamy soil, one bucket of well-rotted compost and one bucket of river sand. Sieve the mixture to remove any stones, twigs or clods. Pack the soil into old plastic or metal containers which have drainage holes in their base. Line containers with a thin layer of stones, then fill them to a height of 7.5cm with the soil mixture. After filling the container pour boiling water over the soil to kill pests or diseases. Wait for the soil to cool before planting seeds in it.

Plant the seeds in rows, about 5cm apart, with seeds not more than 1cm deep. Place a thin layer of fine dry grass or compost over the surface of the soil. Water the seedlings. Make a label for the container stating the crop variety and the date of sowing. When the seedling is 10-15cm high it is ready for transplanting. If you do not have space in your garden for the seedling, transplant it into a larger bag or container until space becomes available.

Discuss

Review what you have learnt in this session then read the summary to check that you have remembered everything.

Summary

- Before starting a vegetable production project, it is important to choose which vegetables you are going to produce taking into account the crop requirements and the market requirements.
- The site which you choose for vegetable production should satisfy all of the crop requirements for water, soil fertility, sun, shelter and protection from predators.
- Good fencing is very important for a vegetable production area to prevent crop damage from livestock.
- When clearing the site make sure that you leave enough trees to provide a windbreak as well as shade for the nursery and compost area.
- When planning your vegetable site, it is a good idea to make a map to help plan how many beds you can fit into an area as well as the location of the compost and nursery areas.
- Young plants need special growing conditions. By starting a nursery, you can improve the success of your vegetable production project.

Homework

Visit the new site for a vegetable production project of one of the members of your group. Discuss the characteristics of the area and give advice about how to improve the site for vegetable production.

Figure 3.1 Solar drier made from plastic and wood

SESSION 4 Soil management

4.1 Introduction

Greet each other and review the learning objectives for this session:

Learning objectives

By the end of this session participants will be able to:

- explain ways to manage the texture of their soil for better vegetable production
- explain ways to manage soil fertility
- understand the importance of using compost and how to make it
- understand how to make and use liquid fertiliser
- understand the importance and method of crop rotation and intercropping

Discuss

Talk about the following:

- What is soil made of?
- Why do plants need soil?
- What types of soil do you have on your farms?

Now read the next section…

In order to grow well, vegetable crop plants need a supply of different nutrients which come from the soil. These nutrients are taken in through the roots of the plants. The nutrients in the soil come from tiny pieces of rock and decaying plants and animals (organic matter). These are broken down by the many living creatures such as worms, insects and micro-organisms which live in the soil. Healthy, fertile soil contains a lot of organic matter which helps to store water and plant nutrients. Healthy soil also contains enough air for the soil creatures to survive. So, healthy soil contains: organic matter, living creatures, water and air.

Too much digging, ploughing, burning or use of chemicals can kill the soil creatures and destroy organic matter. Leaving the soil bare, causes it to become hard and compact with very little air or moisture. This makes the soil less fertile and easily eroded.

4.2 Management of soil texture

The texture of the soil relates to the size of soil particles which influence how much air, water and nutrients the soil can hold as well as how easy it is for the farmer to cultivate the soil. Soil is developed in layers and has a very delicate structure. It is very easy to damage the soil texture with poor farming practices.

Soil types

Soils can light, medium or heavy. Light soils are sandy and have low clay content whilst heavy soils have high clay content. Medium soils are in between the light and heavy soils.
Light soils allow water to sink into them easily but they dry out quickly. Water enters heavy soils more slowly but it stays in the soil for longer. Light soils contain more air than heavy soils.

Organic matter

Organic matter is an important part of the soil. It comes from decayed plant and animal material that is broken down by soil organisms. It contains many nutrients. If added to heavy soils, organic matter

improves air content of the soil and the movement of water into the soil. It improves the capacity of sandy soils to hold nutrients and water.
If we improve the texture of the soil by increasing the organic matter content we will increase the fertility of the soil as well as its ability to hold water. Soil containing organic matter is also easy to work.

4.3 Management of soil fertility

Plants need many nutrients in order to grow well. Nitrogen (N), phosphorus (P), and potassium (K) are required in large quantities. Most soils do not contain adequate nutrients for vegetable production. To improve them we must apply either chemical or organic fertilizers which contain the nutrients needed by plants.

Chemical fertilisers

Chemical fertilizers are special mixtures of mineral nutrients that have been made by agricultural chemical companies for improvement of the growth of different crops. Before using fertilisers you should have your soil tested to find out exactly what is required for the crop that you want to grow. Compound fertilizers usually have numbers that indicate the amount of each of the above nutrients that can be found in 100kg of that fertilizer. For example, Compound D has the numbers 7:14:7. These numbers mean that for every 100kg of compound D, there is 7kg of nitrogen, 14kg of phosphorus, and 7kg of potassium. The order N:P:K is never changed.

The advantage of using fertilisers is that you can give the crop the right nutrients that it needs in the right quantities. They are quickly absorbed by plants. The disadvantages of fertilisers are that they:

- are not readily available in many communities;
- are expensive to buy;
- are easily washed out of the soil (leached) by rain water or irrigation;
- do not improve the long-term soil fertility;
- do not improve the texture of the soil or its ability to store water or nutrients.
- Can cause pest problems as pests will be attracted to fast-growing, dark green plants fed on fertilisers.

Talk about the following:

- Have you ever used lime on your crops?
- Why did you decide to use it?
- How was it applied?
- How did you know how much to use?

Now read the next section

Lime

One important chemical for vegetable growers to use is lime. Lime is not really a fertiliser but it is important for use with other chemicals or with organic soil-improvement methods. Lime helps to balance the soil to improve the ability for plants to absorb nutrients from the soil. Without balancing the soil using lime, crops cannot absorb nutrients effectively. Ideally you should have your soil tested once per year to find out how much lime to use. To apply lime, sprinkle a thin layer on to beds once per year (especially for leaf crops and legumes).

Long-term ways of improving the soil

There are other ways to improve the soil that are less expensive than fertilisers and these methods are better for improving long-term soil fertility:

- Planting your crops in rotation with legumes (the legume family put nitrogen back into the soil when they are growing).
- Applying animal manure (these are rich in nitrogen with other nutrients in smaller quantities).
- Applying liquid fertilizers (these are high in nitrogen and are made with plant material or animal manure).
- Applying compost (this is a specially made organic material that contains many important nutrients for plants).

4.4 Some important soil-improvement methods

Plants need many nutrients in order to grow well. Livestock manure is readily available and it contains a lot of nitrogen but not many other nutrients. The nitrogen in livestock manure is quickly lost if the manure is not combined into the soil or compost. Using compost is a better method for improving the soil because it stores many different nutrients and lasts a long time in the soil.

Discuss

Talk about the following:

- Have you ever made compost?
- What method did you use?
- How did you apply the compost to your crops?

Now read the next section…

How to make compost

Compost is a dark, crumbly material formed by soil creatures. If it is made correctly it stores nutrients and water and slowly releases them for plants. To have a successful vegetable project you need to keep adding compost to your crop beds so you will need to have a lot of compost available. Try to make compost four times per year. Use the following method:

- First collect the different materials you need to make the compost heap. Collect dry materials (containing carbon) e.g. dried grass, dry leaves, paper, cardboard and green materials (containing nitrogen) e.g., green grass, green leaves, food scraps and animal manure.
- Find a cool, shady, sheltered place, close to water to make the compost heap.
- Mark the area where you are going to make the heap – it should be 2m by 2m.
- Fork the surface of the soil where you want to make the heap. Put down a layer of coarse material, such as maize husks, stover or twigs on the soil.
- The compost heap should be made from layers of different materials.
- The layers of green material should be thin while the layers of dry material should be thick.
- Do not add soil, plastic, metal, thick twigs or branches to compost.
- Cut up any large pieces of material before adding to the heap.
- Add a thin layer of manure or other green material. Sprinkle lime if you are using fresh chicken manure. Add a bucket of water to the layer.
- Next add a thick layer of dry material. Water each layer as you add it.
- Keep adding layers of green material and dry material until the heap is as high as your chest. Use dry material for the last layer to keep away flies.
- Make air holes in the heap with a sharp pole and cover the heap with old sacks to conserve moisture.
- Check the heap each day to make sure it is not too dry. It should feel damp but not dripping wet. If it feels too dry, add more water.
- Check that the heap is getting hot by pushing your hand in to one of the air holes. If it is not hot, turn the heap, and add more manure.
- If the heap smells strongly of urine it may contain too much manure and you should add

some more dry material.

- After about a week the heap will begin to cool and it is the time to turn it over to mix the layers together.
- The heap should be turned at least five times in the composting process. The more you turn the heap, the quicker your compost will break down. Well-made compost can be ready in six weeks.

How to use compost

When using compost apply it on the soil surface as mulch. It can be applied to the beds before planting and should be applied as a top-dressing to heavy feeder crops as they mature. Fresh compost must not be dug in to the soil. Compost should be applied to beds every time you plant new crops at a rate of 1.5 buckets per metre of bed.

Home-made liquid fertiliser

Some heavy-feeder crops (such as leaf crops, fruit crops and potatoes) need extra nutrients in order to give high yields. These will benefit from liquid fertiliser which can be made using manure or rotted leaves.

Either half-fill a sack with animal manure then hang it in a drum full of water for about one week. Or collect leaves from leafy green plants such as weeds, tithonia, stinging nettles or amaranth. Fill a drum or container with the leaves and quarter fill with water. Close the lid, but do not tighten. Leave in the sun for two weeks.

How to use liquid fertiliser

Liquid fertiliser must be diluted before use otherwise it will burn plants. Dilute: one part liquid fertiliser to five parts water before applying to plants. If the mixture still smells very strongly after dilution, continue to dilute until the smell is less severe.

Apply liquid fertiliser directly to the base of the plant. Avoid the leaves. Give a small amount to each plant depending on the size of the plant and its stage of maturity. For example mature maize plants can benefit from one cup of liquid manure per plant every two weeks. Tomatoes could have a quarter of a cup of liquid fertilizer every two weeks. Liquid fertiliser should only be applied to heavy feeders. Do not use liquid fertilizer on members of the onion family, legumes or carrots. Apply it to seedlings and plants which look unhealthy.

Warning: Liquid fertiliser can cause crops to grow very quickly with large soft leaves. This makes them attractive to pests. Liquid fertiliser does not improve soil organic matter content and it should only be used with other organic methods such as compost and mulch applications.

4.5 Crop rotation

Crop rotation is very important in vegetable production both for soil management and for pest and disease control. The aim of crop rotation is to avoid the soil becoming exhausted by heavy feeder crops and to avoid the build-up of pests and diseases. This means that each time you harvest a crop from your beds you must plant crops from a different family in that bed. No members of the same family should be planted in the same place or after each other.

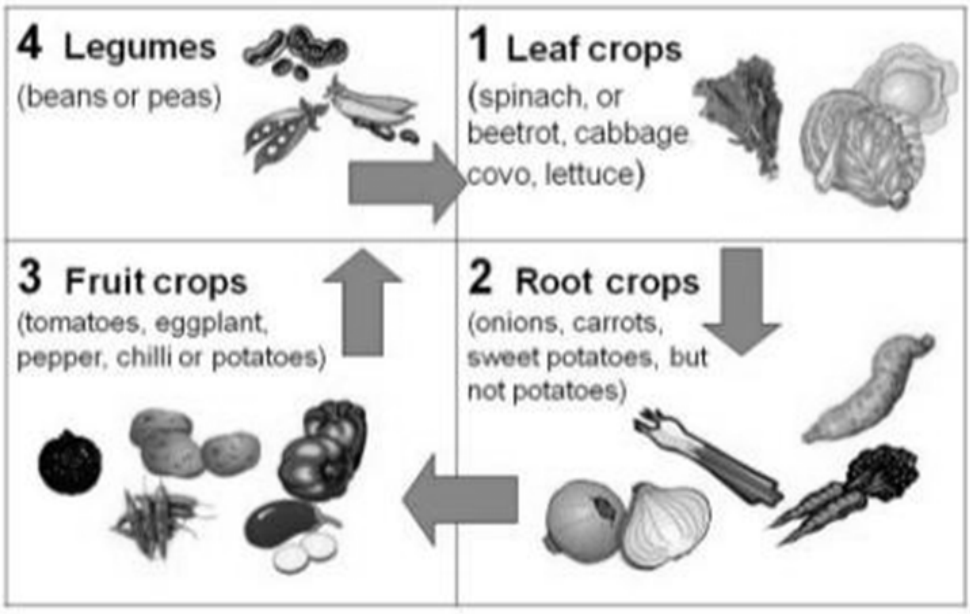


Figure 4.1 Crop rotation diagram

In your rotation, if you plant a leaf crop (such as spinach, cabbage or covo) in your bed, once it is harvested you should plant a root crop (such as onions, potatoes or carrots). Once these are harvested you should plant a fruit crop (such as tomatoes, okra, pepper or chilli). Once these are harvested you should plant a legume crop (peas or beans) as these will return the soil fertility levels. After the legume you can plant a leaf crop and start the rotation once again as shown in figure 4.1.

Activity

Divide into pairs.
Each pair should make a crop rotation plan for four beds in a vegetable production project showing which crops would be planted in three successive seasons.
When you have finished share your plans with the whole group.

Intercropping

Intercropping is an alternative to crop rotation. It involves means planting different types of plants together in the same bed or row. Intercropping has many advantages. It saves space and can reduce labour because all of the crops are planted together so you do not have to walk so far carrying water of compost to the beds. It can also improve soil fertility through the use of legumes. Intercropping helps prevent the soil from drying out on hot days because all of the soil in the bed is covered by a "living mulch". This living mulch also reduces weed problems. Intercropping helps reduce pest and disease problems because pests and disease have fewer of their favourite plants growing next to each other.
When intercropping, remember:

- Plant heavy feeders with light feeders
- Plant leaf crops next to root crops, fruit crops or legumes.
- Plant the seeds or seedlings using the recommended spacing.
- Organise plants according to their different shapes: Tall thin plants such as carrots, leeks, onion and garlic can be grown next to wide low growing plants such as lettuce, bush beans or spinach.
- different crops take up beds for different lengths of time. Covo or spinach may stay in beds for many months or even years as they can continue to grow while the leaves are being harvested. Others such as beans or tomatoes may only occupy beds for a couple of months.

Discuss

Review what you have learnt in this session then read the summary to check that you have remembered everything.

Summary

- Soil management is very important for successful vegetable production. You can use chemical methods, organic methods and crop rotation to improve your soil.
- You can improve the texture, nutrient and water holding ability of your soil by increasing the organic matter content.
- You can improve soil fertility by using chemical or organic fertilisers or by practicing crop rotation and intercropping with legumes.
- Properly made compost should be the foundation of your soil management method.
- It is very important to practice crop rotation when you are growing vegetables to avoid degrading your soil and causing a build-up of pests and diseases on your land.

Homework

- Divide into two groups.
- The first group should make a compost heap using the method described in this session. The second group should make liquid fertiliser.
- At your next meeting discuss the homework.

SESSION 5 Crop protection

5.1 Introduction

Greet each other and review the learning objectives for this session:

Learning objectives

By the end of this session participants will be able to:

- understand the importance of correct identification of a pest or disease problem;
- explain cultural, biological and mechanical methods of control;
- understand the importance of choosing the correct chemical pesticide and the precautions that must be taken when handling pesticides;
- explain how to control crop diseases and pests using cultural methods.

In order to grow vegetables productively it is important to practice strict crop protection methods so that pests, diseases and weeds are kept under control.

Discuss

Talk about the following:

- What is a pest?
- What causes pest and disease problems?

Now read the next section…

Pest, disease and weed problems are usually caused by poor management practices such as growing crops at the wrong time of year, not practicing crop rotation, poor soil fertility or water management. The use of pesticides can often worsen pest problems by killing beneficial insects which eat pests and creating pests which become resistant to chemicals.

The most effective long term way to control pests and diseases is by using a combination of cultural, biological and mechanical methods. Chemical methods should be a last resort if the other methods fail. This is because chemical pesticides and herbicides are expensive and can damage human health and the environment.

A pest is any living organism which interferes with human activities. Pests can include a wide range of animals such as insects, snails, slugs, mites, nematodes, mice, birds, elephants and baboons.

5.2 Identifying the problem

The first step in effective pest and disease control is to be able to correctly identify the type of pest that is causing the problem. Visit your production area regularly and find out which insects and animals live there. Note signs of pest or disease attack such as leaves being nibbled, stems which have wilted, leaf distortion due to viral attack, bacterial or fungal blemishes on leaves, stem and root distortion. Make sure that you find out which creature is causing the problem and identify it carefully. If you are not sure what is causing the problem take a sample of the affected plant to your nearest AGRITEX officer. Look out for and encourage predators.

