STARKE AYRES®

SWEET & HOT PEPPERS

PRODUCTION GUIDELINE

CUSTOMER SERVICES: 0860 782 753 • WWW.STARKEAYRES.CO.ZA• MEMBER OF THE PLENNEGY GROUP

SEEDS OF SUCCESS

SWEET & HOT PEPPERS

1. HISTORY AND BACKGROUND

Sweet peppers, also called bell peppers and even some chilli peppers all belong to the species *Capsicum annuum*. Cultivars of these plants produce fruits in many different colours and shapes. Usually the colours range from red to yellow and orange, but more exotic colours include purple, white and lime green. The fruit is also frequently consumed in its unripe form, when the fruit is still green.

Peppers are native to Mexico, Central America and northern South America. Pepper seeds were later carried to Spain in 1493 and from there spread to other European, African and Asian countries. Today, Mexico remains one of the major pepper producers in the world

The misleading name "pepper" (*pimiento* in Spanish) was given by Christopher Columbus upon bringing the plant back to Europe. At that time peppercorns, the fruit of *Pipernigrum*, an unrelated plant originating from India, was a highly prized condiment. The name "pepper" was at that time applied in Europe to all known spices with a hot and pungent taste and so naturally extended to the newly discovered *Capsicum* family. The most commonly used alternative name of the plant family, "chili", is of Central American origin. Even more so, is the variation of the phonetic "chi l" sound derived from the ancient Aztec language. Today, the word "chili" is used to describe a particular dish of food containing beans and meat, whereas "chile" is used to describe the plant and fruit, usually pungent.

Bell peppers are botanically fruits, but are generally considered in culinary contexts to be vegetables.

While the bell pepper is a member of the *Capsicum* family, it is the only *Capsicum* that does not produce capsaicin, a lipophilic chemical that can cause a strong burning sensation when it comes in contact with mucous membranes. The lack of capsaicin in bell peppers is due to a recessive form of a gene that eliminates the production of capsaicin and, consequently also, the "hot" taste usually associated with the rest of the *Capsicum* family. The term "bell pepper" or "pepper" or "capsicum" is often used for any of the large bell shaped capsicum fruits, regardless of their colour.

2. ADAPTABILITY

2.1 CLIMATIC REQUIREMENTS

Climate is one of the most important factors when determining planting times. Production of a pepper crop depends on the length of a growing season with optimal temperatures. The plant itself stops growing at temperatures below 10° - 12°C, and at 6°C, the leaves can die and flower abortion will start. The same will happen when temperatures increase to over 35°C. A pepper crop requires very stable temperature ranges with minimums and maximums not being too far apart. Temperature variation might result in poor fruit quality or reduced yields. Optimum temperatures would be:

Day time: 25 - 28°C
Night time: 16 - 18°C

This would also be the ideal temperatures for growing under protection. Long periods of overcast weather can also result in poor fruit set and loss of a crop. Hot peppers can withstand higher temperatures than sweet peppers.

Table 1: Required temperature ranges per development stage for optimum sweet and hot pepper production.

Developmental Stage	Temperatures (˚C)		
	Minimum	**Optimum**	**Maximum**
Germination	23	26 - 28	30

Vegetative Growth	21	23 - 25	28
Fruit set – night	15	17 - 18	20
- day	20	23 - 25	28
Colouring	18	20 - 24	30
Cold Damage		under 6	
Frost Damage		under 1	
Terminal Damage		-2	

For the development of the pepper plant, a relative humidity between 65 – 85% is considered optimal. High relative humidity levels negatively influence pollen release and distribution on the stigma. High humidity creates a favourable environment for the development of several foliar diseases. Conversely, low relative humidity may cause infertility, due to pollen drying out before germination of the pollen on the stigma, which leads to small, deformed or flat fruit. At relatively low humidity and high temperature, evaporation rate from the leaves is rapid. If the root system is unable to supply the water volume required, it may lead to partial wilting of the growth tip and increase the incidence of blossom end rot.

