Broccoli farming made easy

Background

Broccoli is part of a large group of plants known as Cole Crops. The term "Cole" crops originated from the word caulis, meaning stem or stalk of a plant. Cole crops are biennials but are generally grown as annuals. In Zimbabwe, Broccoli is growing in popularity especially amongst the middle class who are increasingly becoming health conscious. Large stocks can be seen stocked in major retailers. Broccoli is very popular as well with people suffering from various chronic and non-chronic ailments such as ulcers, bowel disorders and a host of others.. Successful fresh-market gardening involves more than just a talent for growing high quality vegetables. You also need to find a market for them. Before you start, visit other growers, develop a marketing plan, and evaluate the feasibility of your proposed business. Think about what is unique about your product. Are you promoting the product for taste, freshness, health benefits or time of availability? It is good to have a clear business philosophy in farming Cole crops such as Broccoli. The following is a guide of how one can undertake broccoli production.

Climatic conditions

Broccoli requires moderate temperatures ranging between 0 ^{o}C and 29 ^{o}C. However, the optimum growing temperature range is between 15 and 22 ^{o}C. Optimum germination temperature is 29 ^{o}C. High temperatures (greater than 27 ^{o}C) delay maturity and increase vegetative growth. Cool temperatures (1.5-10 ^{o}C) hasten maturity and may induce "bolting". Bolting is the term given when broccoli prematurely forms a flower stalk.

Soil requirements

Broccoli requires soils that can provide continuous water throughout the season. Well-drained, sandy loam soils are suited to early varieties. Loamy and clay loam soils are suited to late varieties because they are somewhat tolerant to poor drainage. Well-drained soils can be rotated frequently because club root is easier to control.

Planting

For early season crops on sites where erosion is negligible, prepare the planting site in late winter. Preparing the soil in late winter will prevent any planting caused by cold, wet soils and will help reduce soil compaction associated with working wet soils. This mostly applies to those who do irrigation production. Compacted soils restrict root growth, reduce the amount of oxygen available to roots, and limit water penetration, all of which can reduce yield potential. Work beds to 150-175 mm deep to promote good rooting. Raised beds are an alternative to the conventional field planting as they improve soil drainage and allow access to the crop without causing soil compaction. Raised beds are typically 1.2-1.5 m wide and 27 m long. The width is determined by the type of equipment used and by the crop. Leave a 30 cm pathway on either side of of each bed to accommodate foot traffic.

Broccoli sprouts should generally be started in greenhouses before the frost-free date depending on the province you are located in Zimbabwe. This allows sufficient time for growth and hardening before transplanting to the field. Shortly before planting treat seeds in a hot water bath. This is done to prevent black rot, black leg, and damping off diseases. This will kill fungi that can decimate young plants. Sterilise empty transplant trays in a 10% bleach solution. Ten days before transplanting to the field, move plants into a cold frame to harden them. Once Cole crop plants have been sufficiently hardened, they will be able to withstand temperatures as high as 28 ^{o}C. You can also purchase transplants commercially which is recommended for those growing the crop for the first time.

For early markets, transplants must be raised in greenhouses. About five to six weeks are required to produce transplants. Plants may be grown in plastic plug trays/plant cells. Broccoli may have two plants per cell in some production systems where large terminal heads are not desired. Normally 300 grams of seed will produce enough plants for one hectare. Old or large plants of broccoli and those grown at low temperatures (10 to 15 ^{o}C) are likely to button (premature head formation) and bolt if exposed to a period of cool weather after field setting. Plant seedlings outside when they are about 15 cm high with 5-6 true leaves. Slight hardening is beneficial, but severe hardening may stunt growth. Hardening is the process whereby transplants are gradually acclimatised to the outdoor environment two weeks before planting.

For late markets, transplants may be raised in plastic plug trays/plant cells, a greenhouse seedbed, or direct seeded. For greenhouse production, follow the instructions given above. If growing on seedbeds, space rows 25 to 30 cm apart and plant 20 seeds per 25 cm of row with a scatter shoe seeder.

Irrigation

The availability of water is critical for successful broccoli production. Irrigation may also be used to cool plants during periods of high temperature. Fertiliser could be applied through an irrigation system. Irrigation at the wrong time can cause problems such as head rot. Broccoli crops require a regular water supply of about 25 mm every 5 to 7 days during the growing season. Shortage of water is detrimental for head development.

Fertiliser application

Lime should be applied to maintain the soil pH in the range of 6.5 to 7.0, unless club root control is required (pH of 7.2). If soil pH is below is 6.2, apply lime six weeks before planting.