The most common pests are insects. They can be grouped into biting and sucking types.
Biting insects have chewing mouthparts and may consume parts of the plants on which they feed, resulting in holes on leaves, fruits and stems. Caterpillars, grasshoppers and beetles fall into this group.
Sucking insects have piercing mouthparts which penetrate the plant and suck plant sap. Aphids, mealy

bugs and scale insects are examples of these insects. By sucking the plant sap, they weaken the plant whose shoots may suffer permanent wilt. The sucking process may introduce microorganisms like bacteria, fungi and viruses which will cause diseases.

5.3 Cultural control methods

Good crop management is the best way to prevent pest and disease outbreaks. Some cultural methods include:

- Keeping crops healthy - give crops enough nutrients and water so they use their own defences against pests. Avoid over-watering and using chemical fertilisers. These make plants grow too fast and make them weak and susceptible to pest and disease attack.
- Practice crop rotation and intercropping.
- Resistant varieties - we should select varieties that are suitable to our local conditions. Such varieties will be able to grow quickly without stresses and hence fight diseases better. A variety not suited will grow poorly and hence unable to fight the pest and disease pressures. If available select varieties that are tolerant or resistant to particular pests and diseases in your area.
- Use of certified seed – this will ensure that seeds themselves do not bring pests, weeds and dis eases. This is so because certified seed is produced and packed under very high standards governed by the laws of Zimbabwe. There are no guarantees on uncertified seed.
- Timing of planting - early planting will ensure that a crop grows and is harvested before heavy build-up of pests and diseases which happen later in the season. Such a crop has a better chance of success than one planted later.
- Use correct crop spacing
- Avoid damp conditions - make trellises to lift cucumber, pumpkin, tomato, bean and pea plants off wet ground. Plant cucumbers and pumpkins on mounds of well-drained soil or compost.
- Destroy infected plant material – remove diseased plants and burn them to avoid contamination with other plants. Pick up all fallen fruit (such as those of tomatoes, pumpkins, and squash) and feed them to livestock to kill fruit fly larvae.
- Weeding – control weeds so that they do not compete with vegetables. Some weeds can cause the spread of pests and diseases to crops.

5.4 Biological control methods

This means using other plants or animals to help control pests to create a natural balance between pests and other living organisms.

Using predators

Many animals and insects eat pests. We call these predators. Predator insects include ladybirds, preying mantis, assassin bugs, parasitic and predatory wasps. Predator animals include frogs, lizards, chameleons, birds, owls and bats.

Livestock rotations or movable units can also be used to clear land of pests before planting. Ducks and chickens eat many pests including grasshoppers, cutworms, caterpillars and bugs. They also remove weeds and eat weed seeds and improve soil with their manure. If fencing is available livestock can be kept and rotated in garden areas.

Repellent plants

Strong-smelling plants such as marigolds, khaki weed, nasturtiums, marjoram, basil, onions and garlic contain chemicals that repel many pests. Plant rosemary, lavender and lemon grass on the edges of gardens or around the base of fruit trees. Prune the leaves for strong-smelling mulch. Sun hemp repels nematodes and improves soil. Vetiver grass and lemon grass repel soil insects and moles.

5.5 Mechanical control

These methods involve preventing pests from reaching the plant or parts of the plant that they want to eat. Larger pests can be controlled by hand-picking. Collect large pests in a bucket partly filled with water. To avoid being stung, wear gloves or put plastic bags over your hands. Swarms of grasshoppers or caterpillars can be removed from plants by brushing plants with a soft broom. They can then be killed by squashing with the broom. If pests are small, squash them on the side of the plant. The smell repels other insects.

Traps

Fly traps - Fruit flies that attack cucumbers, pumpkin and squash can be caught in traps made from old plastic bottles containing water and rotten fruit. Place these traps in affected trees or near pumpkin or cucumber beds.

Beer traps - Slugs and snails can be trapped in shallow containers filled with old beer. Put one or two traps in each bed especially during the rainy season.

Shelter traps - Place old cabbage leaves, half orange skins or half gem squash shells on beds in the afternoon. Early next morning collect the slugs, snails, caterpillars and cut-worms that have hidden under the traps.

Sticky traps - Mix a handful of sawdust with a sticky substance such as molasses, syrup or tree resin and sugar to make a paste. Spread this at points in beds. The sweet smell attracts cutworms, which then get stuck in the mixture.

Barriers

Mulching - Use dry thatch grass or leaf or ash mulch repels many crawling insects such as nematodes, cutworms, grasshoppers, ground beetles, termites, thrips, slugs and snails. Mulch made from clippings of strong-smelling plants such as herbs, Mexican marigold, zumbani, lantana or gum trees repels insects.

Windbreaks - Plant tall plants such as sunnhemp, millet or strong smelling plants around the vegetable production area to stop the spread of flying insects and wind-borne pests.

Oil or grease - smear stems or trunks of plants with a ring of cooking oil or Vaseline to prevent insects from reaching the juicy tips leaves, or fruits of the plant.

Seedling collars - protect young plants from caterpillars, mice and grasshoppers using old plastic containers or tin cans with the base cut out. Press the container a few centimetres into the soil to prevent cutworms.

Powders

Powders repel and kill many insects as they block the insects breathing system. There are several options:

Leaf dust - dust leaves with clay, lime, flour, chalk, rock dust or wood ash to kill thrips, aphids, mites, and whitefly. Lime dust kills loopers, slugs and small beetles.

Ash rings - spread dust or ash around the base of plants to repel most crawling pests.

Chilli or garlic powder can also be used to treat ants, crawling insects and some soil pests.

Grain powders – lavender or imbanje powders can be used to prevent pest attack in stored grain.

Anti-fungal powders made from dried crushed basil leaves, chilli fruit and garlic treat fungal infections.

5.6 Chemical control

Many chemical sprays can be bought. Sprays may seem effective but they may cause more problems than they solve. Many pests build up resistance to pesticides and this makes them able to withstand stronger and stronger chemicals. Most predatory animals on the other hand are easily killed by sprays. This creates a situation of super-pests without any predators to check their populations. Eventually the

farmer becomes more and more dependent on expensive and harmful chemicals while destroying the natural predator-prey balance. This is why chemicals should be used as a last resort.

Natural remedies

You can make your own sprays using locally available ingredients. Dishwasher and soap sprays are also effective on their own. Most pests are so delicate that water from a hosepipe will kill them. A very useful all-round spray is made from chilli and garlic. For some recipes of natural remedies please refer to appendix 1 and appendix 2.

Insecticides

Insecticides are chemicals that kill insects after cultural and other methods fail. Some insecticides have to be eaten by the insect for it to be killed. In order to kill sap-sucking insects some of these (called systemic chemicals) are absorbed into the plant.

Others, called contact poisons are sprayed on to the area where the insect will crawl. The insects are killed when they touch the chemical. Contact insecticides will kill both sucking and chewing insects provided they come into contact with the spray. Some insects such as scales and mealy bugs are difficult to kill with contact insecticides since they have an outer waxy covering which repels the insecticide.

Discuss

Talk about the following:

- Given what we have read about insect pests, why is it important to correctly identify the type of insect causing a problem before purchasing an insecticide?
- What precautions should we use when handling pesticides?

Now read the next section…

Pesticide precautions

Farmers must take great care when using or handling pesticides because some are very dangerous. It is also important to note that some pesticides are not intended for use on crops that are going to be eaten. Only use pesticides that are intended for vegetables.

- Never buy chemicals in unmarked containers.
- Do not use pesticides if you are: ill, pregnant, breastfeeding or under the age of 16.
- Make sure the chemical is appropriate for the pest you want to kill.
- Always read and follow the directions and safety instructions on the container.
- Wear protective clothing when applying the pesticide.
- Avoid contact with your skin.
- Do not eat, drink or smoke when applying pesticides.
- Do not eat vegetables that have been recently treated.
- Do not spray pesticides when it is too windy.
- Store pesticides away from food. Keep out of the reach of children.
- After handling any poison, including homemade ones, wash your hands carefully with clean water and soap.
- Be careful where you dispose of old pesticide containers. They can contaminate the soil and water supplies.

5.7 Disease and weed control

Plant diseases are caused by tiny bacteria, fungi or viruses that infect the plant usually through water, damaged leaves or through a pest attack. Cultural practices are the most important methods for con-

trolling bacterial, fungal and viral diseases. Effective planning and good crop management are very important.

Weeds compete directly with crops for moisture, light and nutrients resulting in reduction of yields. Some weeds become sources of pests and diseases of crops. They should therefore be controlled. Tips for weeding:

- pull up all unwanted weeds before they seed
- use weeds to make compost, liquid fertiliser or livestock feed.
- use thick mulch between vegetable plants to smother weeds.

Review what you have learnt in this session then read the summary to check that you have remembered everything.

Summary

- In order to control pests and diseases effectively it is important to practice good cultural methods, biological methods and chemical methods before resorting to the use of chemicals.
- It is important to correctly identify the pest or disease before choosing the best control method.
- Cultural methods involve correct crop management as well as buying certified seed, resistant varieties and practicing good hygiene when handling crops.
- Biological methods include encouraging natural predators of pests and using repellent plants
- Mechanical methods include hand-picking of pests and making traps, barriers and using powders.
- Chemical pesticides include those that are eaten by the pest and those that kill the pest when it comes into contact with them. It is important to use the correct pesticide for the problem.
- Pesticides are expensive and can be very dangerous to human health and the environment and must only be used when other methods have failed. Safety precautions must be followed when handling pesticides.

SESSION 6: Traditional vegetable production

6.1 Introduction

Greet each other and review the learning objectives for this session:

Learning objectives

By the end of this session participants will be able to:

- Understand that a range of indigenous vegetables have market potential
- Choose the best varieties of tsunga for production under different situations.
- Produce high yields of quality tsunga and chembere-dzagumana through using recommended practices.
- Identify the major pests and diseases for tsunga and chembere-dzagumana and use effective methods to control them.
- To increase tsunga yields through correct harvesting.

In the past, a wide range of traditional vegetables were grown including nyeve (Cleome gynandra), mowa (amaranthus hybridus) and black jack (Tagetes minuta). In addition, leaf vegetables from other crops such as cowpea, pumpkin and Vegetable were used. These products are once again becoming popular and are starting to be seen on supermarket shelves showing that there is an increasing demand. Customers are realising that many of these vegetables are more nutritious than the exotic vegetables that they are consuming. In addition, these crops are better adapted to some of the climatic conditions in Zimbabwe.

In this session, we will focus on two traditional vegetables grown in Zimbabwe, tsunga (mustard rape) and chembere-dzagumana (Ethiopian mustard). These two vegetables belong to the cabbage family. Compared to other members of the family, especially the exotics, there is little information on their production requirements. This is so because the crops have not been considered to be of high value enough in the West to warrant huge investments in research. The trend has been repeated in Africa because of lack of research funds.

6.2 Tsunga overview

The tsunga plant belongs to the cabbage family. It has a short, fleshy stem initially which can reach heights of 1 to 5m. The leaves are light green with a distinct mustard smell and taste. The flowers are yellow and each develops into a seed pod. The seeds are small at first and turn brown when mature and dry. Very dry pods can shatter.

There are several varieties grown in Zimbabwe:

- Ndakupuka – has large smooth leaves
- Chikare - small shiny leaves
- Zifodya - big hairy leaves
- Machembere - big hairy leaves
- Bhama - big hairy leaves
- Marengenya - lacerated leaves

Discuss

Talk about the following:

- Have you ever grown any of these tsunga varieties?
- Share your experiences with your group.
- Talk about the advantages and disadvantages.

Now read the next section…

6.2 Land preparation and planting

Tsunga is grown from seed planted direct or grown in a nursery and then transplanted into beds when the seedlings are 10-15cm tall. Tsunga grows best during cool times of year (April – May). Low temperatures delay flowering making the plant produce large leaves. Growing the crop in soils that are rich in organic matter give good results by increasing leaf size and quality. For good nutrient uptake, the pH should be 5 – 6 (CaCl2).

Planting

If planting direct, put three to four seeds on stations spaced 30 – 50cm between rows and 30cm within the rows. The crop is thinned to one plant per station when seedlings are 2-3 weeks old. Irrigate before and after thinning to firm the soil around the seedlings and to aid recovery of the disturbed plants that remain. The first top dressing is also applied soon after thinning.

6.3 Crop management

Soil improvement

Three options are available:

- The first option is to apply 50 t/ha (50kg per 10m x 1m bed) of well rotten manure or compost and 290 kg/ha ammonium nitrate. All the manure/ compost is incorporated into the soil and thoroughly mixed before planting. The top dressing is applied as follows; 96kg/ha at 3 weeks after crop emergence, another 96kg/ha at 6 weeks after emergence and lastly 98kg/ha at 9 weeks after crop emergence.
- The second option for basal fertilization is to combine manure and compound D fertilizer (7:14:7). 30 t/ha manure and 150 kg/ha Compound D are mixed into the soil thoroughly before planting and the top dressing applied as in first option above.
- The third option is for people who do not have manure at all. In this case you apply 450 kg/ha Compound D and apply the top-dressing as in the two options above.

Irrigation

Since the best time to grow the crop in Zimbabwe is dry, irrigation will be needed. Evaporation rates are lower due to low temperatures so irrigation of about 25mm per week may be adequate.

Crop protection

Aphids are likely to be a problem be a problem on tsunga. It is important to regularly inspect the crop and treat for aphids as soon as their populations begin to increase.
Fungal diseases may be a problem in the rainy season. Sprays of Dithane M45 may control the problem.
As with any other crop, keep the field weed free for the crop to give good yields.

Figure 1.1 Tsunga plant

See appendix 1 and 2 for natural control measures and appendix 3 for chemical control measures.

Discuss

Talk about the following:
What other methods are available to control pests and diseases of *tsunga?*
Have you tried making any home-made sprays that are effective?
How did you make and use them?

Harvesting

Leaves are harvested after six weeks of growth once per week. At least one large leaf should be left per plant to allow growth to continue. The plant growth condition will guide you to decide the number of leaves to be harvested per plant. Leaves should be kept cool and moist and eaten or sold as soon as possible after harvesting.

6.4 *Chembere-dzagumana* overview

Chembere-dzagumana is a Zimbabwean traditional vegetable also from the cabbage family. Some varieties have green stems while others have purple stems and green leaves. Some can be smooth and shiny hence the name shushine. The plants produce yellow flowers that result in flattish seed pods. The seeds, which are bigger and more than those of tsunga, turn brown on maturity. Seed pods do not shatter easily and they can be kept in pods in a dry and cool place for a long time.

Chembere-dzagumana needs plenty of water but tolerates a wide range of temperatures although it grows best in areas with day time temperatures are between 10-25°C. Good quality leaves are produced between April to August. High temperatures promote flowering thereby reducing leaf yields. The crop can

grow on a wide range of soil types provided they have good drainage. Best results are attained in soils rich in organic matter.

6.5 Land preparation and planting

Soils should be prepared to get a fine tilth and be levelled. The crop is best planted by direct seeding although it can be transplanted. Transplanted plants tend to flower earlier. It is advised to plant three to four seeds per station and then thin to one plant three to four weeks after emergence. Plant spacing between the rows should be 30 to 50cm whilst it should be 30 to 45cm within the row. The plant germinates in four to five days and grows vigorously producing abundant side shoots on each node. These side shoots should be removed otherwise the leaves will be abundant but small.

6.6 Crop management

Soil improvement

The crop response well to organic fertilizers mixed into the soil before planting. Fertilizer and manure applications should be the same as those for tsunga.

Irrigation

Irrigate as for tsunga.

Crop protection

Aphids can be a problem at the seed pod stage and bagrada bugs may infest the crop. For natural control see appendix 1,2 and for chemical control see appendix 3.

No diseases have been observed in the rainy season. This does not mean we should not be on guard. Keep fields clean of weeds.

Harvesting

Leaves should be picked once they reach desired size. Delays in harvesting results in loss of quality. Yields are higher in the cooler months. Yields of around 35 to 75 tonnes per ha can be obtained.

Review what you have learnt in this session then read the summary to check that you have remembered everything.

Summary

- A wide range of traditional vegetables can be grown including nyeve, mowa, black jack, cowpea leaves, pumpkin leaves and Vegetable leaves.
- Two traditional vegetables with high market potential are tsunga and chembere-dzagumana.
- These vegetables both belong to the cabbage family and have similar growing requirements.

SESSION 7 Cabbage production

7.1 Introduction

Greet each other and review the learning objectives for this session:

Learning objectives

By the end of this session participants will be able to:

- Explain the characteristics, growth requirements and crop management methods for cabbage.

Cabbage is one of the most widely produced vegetable in Zimbabwe. There are several varieties which are grown for different purposes.

Discuss

Talk about the following:
Describe the cabbage varieties you know and for each give the advantages and disadvantages.
Now read the next section…

You should choose the cabbage varieties which you grow based on market requirements. After identifying the varieties that the market wants, you can then consider factors like drought tolerance, time to maturity and disease and pest resistance. Seed should be bought from reputable suppliers to avoid buying diseased seed.