2.2 SOIL REQUIREMENTS

A very high level of soil fertility is required for the profitable production of a successful pepper crop. The quality and quantity of pepper fruits are of crucial importance and are greatly influenced by the fertility and nutrient levels of the soil. Pepper plants do not perform too well in very high clay soils. They rather prefer sandy to loam soils; In fact they will grow moderately well over a wide range of soil types, provided they are well drained to a depth of at least 600 mm. However certain criteria have to be satisfied in terms of the soil structure and content to make it commercially viable. These factors include:

- Nutrient composition
- Compaction
- Effective soil depth
- pH
- Crop rotation
- Herbicide residues
- Water holding capacity

All these factors can have major influences on the resulting yield. The soil must permit adequate root growth to support the plant and supply water, oxygen and mineral nutrients and must be free of toxic elements. The rate of root growth is dependent on the degree of compaction or bulk density of the soil. The degree of soil compaction varies with soil type and location. The rate of aerial and root growth of plants increases with the oxygen contents of the soil. Root density is highest where there is a high rate of diffusion. Root development of pepper plants can be extensive if soil water and plant conditions are optimal. Early root development should be encouraged, because nearly all root growth occurs before fruit set. The importance of organic matter cannot be over emphasized. Organic matter in the form of decayed leaves, compost, sawdust or animal manure is a source of plant nutrients and acts as a soil conditioner. It increases the capacity of the soil to retain water and nutrients. It also promotes root growth and the infiltration of water and air into the soil. Care should be taken to use, where applicable good quality organic matter known to be free of plant pathogens.

2.3 PRODUCT TYPES

Capsicums consist of approximately 20–27 species, five of which are domesticated: *Cannuum*, *Cbaccatum*, *Cchinense*, *Cfrutescens*, and *Cpubescens*. Many varieties of the same species can be used in many different ways; for example, *Cannuum* includes the "bell pepper" variety, which is sold in both its immature green state and its mature red, yellow or orange state. Many types of peppers are

CUSTOMER SERVICES: 0860 782 753 • WWW.STARKEAYRES.CO.ZA• MEMBER OF THE PLENNEGY GROUP

SEEDS OF SUCCESS

used in dishes across the world. The "hotness"(pungency or spicy heat) of peppers can be measured according to Scoville Heat Units (SHU). The mildest peppers such as sweet bell peppers and cherry peppers are at the bottom of the Scovillescale. Peppers with average pungency like serrano and red cayanne peppers have moderate Scoville Heat Units. At the top of the scale is the habanero type as well as Bhut Jolokia, considered to be the hottest chilli in the world.

3. CULTIVATION PRACTICES

3.1 SOIL PREPARATION

Soil preparation improves the potential for profitable production of peppers. Any primary soil preparation must be aimed at creating growing conditions for pepper plants to develop the optimal root system in a specific soil profile. The highest percentage roots will be found in the top 600mm of the soil. The advantages of soil preparation are:

- No restrictions on root development.
- Less chance of compaction.
- More oxygen in the soil creating better root development.
- Higher yield.
- Reduction in production costs.
- More vegetative growth.
- More tolerance to drought and stress.
- Less root disease prevalence.
- Horizontal and vertical compaction layers broken.
- Better water retention.
- Increased uptake of moisture and nutrients.

The choice of preparation systems should be determined by the plant requirements and the soil type. Thereafter, economic factors should be considered. No standard system can be recommended on all soil types. The choice of preparation method should be made based on the clay content of the soil. For example on sandy soils the focus should be to reduce compaction and erosion, where on heavier soils it will be to reduce crust formation. Soil preparation should be done to depths varying between 300 – 600mm. Ridging is highly recommended, and should be done according to the land contours. The main advantage of ridging a pepper crop is to keep excess water away from the plant, improved oxygenation of the root zone, increased soil depth in the growing bed, to promote root development and keep root diseases at bay.

3.2 PLANTING PERIODS

The **earliest period** for seedling establishment would be when the soil and air temperatures at least meet the minimum requirements for plant growth.
The **latest seedling** establishment period would be after allowance has been made for the growth and harvest periods to be completed before adverse conditions sets in.

Due to the effect of certain factors being prevalent at specific locations, within each of these areas the planting times may be earlier or later than the times given below.

<u>Establishment periods for the main production areas of South Africa will then be:</u>

1. Lowveld (frost free areas) – Feb to May
2. Middleveld (moderate areas) – Sept to Dec
3. Highveld (cold areas) – Oct to Nov
4. Western Cape – Oct to Dec

<u>Under Protection</u>
Growing peppers under protection provides possibly the ultimate level of control currently available to producers. Protection against the natural elements and pests is obtained by the use of a transparent

A pepper plant starts to develop with a period of leaf growth. It then sets the first flower in the axis of the first two branches. Each branch forms one leaf, one flower and two new branches. From here the plant develops very quickly and flowering habit increases dramatically.