- Nitrogen

  About 130 to 150 kg/ha of actual nitrogen is required for broccoli. If manure is applied or a legume is ploughed down, the nitrogen application may be reduced. Broadcast 80 kg/ha before planting and work it in. Apply the remainder as two side-dressings at 7 -10 days after planting, and the second 4-6 weeks later. If the season is very moist, a third side dressing application may be applied three weeks after the second application. Adequate nitrogen produces a dark green colour in broccoli leaves. Leaves of nitrogen-deficient plants are light green eventually turning yellow and may be shed. Excess nitrogen during hot, humid weather will increase the incidence of head rot of broccoli.

- Phosphorus

  A soil test will determine the level of phosphorus requirements. Broadcast or band any needed phosphate before planting and disc it in. Phosphorous is important for root growth. A shortage of phosphorous causes stunted growth.

- Potassium

  A soil test will determine potassium requirements. Excessive potash may lead to increased tip burn (internal and/or external). Potash competes with calcium for uptake from the soil and this is probably what causes the increased tip burn.

- Magnesium

  Older leaves are the first to show deficiency signs, which include blotches of interveinal chlorosis. As the chlorosis intensifies, purple blotches may be seen near the leaf margins. Deficiency is fairly common especially on light acid soils where dolomite limestone has not been applied. To avoid these problems, apply dolomitic limestone or add limestone or add magnesium to the fertiliser. If the problem occurs during the season spray the foliage with magnesium sulphate.

- Sulphur

  Early deficiency symptoms appear as blotches of interveinal chlorosis on the youngest leaves, and the leaves may become reflexed. On sandy soils low in organic matter that has been intensively cropped, soil sulphate levels may be low. Application of gypsum should be considered on these soils. Broccoli crops have a high need for sulphur.

  The recommended balanced fertiliser for basal application is Compound C (5:15:12) or Compound S (7:21:7). For top dressing, apply ammonium nitrate (34.5% N).

Crop rotation

There are many benefits to crop rotation including the suppression of diseases, insects and weeds. In addition, crop rotation improves soil fertility by allowing the soil to replenish its nutrients naturally, and soil structure improves because of the alternation between deep-rooted and fibrous-rooted crops. Crops within a family tend to be susceptible to the same pests, therefore, rotation of non-susceptible crops (or groups) for several years will allow all plant material to decompose and break pest cycles. Without the presence of susceptible plant material, the number of disease and insect organisms will begin to diminish.

Crop rotation aids in weed control because the growth habit of each crop differs, which causes a decrease in the weeds' ability to compete for space. Also, tillage practice and timing are different for dissimilar crops resulting in a decrease in the weeds' ability to permanently establish. Another benefit of crop rotation for weed management purposes is with certain crops, there is a better chance at controlling different weeds. For example, in a broad leaf crop, grass control will be easier because of the use of grass killing herbicides and vice versa.

To create a crop rotation schedule, there are several things to be considered including types of vegetables grown, size of root system, size of planting rows, amount of fertility required for the crop and how much organic matter is left in the soil by the crop. Start designing the crop rotation by making a list of all vegetables to be grown and group them together by botanic relationship (e.g *brassicacea, solanaceae*). Each year, change the location of the entire group within the field. This way, the same crop group will not be planted on the same piece of land two years in a row. Secondly, consider the size of the root system of the crop to be grown. Deep rooted plants will help to break up the soil, while shallow roots will not. Thirdly, consider

the size of the plant rows. The fourth consideration should be given to whether or not the crop to be planted is a heavy feeder. A heavy feeder will deplete the soils of nutrients quicker than a non-heavy feeder. The final consideration for a crop rotation is whether or not the crop will leave a lot of organic matter in the soil. Leaving organic matter behind is beneficial for replenishing the soil of nutrients lost to the crop while it was growing.
A long rotation of more than five years is better than a rotation of two years. Also, ask yourself the following questions when putting together a rotation: Is the rotation profitable? Are the yields sustainable? Does it make use of nitrogen produced by an earlier crop? Are herbicides residues left? Vegetable crops use a lot on nitrogen so it may be beneficial to plant a legume crop before broccoli. Broccoli has an intermediate root depth that will aid in improving soil structure and aeration. This crop has small seeds which will require a fine seedbed. Therefore, previous crop residues will not be tolerated. If transplants are used, the roots can tolerate some plant residue, but too much residue will negatively affect root growth.

Weed Control
Perennial weeds should be controlled prior to planting. Herbicides recommended for use on Cole crops will not provide complete control of weeds. Therefore, it is important to grow Cole crops on soil where the weed seed population is low. The weed seed bank in the soil can be reduced by crop rotation, summer fallow, and the stale-seedbed technique. Care must be taken to avoid fields where residual herbicides from previous years persist in the soil as crop injury may occur. Please refer to the Windmill 1 hectare sheet available under the download section (www.windmill.co.zw).