Cabbage needs about 380mm to 500mm rainfall or irrigation in the dry season. Cabbage prefers cool temperatures (18 to 20oC) so does best during winter. The most difficult time to grow cabbage is the rainy season because of high pest and disease pressures.

Cabbages can be grown in a wide range of soils from light sand to heavier clays. Soils with high organic matter content give the best yields. Soil pH should be between 5.5 to 6.0 for ideal growth. Good drainage is important and soils that become water logged after heavy rain or irrigation are unsuitable. To improve production of cabbages like most vegetables we should apply good quality manure or compost.

7.2 Land preparation and planting

The common method of propagating cabbage in Zimbabwe is through seedlings raised in seedbeds. A better method is to produce seedlings in trays.
About 300 to 450g of seed will raise enough seedlings for a 1 ha or 2.5acre field. Approximately 1g of seed will give 200 - 300 plants. The seedbeds should be fertilised with Compound S (7-21-8) at 60g per m2). The seed is sown in 150 mm spaced rows at a depth of not more than 10mm. Germination takes about 5 to 7 days when temperatures are in the range 20 to 30oC. After germination, the seedlings are thinned to about 11mm apart in the row. The use of grass mulch will improve growth and uniformity of seedlings. The seedlings will be ready for transplanting in four to six weeks after emergence. At this stage they will be about 100 to 150mm tall. Seedlings should be hardened before transplanting by placing them in a sunny position for a day or two.

Land Preparation

The land should be ploughed well and deeply before planting.
Planting can be by direct seeding or by transplanting seedlings. Direct seeding will require about 2kg of seed per ha. Three to five seeds are placed at each permanent planting station and after 3 to 4 weeks

after emergence thinning is done to leave one healthy plant per station. The field is watered one day before planting. When transplanting water the beds just before seedlings are planted and soon after transplanting. To avoid severe shock, it is advisable to do this during the cooler times of the day.

Discuss

Talk about the following:

- Why is it that the seed required for direct seeding is more than four times that for seedlings production to plant the same area?

Now read the next section…

Spacing

When planting small headed cabbage, rows are spaced 45 to 50cm apart with plants in the row spaced 30 cm (a full ruler).

For large-headed cabbages we use 45 to 50 cm inside rows, and 50 to 60 cm between the rows.

7.3 Crop management

Cabbages have shallow root systems and are heavy feeders, so they require heavy applications of fertilizer. This means we require adequate levels of fertilisers or compost/ manure.

Soil improvement

Manure or compost can be applied at amounts of 50 t/ha, (5 kg per m2). If compost or manure is not available in large quantities, use 30 t/ha manure plus 200 kg/ha Compound S (7:21:8) or Compound C (6:15:12). This translates to 3 kg/m2 manure plus 20g/m2, Compound S or C. If manure is not available at all, then apply 600 - 700kg/ha of a compound fertiliser (about 60 to 70g or 2 x size 30 fertilizer cups per m2).

Both the compound and manure should be ploughed into the soil before planting. This helps the plants to start developing a strong root system which will result in healthy growing plants.
Top dressing with ammonium nitrate should be applied at the rate of 5g/m2 at three weeks after transplanting, 10g/m2, three weeks later and another 10g/m2, after three to four weeks. Too much nitrogen application should be avoided, as it can lead to splitting of the head.
Calcium and boron are important nutrients in cabbage production. Additional boron may need to be added to avoid decay and hollowing of the pith (core), and calcium may be needed to avoid tip-burn.

Irrigation

Adequate water must be given throughout the growing season. How often watering is done depends on the soil type, climate and condition of the crop. During the first weeks, irrigate frequently using small amounts of water. As the plants grow (by six weeks) you can reduce watering to giving larger amounts once a week.

Weed Control

It is essential to maintain good weed control if maximum yields and quality are to be achieved and labour costs reduced. Competition from weeds early in the season will slow both emergence and early growth. Weeds should be controlled with shallow tillage to destroy any weed seedlings. Weeds can be controlled using herbicides but these are expensive and dangerous so must be used as a last resort. See appendix 4 for a list of herbicides.

Pests, and disease control

Diseases and pests that attack cabbage are the same for rape and kales. See appendix 1 and 2 for natural control. See appendix 3 for chemical control.

7.4 Insect Pests

Troublesome insect pets in Cabbages, Kales and Rape.
In these discussions we are going to look at some of the most troublesome insect pests and what methods we can employ to control them before they damage our crops.

(a) Cut worms: This cause direct lose and affect plant stand. It's a major problem after transplanting, cuts the plant at the base, use **Karate** at 100 ml/100 l water spray at the base of the plant, this will give the best results. **Carbaryl 85 WP** at the rate of 150 - 200 g/100 l, applied in the planting hole, is also recommended. **Pyrinex 48EC** at a rate of 200ml in 100lt of water drenched soon after transplanting using cup 30/plant is also recommended.

Figure 7.1 cutworms

(b) Bargrada bugs: Black and orange bugs (Fig 7.2) which are usually seen in twos joined back to back. These can cause very serious damage to leaves. The insects will cause the leaves to dry, like a chemical burn, causing poor growth to the plants.

The adult bagrada bug

Initial symptoms of damage by bagrada bugs.
Note small white punctures on the edges of leaves

Crop severely damaged by bagrada bugs
Figure 7.2

(i) Chemical Control, We can control using chemicals like, Dedevap (Dichlorvos) at 15 to 20 ml in 15 litres of water. This is enough to cover an area 1000square metres (100 metres by 10 metres). Another chemical we can use is carbaryl, mix 30 grams in 15 litres of water. Always read the label for full instructions.

(ii) Natural pesticides are recommended (by The Natural Farming Network) for controlling Bargrada bugs, stink bugs and green stink bugs. Large beetles which do not appear in large numbers we can pick by hand, chickens or Guinea fowl on free range can also reduce their numbers and we can use aromatic sprays (sprays made from plants that smell) to repel them. For small beetles we can use aromatic plants

sprays, ash, clay, lime, chickens, manure, soap solutions, tea, pawpaw, syringa. Make sure there are enough trees for birds and other plant diversity for predators (those insects we are our friends)
(c) Cabbage Aphid: This is another troublesome insect pest. It is a small pear shaped insect with a soft body, can have or may not have wings. Aphids suck sap and can also spread virus diseases.

Figure 7.3 Aphids underside of the leaf

(i) Chemical Control: We can control by spraying with Dimethoate (Rogor), 40% EC at 75ml in 15 litres of water will be enough for an area 100m by 10m (1000m2). We must wait for two weeks before we harvest after sparaying. Other chemicals include Malathion 25 WP and Thionex 35 EC.

(ii) Natural Control Methods: Aphids can be controlled by inter or strip cropping of plants like garlic, marigold and onion, which repel certain types of aphids. For natural pesticides we can also use ash, clay, soap solutions like Naturrel, garlic chilli, sweet potato, tomato, tobacco, onion, wild cucumber and syringe. At the back of the book we will find some examples of preparation methods for some of the natural pesticides we have discussed.

(d) Diamond Back Moth: This is one of the insect pests we shall find giving us problems in cabbage and its relatives, in particular from August throughout the rainy season. The adult is a moth (small butterfly) but the damage is from small bright green caterpillar which causes short holes in the leaves, see below picture. This is the larva stage which builds a web (cocoon) around which it can make control difficult because sprays will not reach the pest due to protection by the web or cocoon. It usually attacks the growing parts of the cabbage and its relatives, affecting subsequent growth and giving vegetable leaves holes which are unattractive in appearance.

Diamond Back moth larvae

Damage caused by Diamond Back moth larvae
Figure 7.4

(i) Chemical control:
DDVP, Dichlorvos 1000: apply at 100ml/100 l water as a high volume, full cover spray and repeated at weekly intervals if necessary. The harvest interval is 3 days. Dichlorvos 1000 will also control aphids, caterpillars and whitefly.

Endosulfan 50 WP: spray at 100g + 30ml Sanawett 90/100 l water. Apply as a high volume, full cover spray in at least 100 l mix/ha and repeat at 7 - 10 day intervals as necessary. The harvest interval is 7 days. Thiodan will also control caterpillars.

Methamidophos 600 SL at 100ml/100 l water as a full cover spray repeated weekly if necessary. Do not harvest for at least 21 days after date of last application. Methamidophos will also control aphids and caterpillars.

Malathion 25 WP at 20g + 30ml Sanawett 90/100 l water as a full cover spray applied in at least 1000 l mix/ha and repeated at 7 - 10 day intervals before harvesting. can be used to control the larva.

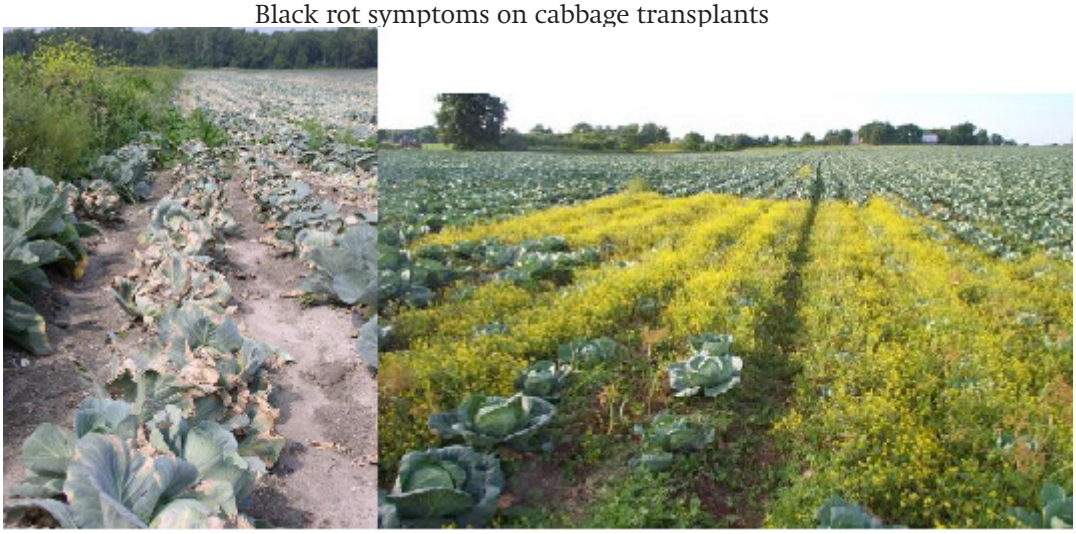
(ii) Natural Control: We can use dusting or spraying with lime which effectively controls eggs, caterpillars and the pupae. Natural pesticide sprays made out of pyrethrum, tobacco, rain tree, and dusting with lime will effectively control the larvae and prevent holes on leaves.

7.6 Diseases

(a) Black Rot: caused by the bacterium Xanthomonas campestris: This is one good example of a disease that is caused by bacteria. Black rot is one of the most serious cabbage diseases. It can cause severe damage during the rainy season.

Symptoms are black rot generally begin with yellowing at the leaf margin, which expands into the characteristic “V”-shaped lesion along the leaf margins and necrotic patches on the main leaf laminae. Leaf veins are also darkened. We can control it by the hot water treatment on the seeds (see under tomato). We can also remove or rogue out infected plants and burn them. We should not feed infected material to animals because the diseases can be transferred back to the field when we apply manure. The disease can also be passed through infected seed, from plant to plant in the field or from the soil. Since it stays for a long time in the soil, we should always practice rotations with non-related crops. Also use clean certified seed and practice strict hygiene in the field.

Black rot symptoms on cabbage transplants



The cabbage field on the left has been destroyed by the black rot pathogen. Portions of the field on the right have been overtaken by related weeds which can serve as a source of inoculum

The cabbage above shows typical black rot symptoms, with V-shaped lesions moving into the leaf from the leaf margin.

Figure 7.5

(b) Downy mildew: This is an example of a disease caused by fungi. Signs that the crop is infected are a white fluffy fungal growth on the underside of the first leaf structures (cotyledon leaves). Infection on seedlings can be very severe resulting in high mortality.

Figure 7.6 Downy mildew on cabbage leaves.

(i) Chemical Control: We should always start with healthy transplants and a routine spraying programme can control the disease in mature plants, e.g Dithane M45, at 30grams in 15 litres of water, or use Ridomil Gold

(c) Damping off: is a common disease in seedlings in general caused by a number of fungi. Plants at seedlings stage will die very close to the ground resulting in the whole plant collapsing. We must make sure the soils are well drained and seedlings are not over crowded.

Figure 7.7 seedlings affected by damping-off

(i) Chemical Control: Use Apron Star 42 WS as a seed dressing. Use 10g/4kg seed. Apron Star 42 WS can also control other diseases as well as protect seedlings from aphids for up to 4 weeks after sowing. Can also use Thiram 80 WP as a seed dressing, at 100g/50kg of seed, mixing well. This will also control some other seedling diseases. If the attack is high we can also drench or spray with, the fungicides, Apron star 42 WS, Captan, Thiram 80 WP around the base of the seedling.

(ii) Natural Control Methods; to control most fungal diseases, as recommended by the Natural Farming Network, we can use Ash, Baking soda, burning, compost, manure, milk, mulch, soap solutions, onion, garlic, chilli, pawpaw, sunhemp, african marigold, thorn apple and pigweed. Garden hygiene and planting of health plants that is use certified seeds, time of planting, Avoid excessive watering

and fertilization particularly with nitrate, practice crop rotation, and watering regime will all assist in reducing fungal diseases.

(d) Stem Rot, Sore Shin (Rhizoctonia solani) And Other Soil Diseases

These could be a problem to brassicas use Quintozene 75 WP at 10g/m2 should be incorporated in to the soil to a depth of 50 - 100mm in the planting holes. The soil surface should be kept moist during the early post-transplanting stage. For seed-box treatment use Quintozene 75 WP at 100g/m3 well mixed into the soil and well watered in, you can also seed dress the seed with Apron star 42 WS at 10g/4kg seed.

Talk about the following:

- Why is it not surprising that cabbage has the same diseases and pests with rape and kales?

Now read the next section…

Physiological disorders

Physiological disorders are caused by changes in the growing conditions and are not a result of pests or diseases.

Hollow stem - If boron is deficient, cabbage stems become hollow and cracked This condition will interfere with nutrient and water uptake. Browning of the head may occur as well. Use vegetable basal fertilizers to avoid this problem.

Tip burn - lack of calcium in the soil causes the tips of cabbage leaves to dry. Often the problem is not lack of calcium in the soil, but conditions like poor watering and low soil pH (acidic conditions). Irrigation with moderate levels of ammonium nitrate will reduce the problem. If calcium is deficient apply lime at 800 to 1000 kg/ha or 80 to 100gm2.

Cracking and bolting - Uniform soil moisture and frequent light irrigations will reduce head cracking in some varieties as they reach maturity, especially during the hotter months. Some varieties are inclined to bolt, producing a seed stalk if planted during the coldest time of the year, or if extreme variations of night and day temperatures are experienced. Such varieties should not be planted in late autumn or winter.

Oedema – If there is too much soil moisture during periods of cool nights and warm, humid days, many small, scabby wounds form on the underside of the cabbage leaves. Oedema may be confused with thrip damage. Avoid over-watering.

Head rot and browning – Both these problems are caused by several factors. Problems with calcium uptake combined with rapid growth can result in either condition, even when soil calcium levels are high. Head rot results from bacteria breaking down the tissues under wet conditions. Browning results from individual flower buds dying under dry conditions. Extended periods of wet or dry conditions during warm temperatures give rise to rapid plant growth while calcium uptake is diminished due to poor transpiration rates in the plants.

The best way to address this problem is through mixing varieties. Select a later-maturing variety to be harvested along with your regular variety for that part of the growing season when you have experienced the problems in the past. The slower growth rate of the later maturing cultivar may prevent your total loss of your crop.

Frost Injury - This is common on margins of the lower leaves which wilt and turn brown leading to death in severe situations. The main veins may crack. Avoid planting in areas that experience frost.

Harvesting

It is important to harvest cabbage at the correct stage of maturity.

Talk about the following:
How do you tell the cabbage is ready for harvesting?
Now read the next section…

Harvesting of cabbages can be done after four to five months depending on the variety grown. Heads should be harvested when firm. Heads may crack if harvesting is delayed.

Review what you have learnt in this session then read the summary to check that you have remembered everything.

Summary

- There are many different varieties of cabbage. You should choose a variety best suited to your market and the growing conditions in your area.
- Cabbage does best during cool times of year. It must be given adequate soil fertility and water for good results.
- Pests, diseases and weeds must be controlled in order to get good results from your cabbage production project. Cabbage may also suffer from physiological disorders.
- Cabbage must be harvested at the correct time when the head is firm to avoid head-cracking

.