Once the fruit has set, it is retained by the plant for further growth development. Pollination is followed by fruit set. The pollen must be moved from the male to the female part of the flower. This occurs by way of the wind or visits by insects such as bees. Pollination in the open land is usually much better than with greenhouse production due to the natural wind factor.

Temperatures for good fruit set should be between 20 and 30° Celsius. In drought and heat stress, pepper plants not only lose flowers, but also buds. Loss of buds delays flowering by several weeks and reduces yields dramatically. Factors influencing flower drop or loss of buds include poor light intensity, excessive nitrogen and insect damage. A pepper plant develops hormones to control bud drop. Normally buds produce auxin, which allows it to develop and grow. However, under severe stress conditions, pepper plants generate ethylene, which causes the plants to drop their buds within two days.

If a pepper plant in production, bearing fruit and buds and setting flowers, is under severe stress, it will first drop its flowers and small buds. In an attempt to survive, the plant will retain the large fruit to finish its life cycle by at least producing some seed for future offspring. Pepper varieties setting fruit under very cold conditions tend to have flat or misshaped fruit with no seed set. This fruit is not marketable and needs to be removed in order to conserve energy for the plant.

Farmers can ensure good fruit set on their plants by taking the following actions:

- Select varieties with good fruit set under local conditions
- Ensure good irrigation management
- Ensure good fertilisation management
- Use a good preventative spraying programme against insect infestation
- Adapt the fertiliser programme to varieties that have the tendency to flush
- Use varieties with extended flower set so as to spread the risks

Research in greenhouse production has shown that there is a vital difference between tomato and pepper fruiting and growth relationships. Tomatoes show a negative correlation between vegetative growth and fruiting, therefore requiring strict control during the first phases of development. Peppers, however, require strong initial growth to promote earliness and abundant fruit set, showing a positive correlation between these stages. Although most pepper field crops are treated as annuals, technically they can be grown as perennials in a protected growing environment but careful economic considerations should be given to the feasibility of such a decision.

Factors influencing pollination:

- High temperatures – pollen not alive.
- Low temperatures, high humidity – pollen grains stick together (misshaped or flat fruit).
- Insufficient humidity – stigma to dry, pollen does not germinate.
- High humidity, low light – pollen makes clumps, cannot germinate on the stigma.
- High temperatures, low light – style elongates, pollen cannot reach ovules.

4.4 WEED CONTROL

In pepper production certain factors may influence yields negatively. These factors could include insect infestations, and fungal or bacterial infections. Weeds also contribute as a yield restricting factor. Firstly, weeds compete directly with the crop for moisture and nutrients available in the soil. Weeds could also be a host for various pests and diseases. It is also known that some weeds have the ability to produce enzymes that reduce plant growth in some crops. Capsicums are very sensitive to weed competition, particularly12 to 48 days after transplant. Problems occurring during this stage could severely affect the yield. Therefore it is crucially important to control weeds at this stage. The best and most effective way to control weeds would be:

material that allows sunlight to enter the structure and then converting the trapped solar energy to heat, thus providing increased temperatures for continued production. In advanced structures, humidity and even light can be controlled to ensure maximum crop yields.

3.3 SEEDLING PRODUCTION

Seedling establishment:

Model 128, 200 seedling trays are the most popular.
Although more expensive, larger seedling trays lead to better and more root development.
Seedlings take 6 weeks in summer to reach transplant maturity.
Seedlings take about 8-10 weeks in winter to transplant maturity.
Deep sowing: More advantageous in warmer conditions.
Seed takes longer to surface due to cooler temperatures and longer growing distances.
Shallow sowing: More advantageous in cooler conditions.
Seed surface quicker due to warmer temperatures and short growing distances. Sufficient levels of moisture are necessary.

The effect of soil- or growth media temperature on seed germination
Table 2 gives a good indication of the best temperature ranges for seed germination. At the optimum soil or growth media temperatures of 25 to 30˚C it will take pepper seeds 8 days to germinate. At temperatures ranges of 0-5˚C, 40˚C and above no germination is expected with seed being dormant.

Table 2: The effect of soil temperature on pepper seedling emergence.