Insect pest control
Below are some of the most important pests attacking Broccoli:

Insect	recommendation
Cutworms	Pyrinex 48EC, Lambda-Cyhalothrin 5EC, Fenvalerate.
Aphids	Dimethoate 40EC and Malathion 25 WP

Thrips	Dichlorvos
Diamond back moth	Malathion 25 WP, Dedevap 100 EC, Cartap hydrochloride, Match.
Hoppers/Loopers/ Crickets	Carbaryl 85 WP, Dipterex 95 SP, Thionex 50 WP.

Disease control

Below are some of the most important disease in Broccoli:

Disease	Symptoms	remedy
Downy mildew	Fuzzy masses in patches on the underside of leaves, stems and heads. Top leaves turn purple, then later turn yellow or brown.	Dithane M45 and Copper Oxychloride 85 WP, Ridomil Gold.
Damping Off	Damping off, Stem above and below the soil line darkens, outer cortex tissue decays and sloughs off in sharply defined area circling wilts topples over.	Thiram 80 WP
Black leg	Small spot on leaves of young plants. On stems, the spots are more linear and often surrounded by purplish borders. Stem lesions at the soil line extending to the root system.	Thiram 80 WP
Black rot	Lesions of at margins of leaves, tissues turn yellow and the lesion progresses towards the centre of the leaves.	Copper oxychloride (Preventative), and Ridomil Gold (Curative).
Broccoli head rot	Heads appear water soaked, decay, sunken area on the head.	Copper oxychloride (Preventative), and Ridomil Gold (Curative).

Physiological disorders

Broccoli crops show various non-parasitic disorders which cause tissues to die off. In some cases, these disorders have been shown to depend mainly on heritable characters whereas in other cases, external factors had a least marked effect. Below are some observed disorders:

- Blindness

  Plants do not form heads, but produce many shoots at ground level. This may be caused by insects or damage to the growing point early in the plants' life.
- Leafy heads

  Small leaves develop and protrude through the head under high temperatures, drastic fluctuations in a day and night temperatures, or improper nitrogen balance.

- Broccoli buttoning

  Buttoning is the premature formation of a head 2.5 to 10 cm in diameter. Buttoning can occur anytime between seeding and maturity, but usually shortly after transplanting into the field. Generally foliar growth slows after buttoning resulting in inadequate nutrients to nourish the head to marketable size. Losses are usually most severe in the early planted crop during cold, wet seasons, when vegetative growth is affected by:

a) Too much hardening of greenhouse plants.
b) Too little hardening.
c) Low soil nitrogen.
d) Low soil moisture.
e) Continued cold weather (4 to 10 ^{o}C for day or more).

Some cultivars, particularly early ones, are more susceptible to buttoning than others.

- Lack of heads in broccoli

  During periods of extreme warm weather (days over 30 ^{o}C and night of 25 ^{o}C) broccoli gradually enlarges to create a hollow stem, sometimes from bottom of stalk into the head. Ordinarily, there is no discolouration of the surface of these openings at harvest, but both discolouration and tissue breakdown may develop soon after harvest. Avoid excessive nitrogen. Dense plantings will maintain even growth rates and decrease the occurrence of hollow stem.

Harvesting and handling

Harvest broccoli heads when bud clusters are tightly closed and the entire head is tight and firm. Heads that are loose or have individual flower clusters with yellow petals should not be picked. The terminall heads mature first. By removing the main terminal head, growth of the

lateral heads (auxiliary buds) lower on the main stem will be promoted and production of smaller heads that can be harvested will commence. Since lateral heads develop unevenly, they cannot all be harvested at one time. Lateral heads must be harvested twice a week. Broccoli heads are usually harvested with about 15 cm of the stem attached. After they have been cut off, part of the foliage is removed from the harvested shoots. The heads are from 5 to 25 cm in diameter and weigh from 100 to 800 g each. Side shoots from 5 to 10 cm in diameter and weigh from 100 to 500 g each. Broccoli intended for fresh consumption is often sold in bunches weighing about 450 to 600 g.

Broccoli heads mature at different times, resulting in two or three cuts needed to harvest a field. Broccoli is harvested by hand and is often cut and packed into wax covered boxes in the field. Broccoli heads are highly perishable and should be cooled immediately following harvest. In addition to icing, hydro cooling and forced air cooling can be used, but good temperature management must be maintained following cooling. If held at 0 ^{o}C and near 100% relative humidity, broccoli can be stored for up to three to four weeks. Exposure to ethylene (from apples, other ethylene producing fruit or engine exhaust) will accelerate the yellowing of flower buds and reduce storage life and should be avoided.