SESSION 8: Rape and kales

8.1 Introduction

Greet each other and review the learning objectives for this session:

Learning objectives

By the end of this session participants will be able to:

- Grow high quality and high yielding rape and kales by applying good production practices.
- Identify the pests and diseases of rape and kales and use appropriate methods to control them

Rape and kales (chomoulier, rugare and covo) are members of the cabbage family but unlike cabbage and cauliflower, they do not form heads. This gives them the advantage of a long harvesting time. They are probably the most popular vegetables eaten in Zimbabwe.

Figure 8.1

These crops are best during the cold season. However, some varieties of kale (such as rugare) are perennial and may last for up to two years.

Kales and rape will grow well on many different soil types as long as there is good fertility and drainage.

8.2 Land preparation and planting

These crops should be planted so that they grow during the cool season. We can plant the perennial kales (such as rugare) throughout the year. Most of the kales and rape can be grown from seed. Rugare can also be raised from suckers (shoots). Seed can be sown in seedbeds at a rate of 500g/ha. For smaller areas 5g will cover 100m2.

Rows should be spaced 30 to 50cm apart with seedlings planted at 30 to 45 cm. If we widen the spacing we will have larger leaves.

8.3 Crop management

Soil improvement

Demand for nutrients by these crops is not as heavy as the cabbage. The perennial varieties need more because they stay longer in the field. Where good quality compost or manure is available, apply the same amount as for cabbage. Chicken manure can be used as top-dressing but apply it in small amounts to avoid burning the crop.

Use the same amounts of compound fertilizers as for cabbage. Organic or chemical fertilizers, should be mixed into the soil before planting. Remember to mulch the crop to conserve moisture.

Talk about the following:

- What are the main pests of rape in your area? How are controlling these pests?
- What are the common diseases of the cabbage family? How are they controlled?

Now read the next section…

8.4 Crop protection

Kales, rape and cabbage suffer from many pests and diseases especially if they are not planted at the correct time of year or not given the right amount of organic or chemical fertilisers or water. They must also be planted in rotation with crops from other classes to avoid the build-up of pests and diseases. See appendix 1 and 2 for natural control measures of the following pests and diseases. See appendix 3 for details on application of chemical sprays.

The most common pests of this family are aphids bagrada bugs, cutworm and diamond back moth. The most common diseases are black rot, downy mildew, damping off stem rot, sore shin and other soil diseases.
Keep the fields free of weeds but avoid damaging the roots which are shallow.

Activity

Divide into groups
Each group choose one pest and one disease. Using appendix 1 and 2 write down natural recipes to control this pest or disease.
Using appendix 3 write down some chemical measures that can be used.
Present your work to the whole group
Now read the next section…

Harvesting

Harvesting can start four weeks after planting; Rape leaves can be harvested for two to three months, Chomoulier up to four months and Rugare up to two years. Some kales (such as Covo) produce flowers and seed after three to four months. Yields and duration of harvesting will depend on management, particularly water and soil fertility management, and time of the year we will have planted. It is also advisable to harvest vegetables early in the morning or late in the evening in order to maintain quality.

Discuss

Review what you have learnt in this session then read the summary to check that you have remembered everything.

Summary

- Rape and kales belong to the cabbage family. Most live only a few months but some varieties such as rugare are perennial and may last for up to two years.
- Rape and kales grow best during the cold season. They require fertile, well-drained soil.
- They are prone to a wide range of pests and diseases so good crop management is very important.
- Their advantage over cabbages is that the leaves can be harvested for many months. This can bring in a steady income for the farmer and supply a regular source of vegetables for the family

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SESSION 9 Tomato production

9.1 Introduction

Greet each other and review the learning objectives for this session:

Learning objectives

By the end of this session participants will be able to:

- Identify the different growth patterns of the tomato and use the skill to better manage the crop.
- Identify the different maturity stages of tomatoes and use the skill to reduce postharvest losses.
- Achieve high yields of high quality by using appropriate production methods.
- Reduce yield and quality losses through correct identification and control of pests and diseases

The tomato belongs to the same family as potatoes, eggplant, tobacco and chili. The tomato is an important crop in Zimbabwe which is grown by many farmers.

Growth habit

Tomatoes are classified into three groups based on their growth patterns;
Indeterminate types – the main and side stems continue their growth in a continuous pattern.
Determinate types – the main and side stems stop growth after a specific number of flower heads.
Semi-determinate types - branches stop growth when a flower head develops, but this usually occurs at an advanced growth stage.

Tomato varieties

There are numerous tomato varieties available in Zimbabwe. New varieties continue to be made available every season. The most common varieties are Starke Ayres Tomatoes such as Star 9008, Star 9011, Star 9062 and Star 9068. The more traditional varieties include Moneymaker, Roma, Rodade, Tshibili, Tengeru (from Tanzania), Jam,

Growth requirements

Tomatoes are a warm season crop and do not tolerate very low temperatures. The optimum temperature is in the range 26 - 29°C. Temperature influences all stages of development of the plant.
Tomatoes can be grown on a wide range of soil types, from light, sandy soils to heavy, clay. Very high levels of fertility are required since they are heavy feeders. Under optimal soil conditions, root development is extensive and can reach a depth of 1.5m.

Talk about the following:

- How would the addition of organic matter to the soil benefit the tomato?

Now read the next section…

9.2 Land preparation and planting

Strict crop rotation must be practiced with tomatoes. Never plant tomatoes time after time in the same beds as this will cause serious pest and disease problems for you. Never put tomato crop residues in your compost heap as this may cause the spread of diseases.

Tomato seedling production

The crop is best grown for seedlings. Soil for the seedlings must be very fertile and free of nematodes, diseases and weeds. The seedbed site should be fenced and windbreaks are desirable. High standards of hygiene will reduce the incidence of disease.

Because tomatoes are deep-rooted the field should be ploughed as deep as possible. The soil must be light and friable, well drained and non-crusting. The addition of compost or manure will improve the friability of the soil.

Beds should be fertilized at the rate of 3kg of Compound S (7:20:8) per 25m2 plus 2 kg dolomitic limestone (where necessary). Seed is sown in rows 7.5 cm apart with 2.5 cm between plants. The depth of sowing is 6mm. A 40m2 bed sown at the rate of 150g seed will be sufficient to plant a hectare.

Give the beds a good watering a few days before sowing. After sowing and before germination, water early in the morning and again at noon using a fine hose. After germination, one watering in the early morning is all that is required. At no time should seedlings be over-watered. Older seedlings require watering only two to three times per week. When seedlings are as thick as a pencil and 12 - 15cm tall, reduce watering, and give water only when they show signs of wilting.

Figure 9.1

Transplanting

If seedlings have been planted in trays, gradually introduce them to sunny conditions until the plants can withstand direct sunlight. Tomatoes can root from the stem so plant them slightly deeper than most other vegetables.

Avoid transplanting when the leaves are wet, as bacterial canker entry is greater under these conditions. Plants should be handled carefully and placed in planting holes so that that the soil when planted is the same level as it was in the tray or seedbed. The slightest damage to the seedlings will increase the possibility of bacterial canker infection.

Plant the seedlings at 30 to 50 cm between plants with 0.75 to 1.2m between rows depending on our chosen method of staking. Try to have at least 30 000 - 35 000 plants per ha.

Discuss

Talk about the following:

- Why is staking and trellising important for tomatoes?

Now read the next section…

9.3 Crop management

Staking and trellising

Staking will reduce diseases by keeping the fruit and the leaves away from the soil. It makes it easy to spray, weed, top-dress and harvest.

There are various methods of staking or trellising depending on availability of materials and resources. We should stake as soon as planting has been done, if left too late, plants are more likely to break when tying them.

Discuss

Talk about the following:
Why should we encourage one main stem by removing all suckers below the first flower cluster?
Now read the next section…

Pruning

Pruning should be done to remove the suckers that form in the space between the leaves and main stem of indeterminate tomato types in order to help the plant produce its food efficiently and reduce risk of diseases. A strong main stem is encouraged by removing all suckers below the first flower cluster. Side shoots should be removed before they are about 5cm in length since smaller wounds will heal faster. Scissors or finger tips can be used to remove the side shoot. However a disinfectant should be used to avoid the spread of diseases.

Soil improvement

Basal fertiliser: Apply compost or manure at the rate of 25 to 50 t/ha (2.5 - 5kg/m2. If are using fertilizers, apply 100 - 150g of Compound S or Compound C, per m2.

Top dressing: apply the top-dressing in stages three weeks apart. You can use ammonium nitrate and potassium sulphate (or sulphate of potash - 50% potassium and 16% sulphur), at a rate of 10g/m2 every three weeks repeated two to three times. The first application is done when the first fruits reach marble size (1cm in diameter). A side dressing or foliar spray of calcium nitrate is required during fruit setting and development.

Irrigation

Tomatoes need frequent irrigation when they are still at seedling stage. After establishment water application can be done in response to the climatic conditions. Once the first fruits are formed, apply water as frequently as possible. Mulching can be used to reduce evaporation. In winter use of the mulch is not advisable.

Discuss

Talk about the following:

- Why do you think the use of a mulch in winter is not advisable?

Now read the next section…

Mulching

In summer application of mulch helps reduce water loss from the soil and protects the roots from high temperatures by blocking the heat of the sun. In winter a mulch would prevent the less intense sun from warming the roots and may also reduce cold air drainage which will settle in the field.

9.4 Physiological disorders

Because they are sensitive to temperature, moisture and soil nutrients, tomatoes can suffer from many physiological disorders. It is important to be able to identify the difference between these and symptoms of diseases.

Blossom end rot - occurs when calcium is inadequate in the soil. It shows as a rotten looking patch at the base of the fruit. Often the problem is not that there is no calcium in the soil, but that watering is irregular. Improving watering often solves the problem. If calcium is lacking, liming or calcium sprays will reduce the problem.

Figure 9.2 water-soaked area at the blossom end of the fruit

Blotchy ripening - occurs when tomatoes have hard green areas which do not change colour when the rest of the fruit is ripe. This is caused by lack of potassium. It usually occurs when there is lot of moisture in the air during humid weather, and the plants are growing vigorously.

Fruit cracking - occurs when soil moisture changes rapidly from wet to too dry. To avoid it, select resistant varieties and keep moisture in the soil at good levels.

Figure 9.3

Sunscald - affects immature fruits on the side exposed to the sun. It appears as a pale patch. Trellising can increase sunburn by increased fruit exposure due to reduced leaf cover.

Figure 9.4 Sunscald

Discuss

Talk about the following
- What are common tomato pests and diseases in your area?
- How are they controlled?

Now read the next section

9.5 Tomato crop protection

Tomatoes are very susceptible to attack by pests particularly aphids, cut worms, heliothis bollworm, leaf miner, nematodes, red spider mite, thrips and whitefly, See the natural pest and disease section appendix 1 and 2 for home-made remedies for these pests or appendix 3 for chemical solutions.

Tomatoes can be affected by a wide range of diseases particularly bacterial canker, bacterial speck, bacterial spot, bacterial wilt, damping off, early blight, late blight, leaf spot and powdery mildew. The best way to control these is to practice crop rotation, good hygiene in the field and correct timing of planting. See the natural pest and disease section appendix 1 and 2 for home-made remedies and appendix 3 for chemical remedies.

9.6 Tomato Diseases

(a) Bacterial diseases

(i) Bacterial Canker:, Plants at any stage of growth are susceptible. Infected seedlings may be quickly killed, or they may produce weak, stunted plants, or if conditions are unfavorable for disease development, infected seedlings may develop into apparently healthy plants that fail to show disease symptoms until they are set in the field. The early symptoms of the disease are wilting, curling of leaflets, and browning of leaves, often only on one side of the plant. As the leaves die, the petioles remain green and firmly attached to the stem. A cut through the stem shows yellowish brown discoloration of the vascular element. We also see small spots on the fruit with a white or yellow spot.

Control: Bacterial canker is one of the most difficult tomato diseases to control. First, there is the problem of detecting infected plants, due to the wide variability of symptom expression. We can control the disease by hot water treatment of seed as we discussed before. We can easily leave the disease in the soil or it can be transmitted through seed. Use only certified, disease-free seed from canker-free plants. Never save seed from a source known to have had bacterial canker. Plant only certified disease-free transplants that have been produced under a vigorous inspection program. It is usually not possible to distinguish between infected or healthy seedlings at the time of transplanting. Fixed copper sprays may help in protecting healthy plants, particularly if only superficial symptoms are present. Practice strict crop rotations and sanitation.

(ii) Bacterial Spot. It usually appears as dark-brown raised spots on the fruits becoming sunken and

rough to the touch. The disease is carried through seed and infection only occurs during wet weather. To control we should practice hygiene during seed bed preparation and planting. We can also use fungicides like, copper oxychloride at 45 grams mixed in 15 litres of water.

Figure 9.5 Bacterial spot

(iii) Bacterial Wilt: which causes a sudden dying of plants (Fig 14), browning inside the wood flesh, from which bacterial slime comes out after cutting across the main root and lower part of the stem. We can control by hygienic practices and avoid places where water stands (water logging soils) without good drainage or use copper oxychloride.

Figure 9.6 crop affected with bacterial wilt

(iv) Bacterial Speck: another common bacterial disease that we can encounter in tomatoes production. We will find occurring to plants during rains and cool weather. The diseases can attack the whole plant including the fruit. On leaves it will be appear as brown spots surrounded by a yellow ring (Fig 15). On fruits we will see black raised spots resulting in a rough appearance on the fruit skin if we touch it. We can control with chemicals like Copper Oxychloride and Mancozeb.

Figure 9.7 fruit affected with bacterial speck

The natural control methods recommended (by the Natural Farming Network) against bacterial diseases are Ash, Burning, Compost, Manure, Sun, Garlic, Chilli, Tomato and Goat Weed.

See Natural Pesticide Preparations in the last pages in Chapter two, on Traditional Vegetable Production Techniques. Regular routine spraying with compost extract, manure and urine mixes are considered to be among the most effective control measures to suppress bacterial diseases.

(b) Viral Diseases

(i) Mosaic Virus: This disease is called mosaic because of the appearance of infected leaves. The disease causes plants to grow slowly with a distorted appearance (stunted growth), leaf curling, purpling of the leaf veins, brown markings sometimes appear on the fruits. We have to practice rotations and avoid cropping where other Solanaceae crops were planted before.

(ii) The second disease caused by virus we call Bunchy Top and it causes a marked reduction in shoot length, resulting in closely crowded leaves at the top of the plant hence the name bunchy top. Fruits will be small and distorted.

Viruses are difficult to control once they are present. If infections are serious leave the land fallow for long periods. They can be prevented by growing and planting healthy plants, rotations, general hygiene. Control of sucking insects which spread the viruses, like aphids, leafhoppers, thrips and mites. Natural pesticides we could also use are Compost, Manure, Milk, Mulch, Oil-mineral-paraffins, Chilli,- Tobacco and Wild tobacco.

(c) Fungal Diseases

(i) Early Blight is the most common tomato disease. It appears as dark reddish brown leaf spots with concentric (round) markings appearing on the bottom leaves causing defoliation. We can at times see the disease on the fruits as well. It appears at any time during wet weather. We can control it by use of fungicides as routine spraying where it is prevalent. For control, spray with Mancozeb as from flowering, once a week, at 20g mixed in 15 litres of water. For curative treatment use Folicur 250 EC at 12ml per 15 litres of water or Score 250 EC at 6ml per 15 litres of water.

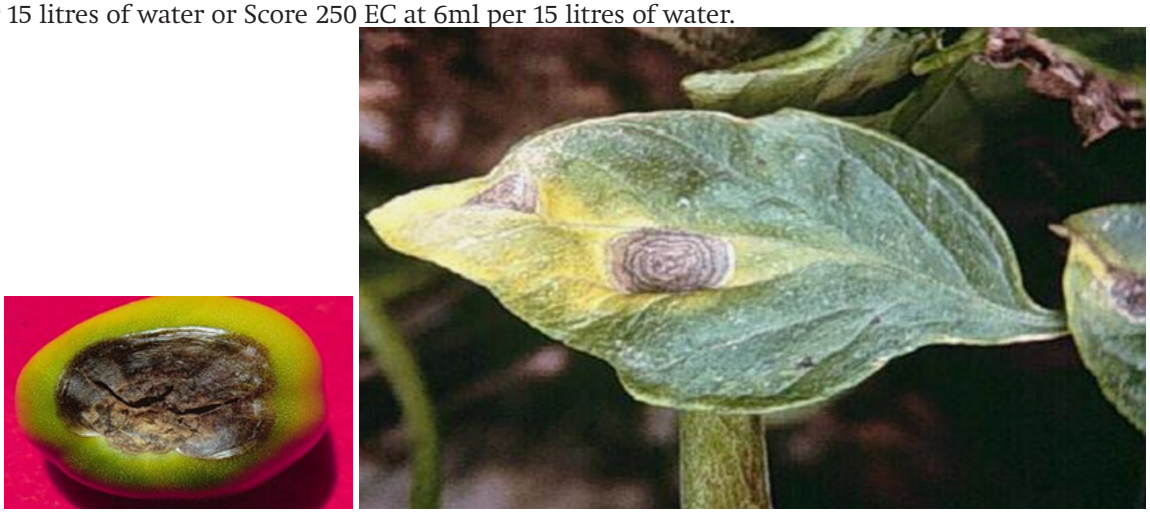

Figure 9.8 early blight

(ii) Late Blight is the second disease caused by fungi. It is very common but it is one of the most destructive diseases in tomatoes and potatoes. Greyish-green water soaked blisters on the leaves rapidly turning black. Stem blisters are dark brown and large mottled areas develop on the fruit. We can experience this disease mostly during wet weather and it can be very serious. Several chemicals are available but it is always better to prevent than to control when it has already attacked the crop. We must also use clean planting material. If we are to use chemical control use Mancozeb as in Early blight, or Ridomil Gold) at 190g per 15 litres of water or use Bravo 500 SC at 30ml in 15 litres of water sprayed once a week. Other recommended products include Milraz, Melody Duo

Figure 9.9 fruit affected with late blight

(iii) Leaf Spot is another fungal disease we are likely to meet in tomato cultivation. We usually see it as small spots with light coloured centres appearing on the older leaves, first causing leaves to turn yellow and then they drop. The disease can cause a lot of damage to tomatoes during wet weather. Use fungicides and natural pesticides.