Soil Temperatures (˚C)	0	5	10	15	20	25	30	35	40
Germination (days)	0	0	0	25	13	8	8	9	0

Seedlings should be grown in a well-aerated medium, which has good water holding capacity and at a pH of around 6.5. Generally, peat, bark and vermiculite mixes are used. Media problems typically include excessive tannins and low air filled porosity, which results in poor drainage and the buildup of green mould. The medium should be pre-enriched and the seedlings should be fertilized.

Seedling management is a critical factor, and the following points may result in physiological disorders:

Incorrect sowing time.
Cold temperatures, particularly below 7 °C.
Cold grown seedlings.
Over-fertilization of seedlings.
Oversized seedlings at transplant.
Temperature differences between the seedling nursery and the farm.

A precision seeder is recommended to place single seedlings at a uniform depth.

3.4 PLANT POPULATION AND SPACING

Open field

The single most important factor when making a decision around plant population is the type of chemical spraying system- or method that the grower is going to use for the duration of the crop. Everything should be designed around this implement so as to get in between rows when spraying to effectively control pests and diseases. Plant population is around 30 000 plants per Ha. This is done by normal single line rows, e.g. 1.5 meters in between rows by 200mm between plant spacing as per table 3 underneath.

A tramline system is also very popular. This is done where the rows are planted closer together or on a dripper system on each side of the dripper line. The advantage of this system is the achievement of a dense plant canopy that protects the fruit against sunburn. The negative aspect of this is that chemical control might be a challenge.

For 'tramline' sy stem:

60 cm between tramlines.
100 cm between rows. } 30 000 plants per/ha
40 cm between plants.

60 cm between tramlines.
100 cm between rows. } 35 000 plants per/ha
30 cm between rows.

Table 3: Plant population guide

Between Rows (cm)	Between plants (cm)					
	20	25	30	35	40	50
150	33 000	26 400	22 000	19 000	16 500	13 200
175	28 500	22 800	19 000	16 300	14 285	11 400
200	25 000	20 000	16 700	14 300	12 400	10 000
225	22 000	17 600	14 600	12 700	11 000	8 800
250	20 000	16 000	13 300	11 400	10 000	8 000

The plant population table above can be used as a quick guideline. For example: if the distance between rows is 2 meters with the distance between plants 30 cm, one will have a plant population of 16700 plants per ha.

Production under protection
The planting density should be around 3-4 plants/m². This is mainly done where medium to smaller fruit is needed for speciality and high quality markets. Plants are trained to single, double or three stems on supporting strings and stopped at a height of2 meters or more.

3.4.1 TRANSPLANTING SEEDLINGS

The production of good quality, healthy seedlings require the correct choice of both variety and seedling grower.The correct soil preparation, analysis and fertilizer application prior to planting also needs to be done. Before seedlings are collected from the nursery, land preparation should be completed and irrigation systems should be in place. At this point some growers already install the trellising system such as poles and first wires. Seedlings must be hardened off before leaving the nursery. This is done by making sure that excessive nitrogen and irrigation is kept to a minimum. Two to five days before collecting the seedlings, the trays must be taken out of the nursery and placed in a position where more sunlight is available to the plants.

It is highly recommended to always establish seedlings in wet soil. Always make sure that the holes on the ridges where seedlings are about to be transplanted are exactly the same size as the seedling plugs. This will prevent issues such as J-rooting where seedling plugs are forced into the soil and roots are bent over resulting in seedling uniformity issues and yield losses. Although it is not recommended to establish these plants, it happens from time to time that a grower receives over mature or taller plants than is considered ideal. In this instance it is recommended to sterilize the stem with a fungicide and plant the seedling deeper into the soil than normal. This is not the best thing to do, but lateral roots will shoot from the stem to help the plants. Sometimes seedlings are received with flowers or buds already setting, it is recommended to remove them at planting in order to give the plant more energy to establish itself. Controlling field irrigation with the use of soil moisture instruments such as irrometers or tensiometers is highly recommended to ensure the development of a healthy root system and avoiding over-irrigation. Domesticated peppers, in particular sweep peppers are very prone to root rot diseases such as *Phytophtoracapsici* and saturated soil conditions for long periods of time should be avoided at all costs.