(iv) Powdery Mildew: We often see it appearing as white powder on the plant. Common in hot and dry weather. Chemical control is by Sulphur 80 WP and Alto at 28mls mixed in 15 litres of water (harvest interval 3 days), plus natural pesticides as we mentioned before. You can also use Sulphur 80 WP at 30 grams per 15 litres of water or Score 250 EC at 6ml per 15 litres of water or Benomyl at 7 grams per 15 litres of water.

Figure 9.10 Symptoms of powdery mildew on tomato leaves

(v) Damping off: is a disease caused by two fungal agencies and it affects crops at seedling stage. The plants will die at the soil level and then collapse. We must make sure soils are well drained. Control by dressing seeds with Apron star at 10 grams per 4kg seed or applying a fungicide like Copper oxychloride and Ridomil (Metalaxyl) at the base of the plants.

Figure 9.1:1 Seedling killed by damping-off

The natural control measures recommended (by Natural Farming Network) for control of fungal diseases are Baking Soda, Burning, Compost, Manure,Milk, Soap solutions, Onions, Garlic, Chilli, Pawpaw, Sunhemp, Tobacco, Castor oil and Mexican marigold.

Insect Pests

(a) Aphid. Aphids are small green sap sucking insects (see picture under cabbage). These small, green insects cluster on the undersides of young leaves and stems and can multiply very rapidly. The leaves of infested plants may become distorted and severely infested plants may become stunted. Aphids are also spread virus disease. Many chemicals are available to control them. Actara 25 WG at 10 grams mixed in 15 litres of water. Dimethoate (Rogor) at 75 mls mixed in 15 litres of water (harvest crop after 14 days) and Malathion 25 WP at 30 grams mixed in 15 litres of water (harvest after 3 days), Chess 50WG at 400g/ha Its harvest interval is 3 days. We can also natural control measures, like Garlic, Marigold, Onions grown as intercrops to repel certain species of aphids. Black nightshade is good trap plants to attract aphids away from the main crop. We can use natural pesticides but, because aphids attack the growing parts, we must ensure concentrations of natural pesticides do not affect plant growth. The following we use as dust or sprays: Ash, Clay, Manure, Salt, preparations, soap solutions, vinegar, garlic, chilli, pyrethrum, sweet potato, tomato, tobacco, wild custard apple, black jack, lantana,mexican marigold, wild cucumber.

(b) Red Spider Mite. A small orange to red mite with 4 pairs of legs of equal size. We occasionally see webs on the plant, very visible when seriously attacked. Red Spider mite is a sucking pest which causes wilting and spots on leaves. We can use many chemicals to control it, like Kelthane at 15 millimetres mixed in 15 litres of water, dicofol, diazinon and amitraz (check rates on labels). We need to rotate the chemicals as these insects build resistance.

Figure 9.1:2 crop attacked by red spider mite

Figure 9.1:3 crop attacked by red spider mite

We can also use natural pesticides like Ash, Clay, Manure, Milk, Soap Solutions, Onion, Garlic, Pyrethrum, Tomato, Syringa, Tobacco, Black Jack and Eurphobia. When plants are severely infested the best way we can control is to remove and burn the plants. We should also check weeds that can host Red spider mite and remove them.

(c) Cut worms: This cause direct lose and affect plant stand. It's a major problem after transplanting, cuts the plant at the base, use Karate at 100 ml/100 l water spray at the base of the plant,this will give the best results. Carbaryl 85 WP at the rate of 150 - 200 g/100 lt, applied in the planting hole, is also recommended. Pyrinex 48EC at a rate of 200ml in 100lt of water drenched soon after transplanting using cup 30/plant is also recommended.

Figure 9.1:4

(d) Thrips are another insect pest that we are likely to encounter in tomato cultivation. When we see small insects shaped with a point (torpedo shaped), with hairy wings they are thrips. Thrips sucks sap causing dying of leaves and they also spread diseases. For control we can use chemicals like Malathion, Dichlorvos (Dedevap), Monocrotophos, Cypermentrin and Endosulfan (Thiodan or Thionex), for how much to apply we must read the label. We can also use following natural pesticides: Clay, Glue, Manure, Soap solutions Onion and Tobacco. Adult thrips can be trapped by hanging blue or yellow sticky boards, a light coating of engine oil can be used in place of glue. Any of the natural control measures mentioned for aphids we can also use to control thrips, although thrips are more difficult to control because they hide in buds and leaf sheaths.

(e) Heliothis Bolloworm: Fruitworms, primarily the tomato fruitworm, feed on tomato leaves and fruit. Distorted leaves often result from feeding upon the tips of the leaves in the developing bud. Color varies from greenish-yellow and reddish-brown or even black with paler stripes running lengthwise on the body. The moth lays its eggs on the tomato foliage and the caterpillars feed on the leaves and fruit, causing extensive damage. It is controlled by using Methamidophos 585 SL at 500ml/Ha, harvest interval 3 days. Carbaryl 85 WP can also be used at 200 g/100 l water full cover spray. Harvest interval for Carbaryl is 7 days. or Thionex 35 EC at 190 ml/100 water full cover spray. Harvest interval is 1 day.

Figure 9.1:5 heliothis damaging the fruit

Figure 9.1:6 tomato fruits severe damaged by tomato fruitworm

(f) Whitefly: Like aphids, whiteflies have piercing-sucking mouthparts so the damage caused is very similar to that of aphids. Direct damage to tomato plants causes deformed new growth and wilting, chlorotic leaves. Whiteflies can also transmit some plant viruses. If your plant gets infected with a virus, do your neighbor a favor and pull it out. Whiteflies, like aphids, secrete honeydew, causing the opportunity for sooty mold to grow. Feeding by whiteflies can also cause deformed fruit and discoloration of your tomatoes. Is becoming increasingly important, especially under greenhouses. Control using Imidacloprid 200 SL ® at 50 ml/100 lt water. Apply in 300 - 500 lt mix/ha. Chess 50WG is recommended at 600g/ha. Harvest interval is 3 days. Actara 25WG at a rate of 400g/ha spray or 0.02g/plant drench is recommended. Harvest interval is 7 days. (Harvest interval: 0 days).

Figure 9.1:7 whiteflies under the tomato leaf

(g) Nematodes

Nematodes are not insects but very small worms that cause a lot of damage to the roots of tomato. We can face serious problems with them if our soils are sandy. We can control them by rotations, and use of resistant varieties. We can use chemicals like Nemacur granules at 10 grams per square metre, Nemacur 400 EC at 18 to 20 mls mixed. However the chemicals can be very expensive.

Figure 9.1:8 tomato roots damaged by nematodes

Natural pesticides like Ash, Burning, Garlic, Pawpaw, Tomato, Cassava, Syringa and Thorn weed can also be used. Adding organic manure has been reported to reduce nematodes; rotations will also assist us to keep levels low.

(h) Leaf miner: Punctures caused by females during the feeding and oviposition processes can result in a stippled appearance on foliage, especially at the leaf tip and along the leaf margins (Parrella et al. 1985). However, the major form of damage is the mining of leaves by larvae, which results in destruction of leaf mesophyll. The mine becomes noticeable about three to four days after oviposition and becomes larger in size as the larva matures. The pattern of mining is irregular. Both leaf mining and stippling can greatly depress the level of photosynthesis in the plant. Extensive mining also causes premature leaf drop, which can result in lack of shading and sun scalding of fruit. Wounding of the foliage also allows entry of bacterial and fungal diseases. There are two types of miners, the American Leaf Miner (ALM) and the Tuber moth. The adult is a fly and is commonly referred to by its species name, Liriomyza. Control is effected by sprays of Cyromazine 75 WP at 150 g/ha or Abamectin 18 EC at 100 ml/100 l water. Both products have a harvest interval of 3 days. The Tuber moth adult is as the name implies, a moth and control effected by spraying with Methamidophos 585 SL at 100 ml/100 lt water or 500 ml/ha. Leaf miner attack often predisposes plants to infection by Early Blight.

Figure 9.1:9 Mine in tomato leaf caused by Liriomyza leafminer

Figure 9.1:10 Mine in tomato leaf caused by Liriomyza leafminer

Activity

Divide into groups
Each group choose one pest and one disease.
Using appendix 1 and 2 write down natural recipes to control this pest or disease.
Use appendix 3 to write down the chemical solutions.
Present your work to the whole group
Now read the next section…

Discuss

Talk about the following:

- How do you tell tomatoes have ripened?
- What care should be taken when harvesting tomatoes?

Now read the next section…

9.6 Harvesting

Ripening stages

Tomatoes can be harvested green and allowed to ripen while in storage. This is because tomatoes fruits produce a gas that helps ripening. Colour changes in tomatoes are due to various chemical changes in the fruit, this is why we notice a tomato does not get red immediately but gradually. As the colour changes the fruit starts to soften and the flavour changes as well. The following are the various colour changes we find occurring in a tomato.

- Pale blossom end: cream coloured streaks appear at the blossom end, the skin is tougher and the fruit picked at this stage will last a week or more before becoming fully ripe.
- Pink blossom end: seeds are developed; stalk gets a brownish colour and the fruit appears light green at the base. The jelly around the seed will have formed. The tomato fruit ripens from bottom upwards. Harvest at this stage if the market is a long distance away and they will ripen well.
- Pink or breaker stage: the majority of the fruit has fully ripened. A pink colour covers a quarter of the bottom end, ripening gas production is beginning.
- Pink stage: Majority of the fruit is ripe.
- Ripe stage: the fruit is red, soft and you can peel off the skin. This stage is too late for any long-distance travel.

Preparing for market

Discuss

Talk about the following

- What are your customers' requirements for tomatoes?
- What is the time of year when prices for tomatoes are highest?
- How will this help you when to plant your tomatoes?
- How do you grade and pack tomatoes?

Now read the next section…

Tomatoes should be graded according to size and quality? Tomato fruit should be sorted and the packed in standard wooden or cardboard boxes, the sizes of boxes will vary depending on the mode of marketing. The most desirable temperature at which to transport tomatoes is 13 - 21°C with a relative humidity of 85 - 90%.

Discuss

Review what you have learnt in this session then read the summary to check that you have remembered everything.

Summary

- There are three types of tomatoes; indeterminate, determinate and semi-determinate.
- Tomatoes are a warm season crop and do better in areas where frost does not occur.
- Tomatoes need fertile soils. Care must be taken when irrigating this crop.
- Physiological disorders include fruit cracking (rapid soil moisture changes), blossom end rot (calcium deficiency), blotchy ripening (Potassium deficiency) and sunburn (fruit exposure to sun).
- Tomatoes suffer from a wide range of pests and diseases. Crop rotation, timing of planting and other good crop management practices are very important to reduce these.
- Trellising of tomatoes especially the indeterminate types is important to reduce risk of diseases and to facilitate cultural practices.

SESSION 10 Onion production

10.1 Introduction

Greet each other and review the learning objectives for this session:

Learning objectives

By the end of this session participants will be able to:

- grow high quality onions by using recommended practices;
- reduce onion storage losses caused by diseases and poor storage conditions;
- increase yields by applying effective disease and pest control methods;
- Prevent big losses caused by buying wrong onion seed for the Zimbabwean climate;
- Prevent yields reduction caused by premature flowering of onions.

The onion is a very important vegetable crop that is widely grown and consumed in Zimbabwe. It belongs to the same family as garlic, leeks and shallots.

The onion produces a bulb in the first season of growth and produces flowers and seeds in the second. We commonly grow it as an annual crop whereby we harvest the bulb and leaves as a vegetable before the seeds are produced. Onion is a shallow rooted crop with a fibrous root system; roots reach a maximum depth of 60cm and are produced from the base of a very short stem.

Growing requirements

For best growth and bulb quality, onion requires cool weather during the early stages of growth and a dry atmosphere with moderately high temperature for bulb development and maturation. Planting should be done between April and May. Onions will grow on a wide range of soils from sandy to clay soils. Soils should be well drained and fertile.

Varieties

Onions varieties start forming bulbs based on day- length. Short-day onions form bulbs when the day length is between 10 and 12 hours whilst long-day onions start to form bulbs when the day length is between 14 and 16 hours.

For cultivation in Zimbabwe choose short-day onion varieties. Such as Early Premium F1, Bon Accord, Texas Grano, Pyramid and Yali (red).

Figure 10.1 Good onion crop

Discuss

Talk about the following:

- What factors should we consider when selecting an onion variety?
- Which varieties have you grown before?
- What were their advantages and disadvantages.

Now read the next section…

10.2 Land preparation and planting

Plough the field as deep as possible breaking up all clods. Lime should be applied a month before transplanting and ploughed in the soil if the soil pH goes below 5 (CaCI2).

In the absence of soil analysis, apply 600 to 800kg/ha of Compound S (50 - 80 g/m2) as a basal dressing. Mix the fertilizer into the soil before planting. The crop responds well to organic matter which should be incorporate together with the fertilizer before planting if available.

Crop Establishment

Onions can be established from direct seeding, by transplants or by using setts (small mature onion bulbs

Onions sown from seed directly into fields will mature four to six weeks earlier than transplanted onion. This is because the plants will not suffer transfer shock. Bolting problems are also reduced because of less stress. However, the method requires high levels of management to keep the small plants growing well on a large area. Watering and weed management should be spot on.

When using seedlings to establish the crop, sow seeds in a well prepared fertilised seedbed. If using trays or boxes, mix fertiliser and the soil well. A 1ha production area requires 5kg seeds. A 300-500m2 seedbed produces enough transplants for one ha. Prepare beds 1m wide and incorporate fertilizer, compost or manure. Line sow 3-5 kg seeds in rows set across the bed 7-10 cm apart. Distribute seeds thinly and evenly to control damping off. Cover the seeds lightly with compost and mulch with wheat straw or grass clippings. Maintain adequate soil moisture. Seeds will germinate in seven - ten days. Speed up seedling growth by top dressing, at two to three weeks after seed sowing, with 30g/m2 ammonium nitrate. Seedlings will be ready for transplanting after six to eight weeks, when they as thick as a pencil. When transplanting, select vigorously growing and healthy plants. When planting bury only the roots. Sets is another method. Sets are produced by sowing onion seeds are sown in a seedbed at a rate of 10 to 13.5g/m2. Once bulbs mature, they are lifted, dried and stored in a cool dry place. Good sets should be 25mm in diameter and 120 to 135 bulbs per kg. Use of sets bigger than 35mm increase the chances of bulb splitting. Planting out into the field can be done during the warm rainy season. These onions will best be sold as green onions and will mature early when there are no onions on the market.

Spacing and transplanting

Transplant seedlings five - six weeks after sowing. Gently uproot the seedlings to prevent root damage. Plant at 15 - 20cm between rows and 7- 10cm between transplants. Use markers for proper spacing and to facilitate transplanting. Care must be taken so as not to damage the basal portion of the plant. Place the white portion of the plant below the soil surface. Press the soil firmly around the basal portion. Irrigate the field before and after transplanting. Sets can be spaced at 5 -7cm within rows spaced 30cm apart.

10.3 Crop management

Soil improvement

Top dressing is applied at the rate of 300kg/ha of ammonium nitrate (34.5% Nitrogen) or 30g/m2, four - six weeks after transplanting. This can be applied in two applications of 15g each if necessary. The first 15g are applied at four - six weeks after transplanting and the second at three weeks later.

Irrigation

Onion, like most horticultural crops, are best produced during the cool dry season. This means water for irrigation is needed. As the crop grows, watering should increase but reduce as the crop nears maturity. Watering should be stopped when the tops of more than half of the crop have collapsed.

Talk about the following:

- What problems have you experienced when growing onions?
- What caused those problems (pests, diseases, weeds, other conditions)?
- How did you address the problems?

Now read the next section…

10.4 Crop protection

Weed control and cultivation

Onion is a poor weed competitor. Hand weeding can be done between rows but is difficult within the rows owing to the close plant spacing used for onions. See appendix 4 for a list of herbicides.

Talk about the following:
It is difficult to weed onions by hand because of the crop spacing.
Divide into two small groups.
Using appendix 4 develop a presentation on weed control for onions using herbicides. One group should present on control of grasses while the other should look at broadleaf weed control.
After reporting back to the main group, read the next section…

Pests and diseases

Unlike tomatoes or members of the cabbage family, onions are not attacked by many pests or disease. The main onion pests are cutworm and thrips. In terms of diseases onions are affected by downy mildew, purple blotch, and storage rots.

Onions do not have problems with a lot of insect pests and disease like tomatoes or the Brassica family. **(a) Thrips:** One of the most common and troublesome insect pest. These are sucking insects which feed on the young leaves causing silver color. Thrips can reduce onion yields to very low levels. We can control by use of chemicals like Malathion 25 WPor Endosulfan (see control of thrips under tomato)

onion thrips

adult thrips

Figure 10.2

(b) Cutworms: Another pest that can cause damage to onion seedling. Cutworms are dull grey to black C-shaped caterpillars (worms) with a smooth skin. They feed at night, cutting plants just below the soil level. One cut worm can cut several plants in one night. They also feed on a wide range of crops at tender age. We can control cutworms by making sure the area we are going to plant is free of weeds six weeks before planting. When we use undecomposed manure or compost.

When we observe cutworm damage and dig slightly around the plant, we will find the cutworm and should kill it. Chemicals to control cutworms are available and these are Kaate 5EC, Carbaryl 85 WP spray or maize baits of Endosulfan 50% WP and Trichlofon 95% SP.

Figure 10.3 cutworm

Diseases

(a) Purple blotch: One of the major onion diseases we are likely to encounter, a disease caused by fungi. As we have said for insect pests, onions also do not have many diseases like other crops we have discussed before. The disease can cause damage when humidity (moisture in the air) and temperatures (heat) are high. When we see small irregular white patches white patches on the leaves, which can enlarge to big dry patches with purplish centres it will be purple blotch. Leaf parts beyond this point will dry. We can control the disease by spraying once a week with fungicides like Dithane M45 at 30 grams mixed in 15 litres of water, Mancozeb at 20 millimetres mixed in 15 litres of water. Natural pesticides we discussed for tomato diseases can also work on onion.

Figure 10.4 purple blotch

(b) Downy mildew (Perenospora destructor) is a serious disease of onions. This disease attacks onions when the weather has full of moisture (humid conditions) in winter. Control is by spraying once a week with fungicides like Dithane M45 at 30 grams mixed in 15 litres of water. Natural pesticide, discussed under tomato, also work.

Figure 10.5 onion crop affected with downy mildew

(c)storage rots, can be experienced and the most common is White Bulb Rot. This is characterized by a black sooty-like mold which develops between the scales of the bulb. Remove and destroy all infected bulbs, and always inspect onion in storage.

Physiological disorders

Common disorders of onion are:

Thick necks - these develop when plants fail to mature properly due to either too much water, excessive top dressing with nitrogen-rich fertiliser and a low plant population. Very wide plant to plant spacing can also encourage thick necks. If we apply manure to onions and use wide inside-row spacing the crop will have a lot of thick necks. Onions which we want to sell or keep as dry bulbs must have thin necks so that they will close or seal at the top of the bulb. This will protect the bulbs from rotting. When thick necks are left to dry, they do not seal at the top causing the bulb to rot from the inside.

Bolting – this occurs during unusually hot weather. The onion may flower in the first season. This affects the bulb quality by producing a hollow flower stalk starting from the top of the flower going down to the bulb.

Split bulbs - this occurs when the developing bulb does not remain as one solid unit, but split into two parts. This will not affect bulb quality but onion with bad shapes will not sell well.

10.5 Harvesting

How do you know onion are ready for harvesting? How do you harvest onion?

Onions can be very rewarding because of high yields. On average, we can get 25t/ha or 2.5kg/m2 but yields as high as 40 to 60 t/ha can be achieved depending on variety and management. About a month before harvest, it is best to start working the soil away from the bulbs. This process should involve two or three cultivations so that about seven to ten days before harvest time, the bulb is about one-third above ground. This speeds-up bulb and neck drying.

Begin lifting onions from the soil when half of the tops of the crop have fallen over. At this stage, the leaf scales will have sealed over the neck of the bulb and the young innermost leaves would have stopped growing. Avoid lifting onions when rains are expected and make sure the crop is exposed to air circulation if it rains.

Leave the crop in the field while the leaves turn yellow and dries out. Bulbs should not be exposed to direct sunlight since they sunburn easily. The tops are cut 1-1.5cm from the bulb, the roots trimmed off, the bulbs placed (not thrown) in field crates and transported out of the field within one to two hours.

Talk about the following:

- What is curing?
- Why do we cure onions?

Now read the next section…

Curing

Curing means drying out the onion. This improves its shelf-life and is very important. If necks are not thoroughly dry, neck-rot results. Tobacco barns or groundnut A-frames or similar structures can be used for curing.

Storage

Bulbs can be stored for household use or to wait for periods when onion prices are high prices. When we want to store for long periods, bulbs should be allowed to mature fully in the field. Maturity is seen when the join between the bulb and the green leaves becomes soft and the tops fall over. Storage structures must protect the bulbs from the sun and rain and maintain good air circulation around the bulbs. This can be achieved by:

- Stacking bulbs on mesh wire or a wooden or cane platform with an air space below.
- Spreading bulbs out on a shelf (not heaping a lot of bulbs on top of each other).
- Plaiting the dried leaves of the bulbs into bunches and hanging these bunches from the ceiling.

The maximum length of time we can store onions depends on:

- Variety
- What sort of storage structure we have
- Whether we have money to buy mesh wire.

- The quality of bulbs that the buyers want.
- Conditions of the bulb when they are placed in storage.

Preparing for market

Discuss

Talk about the following

- What are your customers' requirements for onions?
- What is the time of year when prices for onions are highest?
- How do you grade onions?

Now read the next section…

Onions are graded according to size and quality. A high-quality pack is obtained by eliminating immature, decayed, sunburned, and mechanically injured bulbs, double bulbs, and bulbs that have started a second growth. Buyers usually specify minimum size of the onions they will buy. This minimum size is usually 5cm in diameter although some will buy onions 2.5 cm in diameter. Usually onions 7 to 7.5cm being a premium price. Onions are usually sold in 15kg bags.

Discuss

Review what you have learnt in this session then read the summary to check that you have remembered everything.

Summary

- The onion is sensitive to day-length and as such we should only grow short-day onion varieties in Zimbabwe. They should be grown during the cold, dry season with irrigation.
- Onions are easy to grow as they are not heavy-feeders and are not attacked by many pests and diseases.
- Thrips and the disease purple blotch are some of the major problems of growing onion in Zimbabwe.
- Onions can suffer from several physiological disorders.
- For marketing onions should be lifted when the leaves yellow and fall. They should then be cured on drying structures to improve their shelf-life.

SESSION 11: Carrot production

11.1 Introduction

Greet each other and review the learning objectives for this session:

Learning objectives

By the end of this session participants will be able to:

- Group carrots according to their types and select appropriate varieties to grow;
- Achieve high-quality yields through appropriate growing methods;
- Identify the major carrot pests and diseases and use appropriate methods to control them;
- Reduce production losses through good postharvest practices;
- Improve sales of carrots through grading.

The carrot belongs to the same family as celery, parsnip and parsley. It is a root crop which is highly nutritious. Carrots are particularly rich in carotene (pro-vitamin A). They are consumed either fresh, as a salad crop, or cooked. Large quantizes are also processed either mixed with other vegetables

Discuss

Talk about the following:

- What carrot varieties do you know?
- Which have you grown?
- What are the advantages and disadvantages of those that you have grown?

Now read the next section…

Common varieties

Figure 11.1

Nantes: these are almost cylindrical in shape, and round off at the end rather than tapering off. They have a small core and a larger outer cortex where sugars accumulate, giving Nantes their sweet taste. Nantes have short storage potential.

Imperator: This is the most commonly grown carrot because of its high yields and has long storage potential. Imperators are long and tapered. They are a late maturing variety, and generally have a large, more fibrous core, therefore they do not have the sweet taste of other carrot types.

Chantenay: these are intermediate between a Nantes and an imperator. They are tapered like the Im-

perator, but the bottom rounds off somewhat like the Nantes. Chantenay is sweet tasting like Nantes. Danver: this is medium-length carrots, conical in shape, and thicker than Imperators. The end of the root is tapered. Danvers varieties are used in both the processing and commercial fresh market.

Climatic requirements

Carrots are hardy plants that are not sensitive to winter cold and frost. Carrots do best under cool conditions and the seeds germinate quite well, though slowly. Carrots can thus be grown throughout the year, though summer production is not easy because of the high rainfall. Diseases such as Alternaria leaf blight also cause more problems, with warm temperatures and high humidity.

Temperature and soil moisture influence the shape, colour and quality of carrots. Plant growth is optimal between temperatures of 15 to 20oC, and the roots also develop the best colour and flavour at such temperatures. When high temperatures prevail, roots tend to be shorter, often with poor flavour. Forked and cracked roots are more common in summer and the central core tends to be thicker.

Soil requirements

Carrots favour well-drained, fine textured soils with good water-holding capacity and a pH range of 5.5 to 6.0. Sandy, loamy soils are most suitable. Carrot seedlings are very weak, and do not tolerate soil crusting so avoid heavy clay soils. Seedbed preparation must eliminate clods as they interfere with uniform growth of the roots.
Seed treatment: It is a good idea to treat seed with fungicides such as Apron star 42 WS, Thiram 80 WP, to prevent seedling blight, damping off and seed decay.

Talk about the following:

- When should carrots be planted?
- How should the land be prepared for carrots?
- How should we plant the carrot seeds?

Now read the next section…

11.2 Land preparation and planting

Carrots should be planted at the beginning of winter.
Since the taproot is the part eaten, the field should be tilled to 30 cm deep to ensure that root penetration is not restricted. Raised beds are very popular in carrot production as they help the soil warm up faster in winter, promoting faster emergence.

Always base your fertilizer program on a soil test. Random soil samples should be collected from the entire field that you intend to plant. Over application of ammonium nitrate can lead to excess top growth at the expense of the tap root. Avoid applying fresh manure as it leads to root branching (forking). If phosphate level is low broadcast 200 to 250kg/ha of Single super phosphate, and then broadcast 700kg/Ha of Fruitfert (Compound J 15:5:20).

Carrots are sown straight into beds which means there is no transplanting. The seed is very small, and should be planted not more than 1cm deep. Seedlings are delicate and cannot push through a tight or deep covering of soil. The first seedlings to emerge usually remain dominant and the later emergences are suppressed.

Plant population density

About 4 - 5 kg seed is required to plant 1 ha. Mixing seed with sand in a 1:6 ratio is helpful in planting to

achieving a good distribution. It is important to try to achieve the optimum plant population. General seeding rates are 10 to 16 plants per 30cm of row. If the plants are too widely spaced, roots become too large, and can split. If the plants are too close together roots tend to smaller and of poor quality. Dense plantings should be thinned out.

11.3 Crop management

Topdressings are not usually required after planting. On sandy soils, or where there has been leaching of nitrogen, apply 100 - 150 kg/ha ammonium nitrate six weeks after sowing.

Irrigation

Carrots are most sensitive to moisture stress during root enlargement and seed germination. Irrigation can improve emergence. Watering at germination will also help to prevent soil crusting, which retards the growth of new seedlings. Lack of water or inconsistent watering will lead to woody flavoured carrots and irregular growth patterns or misshapen roots.

Water stress may also cause growth cracks and cracking often occurs when watering after the plant has suffered from water deficiency. Insufficient soil moisture results in a longer and thinner root, while very wet conditions have the opposite effect and also give rise to a lighter colour. It is important to maintain the soil moisture at 50% of available moisture throughout growth. Generally, 25mm of water per week should be adequate, but under warm, dry, summer conditions, especially if accompanied by hot, dry winds, up to 50mm may be necessary.

Talk about the following:

- How have you controlled weeds when growing carrots?

Now read the next section…

11.4 Crop protection

Weed control

Carrots are small, delicate plants during the early stages of growth. Many weeds, can easily compete with them so it is very important that weeds be controlled in the early stages of crop development. Weed control can be achieved mechanically, by hand, chemically or by combination of these methods. See appendix 4 for recommended herbicides.

Talk about the following

- What are the common carrot pests in your area?
- Describe the damage they cause.
- How did you control them?

Now read the next section…

Pests

A three-year rotation is advisable between planting carrots, mainly to reduce the risk of pest and disease build-up. By including deeper-rooted crops in rotation with shallow rooted carrots, nutrients and moisture from the deeper soil layers can be utilized.

The most common pests affecting carrots are aphids, leaf hoppers and nematodes. Mature carrots are

often affected by Alternaria leaf blight. Sclerotinia can also be a problem.

Figure 11.2 root knot nematode on carrots roots.

Physiological disorders

Carrots can suffer from a wide range of physiological disorders.

Root browning – this is caused by lack of moisture after harvest, reasons for this include, harvest in hot conditions, delay in transporting carrots to storage, and failure to quickly cool the carrots once in storage.

Greening - this will occur if the top part of the carrot root is exposure to sunlight. It tends to be a problem in light soils prone to wind or water erosion and when carrots are planted in raised beds. Hilling carrots during the season will help to control this. Thick stands create enough shade to protect the roots from the sun.

Misshapen roots - can be caused by a number of factors such as, hardpan, cultivars, compacted soil and over irrigation. Hardpans prevent the root from growing straight down. Untimely or uneven precipitation causes the root not to grow straight. Deep tillage of the soil prior to planting may cure some of these problems, as well as ensuring a finely worked seedbed. Carrots do poorly in heavier soils. Longer rooted cultivars may be stunted or exhibit forking in these heavy soils. If you have heavier soils, the use of raised beds may be the better option for you.

Figure 11.3 Carrots with multiple taproots (forks) are not specific cultivars but are a byproduct of damage to earlier forks often associated with rocky soil

11.5 Harvesting and after harvest

Harvest occurs when carrots reach adequate size, however carrots do not mature evenly so larger roots are often selectively harvested prior to lifting the main crop. Sweetness and storage potential increase with maturity. Avoid wounding carrots during harvest to reduce the incidence of Sclerotinia in storage. Carrots are harvested either through lifting the roots by hand or by cutting off the tops, and using a digger to lift the carrots. Avoid drying out the carrots between harvest and in storage. There is greater moisture loss (reduced shelf life) when the leaves are left on the carrots so leaf removal is highly recommended.

Talk about the following

- What are your customers' requirements for carrots?
- How do you grade carrots?

Now read the next section…

Grading

The following are some market requirements for carrots: they should not be soft, flabby or woody or misshapen; they must be reasonable clean and properly trimmed.
Storage

Carrots should be kept cool as soon as they are taken from the field. They should be cleaned and washed before storage. During washing, remove any damaged or diseased carrots. Prior to harvest two percent of copper sulphate should be used to clean the storage area and kill any disease organism is that may be present.

Review what you have learnt in this session then read the summary to check that you have remembered everything.

Summary

- Four varieties of carrot are grown in Zimbabwe: Nantes, Imperator, Chantenay and Danver.
- Land for planting carrots should be ploughed as deeply as possible and free of clods.
- Fresh manure should never be used on carrot as it causes forking.
- Winter period is the best planting time in Zimbabwe.
- Plants should be thinned to create an optimum population density.
- Leaf blight is a serious disease especially for carrots planted in the rainy season.

Glossary

Basal fertiliser: Fertiliser applied during land preparation before planting

Bolting: When a plant unexpectedly produces a flower-head usually in response to sudden hot temperatures

Compost: A stable material, containing high levels of organic matter, made from decayed plant or animal material

Compound fertiliser: A fertiliser containing several minerals

Evaporation: Water lost, from the soil or a plant, into the air

Harvest interval: The amount of time we must wait, after spraying a crop, before harvesting the product

Herbicide: A chemical developed to kill weeds

Hygiene: Keeping yourself or an area clean to prevent the spread of disease

Larvae: The young stage of an insect

Mulch: Material placed on the surface of soil to reduce evaporation

Nitrogen: A mineral that all plants need in order to grow

Nutrient: A substance that living things require in order to be healthy

Oedema: Swelling caused by water

Organic matter: Material from decayed plants or animals used to improve the soil

Perennial: A plant that lives for several years

Pesticide: A chemical developed to kill pests

Petiole: The stalk that joins a leaf to a plant

Phosphorus: A mineral required for plant growth

Physiological disorders: Distortion to a plant or fruit structure caused by lack of nutrients, soil moisture stresses or unfavourable environmental conditions.