3.5 FERTILIZATION

During the production of sweet and hot peppers, correct fertilization is the single most important factor that determines the success of a crop. With good management practices these crops could be produced under a wide range of different conditions, however some growing conditions are more favourable than others. In order to calculate the correct nutrient requirement, the following aspects need to be available and taken into consideration:

Nutrient withdrawal figures
Fertilizer used in the past on the specific area intended to be planted.
Soil type.
Soil analyses.
Soil Acidity (pH).
Quality of irrigation water.
Micro elements.

3.5.1 FERTILIZATION GUIDELINE

The ideal soil analyses or soil status for sweet and hot pepper production should be:

pH (H_2O): 5.6 – 6.8 (NB!! MUST BE CORRECT.)
P: 30 – 60 mg/Kg (Bray1)
K: 100 – 250 mg/Kg
Ca: 300 – 2000 mg/Kg
Mg: 120 – 300 mg/Kg
Na: 10 – 50 mg/Kg

Table 4:

Nutritional requirements of pepper in open field										
Expected yield	**Removal by yield (kg/ha)**					**Uptake by whole plant (kg/ha)**				
(Ton/ha)	N	P	K	Ca	Mg	N	P	K	Ca	Mg
20	40	12	70	10	6	121	30	173	95	28
40	80	24	140	20	12	191	49	282	137	43
60	120	36	210	30	18	261	67	390	179	57
80	160	48	280	40	24	331	86	499	221	72
100	200	60	350	50	30	402	205	608	263	86
120	240	72	420	60	36	472	124	716	305	100
140	280	84	490	70	42	542	142	825	347	115

Table 5:

Nutritional requirements of pepper in greenhouse										
Expected yield	**Removal by yield (kg/ha)**					**Uptake by whole plant (kg/ha)**				
(Ton/ha)	N	P	K	Ca	Mg	N	P	K	Ca	Mg
25	50	15	87	12	7	140	35	201	107	32
50	100	30	175	25	15	221	57	330	153	49
75	150	45	262	37	22	303	79	457	198	64
100	200	60	350	50	30	384	101	585	244	81
125	250	75	437	62	37	466	123	712	290	97
150	300	90	525	75	45	547	145	841	336	114

175	350	105	612	87	52	629	167	968	381	129
200	400	120	700	100	60	710	189	1096	427	146

3.6 IRRIGATION

The supply of adequate water to the roots of a pepper plant is critical. Under- or over irrigation can have a devastating effect on the outcome of the crop. It is therefore very important to apply water at optimal times. More frequent light irrigations are needed on sandy soils. Higher applications with longer intervals will be needed on clay soils.

Too little water might lead to:

- Sub-optimum yields.
- Decrease in the photosynthetic rate.
- Plants developing stunted growth.
- No production of flowers.
- Low percentage fruit set.
- Slow fruit development.
- Small fruit sizes.
- Poor quality.
- Flower abortion.

Too much water might lead to:

- Not enough oxygen in the soil.
- Plants becoming wilted.
- Root diseases becoming prevalent.
- Stunted plant development.

When scheduling irrigation, the size of the root system at the time of irrigation needs to be taken into account. In general, the root system can be compared to the aerial growth of the plant. The roots spread into the soil at a similar rate to which the aerial growth develops. Most pepper roots occur in the top 500 – 600 mm of soil level, even at maturity. For this reason irrigation should be monitored at this level with irrometers. Deep, thorough irrigations are preferable to light and regular watering intervals. Drip or flood irrigation is preferable to overhead irrigation, due to susceptibility to foliar diseases. The amounts of water used will vary depending on the climatic conditions. During the cooler months peppers require about 25mm per week and this might increase to 50mm under very hot, windy and dry conditions. For irrigation purposes, the growth of peppers can be divided into four growth stages.

Stage 1: Establishment

- Can last up to 2 weeks.
- Seedling establishment takes place and plants start to grow actively.
- Low amounts of water are used.
- After seedling establishment to just before first flower, it is highly recommended (although a fine line of management) to reduce water drastically. It will force the roots to grow aggressively deeper into the soil looking for moist. This will help the plants at fruit set stage to handle difficult and stress related periods better due to the increased roots.

Stage 2: Vegetative growth

- Development of first flowers and fruit.
- Double the amount of water is used compared to the previous stage.

Stage 3: Fruit set

- Growth is at its highest.
- Water usage at this stage is at its highest during the lifespan of the crop.

Stage 4: Ripening and harvesting

Very high loads carried on the plant.
Water usage starts to decrease.

Table 11 IRRIGATION REQUIREMENTS.