Potassium A mineral required for plant growth

Predators: An animal that hunts and eats another animal

Systemic pesticide: A pesticide that is absorbed into the tissues of a plant

Variety: A type of plant that has been developed for certain characteristics through crop breeding

Appendix 1: Natural pest and disease remedies

The following recipes are taken from: Natural Pest & Disease Control by Henry Elwell and Anita Maas. Natural Farming Network (1995).

Apple of Sodom *(munhundurwa, intume)* spray

Use on ants, cutworm, red spider mite and termites.

- Cut 10 -15 fruit into four pieces.
- Soak in 1L of water for 24 hours
- Spray the affected crop.

Basil spray

Use on soil born pests and diseases or as a fungicide.

- Crush basil leaves. Soak in water for 24 hours. Pour on soil around plants on seed bed before planting.
- Use dry leaves to make a dusting powder.
- Plant basil in beds as a repellent.

Black jack *(muuwu, ucucuza)* spray

A general repellent spray for most insects.

- Crush seeds. Boil in water for 5-10 minutes. When it has cooled use as a spray or pour on soil around affected plants for soil pests.

Baking soda spray

Controls downy mildew and rusts

- Mix 100g baking soda with 50g green soap. Dilute with 2L of water and spray infected leaves. Do not use on hot days.

Castor oil plant *(mupfuta, umhlafutho)* spray

Spray for aphids, caterpillars, cutworm, mites, stinkbugs, termites, nematodes, fleas, lice, moles, fungi, anthracnose, brown patch, damping off and root rot.

- Soak crushed green seeds and leaves in water for 24hours, filter and spray.
- Dry green seeds and leaves and grind for dusting powder.
- For cutworm, place 4 cups of crushed shelled seeds in 2L water. Boil for 10 minutes; add 2 tea spoons of paraffin and some soap. Dilute to 10L and water immediately into the soil.
- Put green seeds into mole holes or rat nests as repellent.
- Dig seeds or leaves into the soil to kill fungal diseases.
- Mulch with branches and leaves to repel termites.

WARNING: poisonous to people and poultry

Cassava spray

A very effective treatment for nematodes.

- Crush cassava roots and dilute the juice with equal amount of water. Spray soil immediately.

Chilli and garlic spray

Used as a general spray for all insect pests.

- Grind up five red chillies and five cloves of garlic. Pour in half a litre of boiling water. Leave to soak overnight. Add a teaspoon of dishwasher or washing powder or green soap or 1tsp paraffin or cooking oil.
- Spray affected part but should not be used on legumes as it repels soil bacteria

Cooking oil and soap spray

Spray for aphids, caterpillars, flies, insect eggs, red spider mite, scale, trips and whitefly.

- Mix 20ml cooking oil with 100g green soap in 15L water.
- Spray at cool times of day to avoid leaf scorch.
- Avoid spraying soft leaved plants such as tomatoes and cucurbits.

Flour and sour milk spray

Spray for ants, aphids, beetles, bugs caterpillars, cutworm, and eggs of insects, mites, trips, white fly and club root.

- Mix 4 cups flour, half a cup of sour milk and 20L of water. Spray plants.

Garlic or onion powder

For bean rust, tomato blight, mildew and scab.

- Used dry crushed bulbs as dusting powder.
- Should not be used on legumes.

Lantana *(mbarapati, ubuhobe)* spray

A general repellent spray for most insects.

- Crush 1 handful of leaves in 1L water. Add little soap. Spray affected plant.
- Burn lantana branches and use the ash to dust over beetles and leaf miner.

Liquid manure spray

Spray for aphids, bugs, birds, caterpillars, cutworm, fruit flies, grasshoppers, mites, thrips, fungal, bacterial and viral diseases.

- Mix 3 tablespoons vinegar, 3 tablespoons liquid soap, 2 tablespoons liquid manure and 10L of water. Spray plants.

Mexican marigold *(mbanda, imbanje)* spray

Controls fungal diseases, nematodes, termites, ants, aphids and grain storage pests.

- Collect one mature plant (before it has flowered). Crush and soak in 2L of water for 24 hours.

Filter and spray.

- Allow some mature plants to remain in beds to repel nematodes. Cut the leaves and dig them into the soil to repel ants and control soil diseases.
- Plant Mexican marigold around gardens to repel insects and soil pests.
- Dried plants can be used to repel grain storage pests in grain bins.

Milk spray

Controls red spider mite, fungal and viral diseases.

- Use 1L milk, diluted with 10-15L water. Spray affected plants. Repeat after 10 days.

Onion spray

Used as a general spray.

- Soak 10-100g onion in 1L of water for 4-7 days. Spray plants.

Pawpaw spray

Can be used to control aphids, bugs, caterpillars, cutworm, root-knot nematodes, termites, coffee rust, powdery mildew, and rice brown leaf spot.

- Add 1kg finely shredded leaves to 1L of water and shake vigorously.
- Filter, then add 4L of water, 2 teaspoons of paraffin and about 20g soap.

- Spray or water into the soil for cutworm.
- Extract the juice from green fruit to control termites.

Rubber hedge sap spray

Effective spray against red spider mites

- Spray with 10 drops of rubber hedge sap in 1L of water.

Salt and vinegar spray

- Spray for aphids, cabbage worm, caterpillars, slugs, snails and whitefly.
- Mix 1 teaspoon of salt with 20ml vinegar, one litre of water and half a teaspoon of soap. Spray affected plants.

Soap spray

Spray for aphids, caterpillars and whitefly.

- Use 50g (10 teaspoons) green bar soap dissolved in2-5L water. Spray plants

Soap powder spray

Spray for armoured crickets, army worm, caterpillars, leaf miner.

- Add 1 tablespoon of soap powder and 1 and a half teaspoons of bar soap to 1L of water. Spray plants

Squashed pest spray

This is a general spray for many pests

- Mix one handful of crushed pests into 10L water. Add a little liquid soap. Leave for 12-24 hours.
- Spray on affected plants

Starch spray

Spray for aphids, caterpillars, spider mites, thrips and whitefly.

- Boil potatoes or cassava. Reduce liquid by boiling until gluey starch is left in the pot.
- Spray pests when starch has cooled.

Sugar spray

An effective treatment for nematodes.

- Pour a mix of 2kg sugar in 5L of water on the affected soil.
- After 24 hours, flush the sugar out of the soil with plenty of water.

Tephrosia spray

Crush 50 leaves in 1L water.

- Leave for 24 hours. Filter, and then spray plants.
- Warning – this spray is toxic to all insects.

Tomato leaf spray

This is a general spray for most insects.

- Soak tomato leaves in water for a few hours. Filter and spray
- Or place tomato leaves over cabbage heads at night to repel caterpillars.

Urine spray

Spray to prevent aphids, caterpillars, cutworm, mealy bugs, mites and thrips, and plant diseases.

- Collect cattle/ goat or donkey urine. Leave overnight in a bottle to ferment.
- Dilute 1 part urine with 1 part water.

- Spray on a warm day.

Zumbani spray

Spray for ants, aphids, caterpillars, termites and whitefly.

- Crush leaves and branches of zumbani. Leave to soak in water for 2-3 days. Add a little soap. Spray plants.

Appendix 2: Natural controls for pests and diseases

Pest/ disease	Description	Method of control
Ants	Small, black ants usually do not attack plants but they may build their nests around the base of some crops especially beans and carrots Ants often encourage aphids which attack crops. Ants drink the sweet liquid produced by aphids. This liquid can lead to bacterial and fungal diseases on leaves.	• Apply grease or petroleum jelly, dung or clay to trunks and stems. • Mulch with ash or fine powder. • Spray with Mexican marigold, chili and garlic, garlic, lantana, Zumbani, blackjack. • Intercrop with garlic. • Place garlic cloves or chopped onions in ant holes. • Dust with chilli powder at base of plants.
Aphids, also spider mites, thrips and whitefly	These tiny sucking insects attack most vegetables. Some are winged, others wingless. Grey and green aphids attack rape, covo, tsunga and cabbage. Black aphids eat bean leaves while tomato aphids are often green. Aphids may spread viral diseases. They prefer hot times of year.	• Avoid use of manures and fertilisers, especially liquid manure. • Avoid over-watering plants. • Intercrop with garlic, chives, marigold, nasturtiums, onions and milkweed. • Use any of the following sprays: flour and sour milk spray, cooking oil and soap spray, salt and vinegar spray or spray with liquid or bar soap diluted in water, liquid manure spray, onion spray, tomato spray, lantana or zumbani spray.
American bollworm	This caterpillar grows about 3.5cm long and feeds on buds, flowers and fruit of beans, crucifers, cucurbits, groundnuts, maize, peas, potatoes and tomatoes.	• Handpick caterpillars and crush. • Use squashed pest spray, soap spray or starch spray. • Dust caterpillars and plants with lime. • Send chickens into the garden to eat caterpillars. Remove birds before they damage crops.

Pest/ Disease	Description	Method of Control
Beetles and bugs (bagrada bug, CMR beetle, tip wilters)	These tiny sucking insects attack most vegetables. Some are winged, others wingless. Grey and green aphids attack rape, covo, tsunga and cabbage. Black aphids eat bean leaves while tomato aphids are often green. Aphids may spread viral diseases. They prefer hot times of year.	• Intercrop with repellent plants • Use chili and garlic, spray paw-paw spray or blackjack spray. • Make barriers around the stems of affected plants with mineral oil or other sticky substances. • Hand-pick and squash adults. Use the squashed bugs to make a repellent spray
Cabbage webworm	These small greenish-yellow caterpillars attack the leaves of brassicas. They make white web-like cocoons and turn into grey moths.	• Dust leaves with flour, ash or lime. • Use the following sprays: blackjack, castor leaf, cooking oil, garlic, mexican marigold, pawpaw, salt and vinegar, starch, tomato, urine, zumbani. • Intercrop brassicas with garlic. • Use onion spray
Crickets (Armoured crickets)	There are many species of cricket. Some are brightly coloured. They can become serious pests if there are large numbers of them, eating practically anything in their path.	• Plant millet or sunnhemp as a trap around the garden. Slash crop when crickets are seen. • Trample or beat insects with brooms. • Use soap powder spray. • Make traps by pouring old beer into small bowls. Place in beds. • As a last resort send chickens or other poultry into the garden to eat crickets. Remove before they damage crops. • Use blackjack spray
Codling moth	This is a type of caterpillar.	• Paint trunks of trees with a paste of cattle manure and clay. Use it to seal wounds and cuts after pruning.

Cutworm	These greyish caterpillars spend the day in the soil. At night they feed on the stems of seedlings by cutting the stem with their bodies. They do not seriously damage adult plants. They attack beans, crucifers, cucurbits, groundnuts, maize, onion, peas, potatoes, tomatoes and many other crops.	• Grow seedlings in containers rather than seed beds. • Transplant seedlings only when the stem is too wide or strong for the worm to cut. • Improve the soil using plenty of well-rotted compost. • Use lime on acid soil to repel. • Use mulch of repellent plants. • Use poultry to clear beds before planting. • Transplant seedlings only when the stem is too wide or strong for the worm to cut. • Protect individual plants with barriers made from sticks pushed into the soil. • Make pawpaw leaf spray from 1kg shredded pawpaw leaves shaken in 1L of water. Filter and dilute in 4L of water. Add two teaspoons of paraffin and a little soap. Spray the soil.
Diamond Back moth	The caterpillars are about 12mm long, green and feed on the undersides of leaves. They attack rape, covo, tsunga and cabbage. They attack throughout the year, especially in hot dry weather. The adult moth is 7-8mm long.	• Intercrop crucifers with tomatoes, onions or basil to repel moths. • Spray the upper surface of leaves with garlic, tomato or basil. • Dust caterpillars with ash. Spread rings of ash around plants. • Spray undersides of leaves with blackjack, castor, cooking oil, garlic, Mexican marigold, pawpaw, salt and vinegar, starch, tomato, urine or zumbani.
Fruit fly	Fruit flies are tiny insects which lay their eggs in most fruit including pumpkins, squash and cucumbers. The eggs hatch into tiny maggots which feed on the fruit.	• Collect and bury all fallen fruit or feed them to livestock. • Spray the fruit with repellent sprays such as chilli and garlic, tomato leaf and Mexican marigold. • Spray flies with spray made from soaked residue of finger millet.

Grain and seed storage pests (such as weevils and borer)	These tiny beetles feed off grain.	• Place dried lavender leaves in grain/ seed storage containers. • Line storage containers with dried, crushed Mexican marigold plants or zumbani leafy branches. Or sprinkle Mexican marigold powder between layers of stored grain. • Line storage containers with a layer of 3-5 cm of leafy Zumbani branches.
Grasshoppers/ locusts	These are long-legged jumping insects. There are hundreds of different species of grasshoppers and locusts. Some are tiny and some are over 10cm long. Some can fly.	• Plant millet or sunnhemp around the garden as a trap. Slash and trample crop when locusts are observed in the trap crop. • Intercrop vegetables with marigolds. • Use ash mulch. • Use Tomato or tephrosia spray. • Trample or beat insects with brooms. • As a last resort send chickens or other poultry into the garden to eat locusts. Remove before they damage crops.
Leaf miner	These tiny grubs burrow into leaves making white or grey tunnels. The adult is a small fly. Vegetables which are commonly attacked are legumes, spinach, tomatoes.	• Make sticky traps - yellow boards painted with a sticky substance such as oil or tree resin. Place on sticks about 60cm high. This will trap the flies. • Hand picking - squash worms in their tunnels in leaves. • Use soap powder spray or lantana spray.
Leaf roller	There are many types of leaf roller caterpillars of different shapes and sizes and attack a wide range of vegetables. They make a protective cover for themselves by folding the edges of leaves over and sticking them down. They then eat the leaves beneath.	• Dust caterpillars and plants with lime or ash. • Use the following sprays: blackjack, castor leaf, cooking oil, garlic, mexican marigold, pawpaw, salt and vinegar, starch, tomato, urine and zumbani. • Intercrop brassicas with garlic.

Maize stalk-borer	This insect larva lives in the stems of maize plants.	• During the dry season, compost crop residues or feed to livestock. If residue is left as mulch, chop maize stover into small lengths to expose the larvae to the sun. Practice rotations with wide gaps between members of the grass family. • Block central funnel of the maize plant with dry soil. Pour soil into the area where the leaf meets the stem. This suffocates the pest. Use the method when maize plants are small and repeat when they have grown larger.
Mealybug and scale insects	These are sucking insects which attach to stems of plants.	• Control ants which protect these insects. Wipe insects off plant by hand. • Spray plant with light oil or chili and garlic. • Encourage predators such as wasps, ladybirds, spiders, dragonflies and mantids.
Nematodes	These tiny worm-like creatures live in the soil. Most species are beneficial but some enter roots and damage crops such as legumes, carrots, cucurbits, spinach, onions and tomatoes. Plants which are attacked have swollen roots with cracks and dead spots.	• Keep soil organic matter levels high. • Practice crop rotation. • Plant barriers of sunnhemp and Mexican marigold around the garden. • Avoid digging and ploughing. • Intercrop with garlic, cassava, leeks, mustard, onions, pawpaw, marigolds. • Pour a mix of 2kg sugar in 5L of water on the affected soil. After 24 hours, flush the sugar out of the soil with plenty of water. • Make spray from pawpaw leaves or tomato leaves. • Crush cassava roots and dilute the juice with equal amount of water. Spray immediately.

Red spider mite	This tiny, red mite, with eight legs, makes webs. Sometimes it is mistaken for a disease in early stages of attack. It is found on lower sides of leaves of tomatoes and other members of the tomato family. It is often spread from cotton or tobacco fields. Most usual period of attack is during hot, dry weather.	• Practice crop rotation and intercropping especially between host plants such as cotton, tomatoes and brassicas. • Plant crops close together and water regularly. • Plant a hedge of pigeon pea round the garden to encourage predators. • Intercrop tomatoes with onions or basil to help repel and to create a moist microclimate. • Mulch soil to increase moisture retention. • Remove and burn heavily infested plants. • Use chilli and garlic spray mixed with soap, sour milk and flour to increase stickiness. • Use Apple of Sodom spray, milk spray or rubber hedge spray
Slugs and snails	These are soft-bodied creatures that breed in wet conditions.	• Mulch with ash or fine powder. Sprinkle grains of salt on slugs or snails. Rotate poultry throughout vegetable garden to get rid of infestations. Dust affected areas with dry builder's lime or mix lime and water leave to stand for a few days. Spray plants.
Termites	These insects live in nests and are about 15mm long. Most termites do not intentionally eat living plants. However, when no other food is available they may damage crops. At dry times, mulch may attract termites which may damage crops especially seedlings or weak plants.	• Use the crushed pods of snake bean (Swartzia madagascarensis) or long pod cassia either placed directly around the infested soil or a water extract of the crushed pods is poured into the ground. Soak the crushed pods in water for 2 hours or longer, even overnight. • Blackjack spray. • Intercrop with garlic. Use garlic spray. Place garlic cloves or chopped onions in ant holes. • Spray with juice from immature pawpaws.

Thrips	These are tiny black, brown or yellow sucking insects. Attack is worst during hot dry times of year. They mainly attack onions and garlic but sometimes go for tomatoes, and other crops. Onion thrips can spread tomato spotted wilt virus.	• Dust leaves of crops with ash or clay dust. Repeat after watering or rain. • Spray with flour and sour milk, starch spray, urine, cooking oil, soap, onion, chilli and garlic. • Make sticky traps with yellow boards painted with sticky substances. • Use onion spray
Whitefly	Tiny white sucking insects.	• Use the same methods as for aphids • Intercrop tomatoes with basil. • Use blackjack or onion spray

Appendix 3: Chemical control of pests and diseases

Aphids

To control aphids, you must also control back ants which attract aphids, scale and mealy bugs. Ants encourage these pests to attack the soft parts of plants and they protect these pests from attack by other insects. Control black ants by placing a ring of ash around each crop plant.

Control aphids by spraying with Dimethoate (Rogor), 40% EC at 75ml in 15L water. This will be enough for an area 100m x 10m (1000m2). Wait two weeks (harvest interval) after spraying before harvesting. Other chemicals include Malathion 25 WP and Thionex 35 EC.

Bagrada bugs

These damage the leaves of the crop so that they look as though they have been burned. Control them using Dedevap (Dichlorvos) at 15 - 20ml in 15L of water. This is enough to cover an area 1000m2 (100 metres x 10 metres). You can also use is Carbaryl, (mix 30 grams in 15L of water). Always read the label for full instructions.

Cut worms

Cut worms are a common problem for seedlings. To control, use Karate at 100 ml/100L water spray at the base of the plant, this will give the best results. Carbaryl 85 WP at the rate of 150 -200g/100L, applied in the planting hole, is also recommended. Pyrinex 48EC at a rate of 200ml in 100L of water drenched soon after transplanting using cup 30/plant is also recommended.

Diamond Back Moth

This is one of the insect pests which gives problems in the cabbage family, in particular from August throughout the rainy season. The adult is a moth (small butterfly) but the damage is from small bright green caterpillar which causes short holes in the leaves. This builds a web (cocoon) which makes its control difficult because sprays will not reach the pest.

Chemical control: DDVP, Dichlorvos 1000: apply at 100ml/100L water as a high volume, full cover spray and repeated at weekly intervals if necessary. The harvest interval is three days. Dichlorvos 1000 will also control aphids, caterpillars and whitefly. Endosulfan 50 WP: spray at 100g + 30ml Sanawett 90/100L water. Apply as a high volume, full cover spray in at least 100L mix/ha and repeat at seven to ten day intervals as necessary. The harvest interval is seven days.

Methamidophos 600 SL at 100ml per 100l water as a full cover spray repeated weekly if necessary. Do not harvest for at least 21 days after date of last application. Methamidophos will also control aphids and caterpillars.

Malathion 25 WP at 20g + 30ml Sanawett 90 per 100L water as a full cover spray applied in at least 1000L mix/ha and repeated at seven to ten day intervals before harvesting. It can be used to control the larva.

Heliothis bollworm

This fruit caterpillar feeds on tomato leaves and fruit. It causes distorted leaves. The moth lays its eggs on tomato leaves and the caterpillars feed on the leaves and fruit, causing extensive damage. The colour of the caterpillar varies from greenish-yellow and reddish-brown or even black with paler stripes running lengthwise down the body. It is controlled by using Methamidophos 585 SL at 500ml/ha, (harvest interval three days). Carbaryl 85 WP can also be used at 200 g/100L water full cover spray (harvest interval seven days), or Thionex 35 EC at 190 ml/100L water full cover spray (harvest interval 1 day).

Leaf Hoppers
These are small flattened green insects with transparent wings. They are very active in hot weather and cause damage to carrots. Apply: Malathion 1% Dust at 100 -175 g/10m2. Harvest interval is 3 days. Malathion 25% WP at 200 g/100L water. Harvest interval is 7 days and Malathion 1 Dust at 100-175g/m2, Harvest interval is 3 days. Repeat sprays as necessary. These sprays will also control red spider mite.

Leaf miner
The adult insect punctures the leaves especially at the leaf tip and along the leaf margins. The larvae, tunnels into the leaf. The effect is reduced growth in the plant as well as leaf drop, which can result in lack of shading and sun scalding of fruit. Wounding of the leaves also allows entry of bacterial and fungal diseases. Use sprays of Cyromazine 75 WP at 150 g/ha or Abamectin 18 EC at 100 ml/100L water. Both products have a harvest interval of three days. The tuber moth adult can be controlled by spraying with Methamidophos 585 SL at 100 ml/100L water or 500 ml/ha. Leaf miner attack often predisposes plants to infection by early blight.

Nematodes
Nematodes are small worms that cause a lot of damage to the roots of crops especially in sandy soils. They can be controlled by crop rotation and the use of resistant varieties. Adding organic manure to the soil has been reported to reduce nematodes.

Chemical control is with Nemacur granules at 10g/m2 or Nemacur 400 EC at 18 to 20ml mixed. However, the chemicals can be very expensive. For attack on carrots, fumigation with EDB 45, EDB 92 or EDB Tech is advisable on light soils.

Red spider mite
This small orange to red mite has eight legs like a tiny spider and sometimes makes webs on the plant. This is a very serious sucking pest which causes wilting and spots on the leaves. When plants are severely infested, the best way to control is to remove and burn the plants. Also remove any weeds that might host red spider mite. Many chemicals can be used to control it, such as Kelthane at 15ml mixed in 15L of water, dicofol, diazinon and amitraz (check rates on labels). We need to rotate the chemicals as these insects build resistance.

Thrips
Thrips are small sucking insects shaped with a point, with hairy wings. They suck sap causing dying of leaves and they also spread diseases. They are one of the most common and troublesome pest in onions. They feed on the young leaves causing them to turn silver in colour. Thrips can reduce onion yields to very low levels. Any of the control measures mentioned for aphids also use to control thrips, although thrips are more difficult to control because they hide in buds and leaf sheaths.

For chemical control use Malathion, Dichlorvos (dedevap), Monocrotophos, Cypermentrin and Endosulfan (Thiodan or Thionex).

Adult thrips can be trapped by hanging blue or yellow boards painted with a light coating of engine oil, resin or glue.

Whitefly
Like aphids, whiteflies have piercing-sucking mouthparts. Direct damage to tomato plants causes deformed new growth and wilting, yellow leaves. Whiteflies can also transmit some plant viruses. If your plant gets infected with a virus destroy it. Whiteflies, like aphids, secrete honeydew, often causing sooty

mould to grow. Feeding by whiteflies can also cause deformed fruit and discoloration of tomatoes. Is becoming more common especially under greenhouses. Control using Imidacloprid 200 SL at 50 ml/100l water. Apply as a 300 – 500L/ha mixture. Chess 50WG is recommended at 600g/ha (harvest interval three days). Actara 25WG at a rate of 400g/ha spray or 0.02g/plant drench is recommended (harvest interval seven days).

Disease control

Alternaria leaf blight (Alternaria dauci)

Leaf blight is a common disease of carrots in Zimbabwe. It occurs mainly during wet weather in summer, with prolonged heavy dews frequently promoting severe outbreaks. Dark brown to black spots, some with yellow edge, appear on the leaves. The spots at first appear mainly on the leaf edges, where they merge, so that the leaves assume scorched appearance. Older leaves are more susceptible than younger ones. The fungus can be transmitted with seed, and may cause damping-off of the seedlings. Control: plant cultivars that are tolerant to the fungus ensure the seed is disease-free that is certified seed. Practice strict crop rotation programme. Spray with: Dithane(R) M-45 (Mancozeb) at 200 g/100L water prior to the onset of rains and repeat at 10 - 14 day intervals throughout the wet period. Harvest interval is 3 days. Flower Power at 500-800 g/100L water is another good option.

Bacterial canker

Infected seedlings will either die or produce weak, stunted plants. Infected seedlings may also develop into healthy-looking plants that do not show disease symptoms until they are set in the field. The early symptoms of the disease are wilting, curling of leaflets and browning of leaves, often only on one side of the plant. As the leaves die, the petioles (leaf stems) remain green and firmly attached to the stem. A cut through the stem shows yellowish brown discoloration. Small white or yellow spots appear on the fruit. Control: Bacterial canker is one of the most difficult tomato diseases to control. Soaking the seed in hot water before planting can help. Use only certified, disease-free seed and seedlings. Never save seed from a source known to have had bacterial canker. It is difficult to distinguish between infected or healthy seedlings at the time of transplanting. Fixed copper sprays may help in protecting healthy plants, particularly if only superficial symptoms are present. Practice strict crop rotations and sanitation.

Bacterial speck

This is another common bacterial disease in tomatoes production. It happens to plants during rains and cool weather. The diseases can attack the whole plant including the fruit. On leaves, it will appear as brown spots surrounded by a yellow ring. On fruits, we will see black raised spots resulting in a rough appearance on the fruit skin. Control with chemicals such as copper oxychloride and mancozeb.

Bacterial spot

This usually appears as dark-brown raised spots on the fruits becoming sunken and rough to the touch. The disease is carried through seed and infection only occurs during wet weather. To control we should practice hygiene during seed bed preparation and planting. Also use fungicides like, copper oxychloride at 45g mixed in 15L water.

Bacterial wilt

This causes a sudden dying of plants, browning inside the wood flesh, from which bacterial slime comes out after cutting across the main root and lower part of the stem. Control it through hygienic practices and avoid water-logged soils. To control use copper oxychloride.

Black rot

This can cause severe damage during the rainy season. The disease can be passed through infected seed,

from plant to plant in the field or from the soil. Since it stays for a long time in the soil, we should always practice rotations with non-related crops. Also use clean certified seed and practice strict hygiene in the field.

Symptoms begin with yellowing at the leaf margin, which expands into the characteristic V-shaped wound along the leaf margins with dead patches on the main leaf area. Leaf veins are also darkened. Control it by soaking the seeds in hot water before planting them. Also remove infected plants and burn them. Do not feed infected material to animals because the diseases can be transferred back to the field when you apply manure.

Damping off

This is a common disease in seedlings in general caused by fungi. Seedlings will rot very close to the ground. Make sure soils are well drained and seedlings are not over crowded.

Chemical Control: Use Apron Star 42 WS as a seed dressing. Use 10g per 4kg seed. Apron Star 42 WS also controls other diseases as well as protecting seedlings from aphids for up to 4 weeks after sowing. Thiram 80 WP can be used as a seed dressing, at 100g per 50kg of seed, mixing well. This will also control some other seedling diseases. If the attack is high, drench or spray with, Apron star 42 WS, Captan, or Thiram 80 WP around the base of the seedling.

Downy mildew

This is a fungal disease. The infected plant has a white fluffy fungal growth on the underside of the young leaves. Infection will kill most seedlings. Always use healthy seedlings.
Downy mildew is a serious disease of onions attacking in cool and humid weather conditions. Control is by spraying once a week with fungicides like Dithane M45 at 30g mixed in 15L water or Ridomil Gold can control the disease in mature plants.

Early blight

This is the most common tomato disease. It appears as dark reddish brown leaf spots with round markings on the bottom leaves causing them to fall off the plant. You can sometimes see the disease on the fruits as well. It appears at any time during wet weather. Prevent it by spraying with Mancozeb once a week from flowering at 20g mixed in 15L of water. For curative treatment use Folicur 250 EC at 12ml per 15L of water or Score 250 EC at 6ml per 15L water.

Late blight

This is also very common and is one of the most destructive diseases in tomatoes and potatoes. Greyish-green water soaked blisters appear on the leaves rapidly turning black. Stem blisters are dark brown and large mottled areas develop on the fruit. This disease mostly occurs during wet weather. Several chemicals are available but it is always better to prevent than to control when it has already attacked the crop. Always use clean planting material. For chemical control use Mancozeb as in Early blight, or Ridomil Gold at 190g per 15L of water or use Bravo 500 SC at 30ml in 15L water sprayed once a week. Other recommended products include Milraz, Melody Duo.

Leaf Spot

Leaf spot is another common fungal disease. It usually appears, on older leaves, as small spots with light coloured centres. It causes the leaves to turn yellow and then they drop off the plant. The disease can cause a lot of damage to tomatoes during wet weather. Use fungicides and natural pesticides.

Powdery mildew

This appears as white powder on the plant often in hot, dry weather. Chemical control is by Sulphur 80

WP and Alto at 28mls mixed in 15L of water (harvest interval three days). You can also use Sulphur 80 WP at 30 grams per 15L water or Score 250 EC at 6ml per 15L of water or Benomyl at 7g per 15L of water. Symptoms of powdery mildew on tomato leaves.

Purple blotch

This is one of the major onion diseases we are likely to encounter, a disease caused by fungi. As is the case with insect pests, onions do not have many diseases like other crops we have discussed before. Purple blotch can cause damage when humidity (moisture in the air) and temperatures (heat) are high. Leaves infected by the disease have small irregular white patches which can enlarge to big dry patches with purplish centres. Control the disease by spraying once a week with fungicides like Dithane M45 at 30 grams mixed in 15L of water.

Sclerotinia

This disease is caused by a fungus very significant disease in both the field and storage. Symptoms include foliage that is dark brown and coated with a whitish mould. Later on, black dots will appear amid the white mould. Infected carrots become soft and watery in storage. White moulds cover the infected carrot and the black dots will follow. Control begins with crop rotation and careful handling of carrots after harvest.

Stem rot, sore shin and other soil diseases

This affects members of the cabbage family. To treat these use Quintozene 75 WP at 10g/m2 incorporated in to the soil to a depth of 50 - 100mm in the planting holes. The soil surface should be kept moist during the early post-transplanting stage. For seed-box treatment use Quintozene 75 WP at 100g/m2 well mixed into the soil and well-watered in, you can also seed dress the seed with Apron star 42 WS at 10g per 4kg seed.

Storage rots

These can affect onions. The most common type is White Bulb Rot. This is characterized by a black sooty-like mould which develops between the scales of the bulb. Remove and destroy all infected bulbs, and always inspect onion in storage.

Appendix 4: Weed control using herbicides

Lasso 48 EC can also be used at 4,0l/ha in 200 – 300L/ha water, as soon as possible after the first post-transplant irrigation. The residual effect of the herbicide will not exceed two to three months.

Grasses

Fusilade Forte can be sprayed after weeds have emerged over the top of the crop will control all annual and, at the higher rates, perennial grasses as well. It is applied at the rate of 1.0 – 1.3L/ha depending on the weed species present, their stage of growth and the type of control or suppression required. Apply early before emergence of grass weeds and of crop. Will not affect emerged seeded onions or seedlings so may safely be sprayed "over the top". It is applied at the rate of 0.5 - 1.5 L/ha in a convenient volume of water. Established perennial grasses will require higher rates. It will not control broadleaf weeds nor sedges. Contact with the crop will not cause damage. Do not plant maize, sorghum, wheat, barley or oats within four months of applying Fusilade Forte. DO NOT mix with other chemicals.

Afalon(R) 50 WP is registered for the control of pre- and early post-emergent weeds in carrots. It should not be used on sandy soils or if heavy rain is eminent. It may be sprayed at 1.5 – 2.0 kg/ha on annual grasses and broadleaf weeds immediately after sowing for pre-emergent control and after the 4-leaf stage for post-emergent control.

Agile 100EC is registered for the post-emergent control of annual and perennial grasses. The rate is 1.0 – 1.5L/ha, depending on weed height and species.

Gallant super®: is registered for the post-emergent control of annual and perennial grasses. The dose rate depends on weed height and species.
Trifluralin 48EC can be applied from three to four weeks to immediately prior to sowing. It must be mechanically incorporated within 10 minutes of application. It is used mainly against annual grasses, but will also control some few broadleaf weeds.

Grasses and broadleaf weeds

Goal 24 EC: Controls many annual broadleaf weeds and some annual grasses pre-emergence. Can affect nutsedge. Rate/ha – 3L in 250L of water applied 10 - 18 days after transplanting only to well-established actively growing transplants, preferably before weed emergence.

Trifluralin should be thoroughly and evenly mixed into the soil to a depth of 100 - 120mm before transplanting. It should be applied at the rate of 1.1 - 1.6 L/ha, depending on the clay percentage of the soil. The higher the clay content, the higher the rate. It will persist in the soil for about three months and so it should not carry over to the following crops.

Ronstar - this is effective for controlling weeds of onions. For direct seeded onions: Apply 4 -5L/ha. Apply only after emergence of onion seedlings and not before the 3 - 4 leaf stage. For set planted onions apply 4 – 5L/ha either before or after emergence of the onion sets. Apply after transplanting onions, preferably while the weather is hot and sunny. Irrigate immediately after application.