WEEKS AFTER PLANT	ROOT DEPTH (mm)	SOIL MOISTURE %	CROP FACTOR	DAYS BETWEEN IRRIGATION	AMOUNT NEEDED (mm)
0 - 2	400	20	0.3	2	10 - 15
3 - 6	500	30	0.4	3 - 5	15 - 25
7 - 15	600	40	0.6	5 - 7	30 - 40
16 - +	700	50	0.8	7 - 10	20 - 30

Please Note! Soil should be wet at planting. Irrigate 20 - 30 mm directly after planting.

4. OTHER CULTURAL PRACTICES

4.1 TRELLISING

This is one of the expensive factors contributing to pepper production costs. Costs will directly be linked to the chosen variety. Some compact types don't need to be trellised, but are more prone to a concentrated sets over a shorter period of time. More compact types will use less inputs compared the taller growing indeterminate types. Indeterminate or less compact types needs to be trellised and are known to grow and develop over longer period of time. It has an extended set and harvest period resulting in higher yields. The advantages and disadvantages of trellising and non-trellising of peppers would be:

<u>Trellising:</u>
Advantages:

Very high percentage pack outs.
Highest percentage first grade pack out.
Less disease prevalence.
Less spraying needs to be done.
Reduced risks.

Disadvantages:

Increased productions costs.

<u>Non-Trellising:</u>
Advantages:

Lower input costs.

Disadvantages:

Reduced fruit quality and lower pack out percentage.
Higher percentage plants falling over.
Higher percentage fruit rot.
Higher percentage leaf diseases prevalent.
Increased spraying program.

For open field trellising poles should be between 1.2 – 1.5 meters long. Treated poles last longer, but caution should be taken with Creosote treated poles as this might burn some of the plants on hot days. Poles should be planted directly after seedling transplantation. Some growers even do the planting of poles before the time. Wire or rope can be used and should be done at first flowering stage

or around one month after transplant. Although more expensive, wires last longer and don't have the ability to gather diseases. Rope could be infected with bacterial spores and should be sterilized after use. Poles should be planted around 40 – 50 cm into the soil and not more than 3 meters apart. It is essential that the end or corner poles are supported. Poles should be able to carry the plant and its fruit, and withstand side winds. When rows are 1.5 meters apart and the crop is planted in a 1 hectare square block of single lines, one would need 2200 poles and around 40 000 meters of wires if 3 sets or 6 lines of wire are used.
For the 'tramline' system (as discussed in the plant population section) one would need double the amount of poles as it would be placed opposite each other on either side of the tramlines.

A pepper plant has the ability to grow and develop very fast and constant trellising should be done. The plant will make side shoots that grow to the sides of the main plant. These shoots should be neatly tucked in between the wires and not damaged. This should at least be done on a weekly basis. Trellising under protection could be done in two ways.

One way would be to do it the same way as the conventional open field method, or what growers refer to as the Spanish method. With this method plants grown in a single line or double lines (tramline) are boxed on either side with poles, string or wire. Plants will then grow inside this boxed area upwards to the desired height. Layering of plants grown this way would not be possible and one will need to use the height to the top of the structure to its maximum potential.

The alternative way would be done by trellising a steel wire at 2 – 2.5 meters above the single or double row. Rope or twine is then hung down from this wire for the plant or stems to be able to be guided up against the rope. As the plant matures, the rope would then be shortened or rolled up at the top if necessary, or the plant would guide itself along the rope to the top. With this method, only one or two stems are allowed to grow, and all suckers are removed. Layering of plants could be done with this method as all the plants and or stems have their own individual supportive string.

4.2 PRUNING

Pepper plants grown in a greenhouse are normally trained to two stems and need good support from an overhead trellising system due to the brittleness of their stems. The first training of the stems is done one month after transplanting and will continue every other week, depending of the growth rate. This type of training system allows for better light penetration, but if more light is available, more stems per plant may be considered. A maximum of up to four stems are used. One fruit should set for every two leaves the plant produces and flowers are allowed to set after the lateral branches have produced four leaf axils after the fork. The first flower produced by the immature transplant should always be removed so as not to inhibit future growth. Scissors or finger tips can be used to remove the desired shoots. Smaller wounds will heal faster. A disinfectant should be used to prevent the spread of disease. If too many stems are allowed to develop, energy is used in developing the multiple growing tips and fruit production may be slowed. More stems will however result in more, smaller fruit, produced increasingly later in the season. Fewer stems will produce fewer, though larger, fruit, and the plant will take less space.

More compact type peppers do not require pruning, as they are mainly grown in open field which would result in less vegetative growth and a increase in sunburn damage to the fruits. Topping the plants around 30 days before the first frost will give every fruit that has set an opportunity to mature, as the removal of the growing tips will direct all sugar produced by the plant to the fruit.

4.3 POLLINATION

In general, pepper plants are more susceptible to cold than most vegetable types. Low temperatures can cause plants to lose flowers and buds, which can lead to dramatic yield losses. Capsicums are self-pollinating, and 60 -70% relative humidity is considered optimal for good pollination and fruit set. With humidity levels of 90% or higher, pollen may not shed. As less pollen is produced on cloudy days, better pollination is required at these times to ensure good fruit set. Good pollination improves fruit quality and yield and this aspect can be influenced by the farmer. Methods of aiding pollination include tapping support wires, hand-held electric vibrators or use of motorized back-packs that blow air onto the plants. Under proper conditions, pollinating each cluster every second day is generally adequate. Fertilization occurs 48 hours after pollination. This is the most critical stage in production.

- Manual weeding.
- Mechanical weeding with small tractor and implements.
- Mulching of the rows.
- Weed control products.

There are a few products are registered to control weeds, particularly on post-emergence annual and perennial grasses, and pre-emergence for grasses and broadleaf weeds.

5. HARVESTING AND MARKETING

Factors such as nutrients, climate, temperatures, management and logistics play an important role in the general holding ability of peppers. New generation peppers varieties have been developed, due to breeding efforts over a period of years, to possess better firmness, holding ability and shelf life. All this is useless information if a crop of peppers is not picked at the right stage, distances to the markets are not taken into consideration and the cold chain is broken (constant temperature range in which the crop is transported to its destiny).The farmer must always bear in mind that quality is profitability. The qualities that attention should be paid to include: pack-out, uniformity, fruit shape, ripening ability, firmness and flavour. The specific characteristic required will depend on the market requirements, as dictated by the packer, shipper, wholesaler, retailer and consumer.

Sweet peppers are mainly marketed in the green stage. All Capsicum types will be green in this stage and only once fully matured will turn colour to its genetic background. There are various colours on the market available, but the main ones would be red, yellow and orange. In the green stage the pepper is not matured and shelf life is expected to be much longer. Shelf life in the coloured stage is highly vulnerable to the fruit being fully matured. The fruit size of a pepper rarely indicates the maturity stage as some varieties are genetically larger in size than others. As an indication of when peppers should be harvested in the green stage the firmness of the fruit plays an important role. Coloured peppers are normally harvested at colour break stage. This will give sufficient time to get the product to the desired market depending on the distance etc.

Green Stage:
The pepper fruit is still green and when picked at this stage, will most probably last up to a maximum of two weeks in cold storage. Internally and externally fruits are very hard and crispy. This is the main segment in which the product is marketed.

Colour Breaker Stage:
These are the stages just before the pepper turns to its full genetic colour. Internally the pepper has already started to colour. On the outside one could clearly see blotches of the green fruit starting to colour. In South Africa this is the most common stage to pick coloured peppers as some farms are far away from the national markets. Fruit colouring to the full ripe stage will happen during the transportation process, or if temperatures are low it will colour on the market. Colouring of the fruit will start around the side mostly exposed to the sun. Fruit at this stage should be stored at 16-21°C.

Ripe to Full Ripe Stage:
Worldwide this is the stage where consumers buy coloured peppers. This stage gives the best colour and taste. Potentially this is the stage where the highest sugar content could be expected. This is measured with a refractometer and is expressed as brix %. Fruit at this stage should be stored at 13-18°C and 90 – 95% relative humidity. At this stage of ripening one can expect 6 % brix. Peppers are sensitive to cold and should not be stored below 13˚C.Peppers are sensitive to ethylene (ripening hormone) and should not be stored with fruit that produce ethylene, such as bananas, avocados, and kiwi fruit.

INDEMNITY
All technical advice and/or production guidelines given by STARKE AYRES or any of its personnel with reference to the use of its products, is based on the company's best judgement. However, it must be expressly understood that STARKE AYRES does not assume responsibility for any advice given or for the results obtained.