GROWING & USING CAPSICUMS & CHILLIES

WRITTEN BY JOHN MASON AND STAFF OF ACS DISTANCE EDUCATION

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CHAPTER 1 HISTORY AND SCIENCE

We all know capsicums as the vegetable that can be eaten fresh or cooked; or used to add flavour to a huge range of dishes, from Asian stir fries to Mediterranean dishes and Mexican chilli beans. Capsicums have a huge range of other uses as well, from condiments such as sweet chilli sauce, to ornamental uses as a bedding plant grown for colourful foliage or fruits.

Capsicums are also known by the common names of pepper or chilli. The capsicum species that we grow most widely around the world is *Capsicum annuum.* Capsicums belong to the Solanaceae family of plants, as do tomato, eggplant and potato. A very wide variety of weeds and ornamental plants also belong to this family; some are also edible, but many are toxic, if not deadly.

Most capsicum cultivars grow to between 40 and 90 cm tall, though occasionally they can be outside this range. They are actually perennials, and may survive two or more years in mild climates or greenhouses; however, they are more commonly treated as annuals, being grown over the warmer months of the year in temperate and sub-tropical climates.

Plants grow fast if conditions are good i.e. moist, well drained, fertile soils, and warm (but not hot) temperatures. Healthy and strong growing plants can produce ongoing flushes of flowers, followed by rapid development of fruits, for as long as conditions remain good.

Capsicum annuum - Bell Pepper fruits are wide, with a bell like shape, and have a fat sweet and not so hot flesh

Chilli Peppers are generally longer and narrower than the sweet or bell peppers; and are hotter tasting.

Bell peppers come in a range of colours. Often, but not always, they start as green fruits, and change colour as they ripen. You may harvest as a green fruit, or wait and harvest as a different colour.

HISTORY OF THE CAPSICUM

All except one species of capsicum are indigenous to central and south America; there is prehistoric evidence of capsicums in Peru and it is thought that capsicums were cultivated as early as 7,000 BC in the Americas. Capsicums were being widely cultivated when the Portuguese and Spanish began to colonize South America.

Capsicums are known to have been introduced to Europe by Columbus in 1493. Europeans initially used dried, crushed capsicums as a substitute for peppercorns *(Piper nigrum*)

The Portuguese introduced capsicums to their colonies in Asia in the 16th century, where it was widely adopted into Asian cooking (largely because it was easier than *Piper nigrum* to grow).

Chilli pepper was being sold widely across Europe, in a grounded powder form, by the 1600's. The sweeter types of capsicums are relatively recent introductions. The first mention of a sweeter type of pepper may have been a variety in Hungry in 1580's derived from a so called "Hungarian Paprika". Bell Peppers however, did not begin to be widely cultivated until the 20th century.

One species (*Capsicum anomalum*) is indigenous to Japan.

The introduction of rapid refrigerated transport and growing awareness in health benefits of capsicum, led to ever increasing popularity of bell peppers over the second half of the 20th century.

Capsicum fruits come in a wide variety of different colours and shapes; The taste can be almost as diverse as well.

TAXONOMY OF THE CAPSICUM

"Linneus" recorded two species of Capsicum in the first edition of his "Species Plantarium" in 1753; and a further three species were added in 1797

Over the years, there has beaen considerable confusion and conflicting opinions about the taxonomy of capsicums. Some experts suggest as many as 40 different species; though most authoritative experts would suggest less than half that number.

Some of the earlier botanists recognised many different species of capsicum; but a botanist by the name of "Irish" in 1898 recognised two species, with *C. annuum* having seven different botanical varieties.

Another botanist called "Bailey" in 1949 recognised only one species with six botanical varieties or sub species. In some of his work though "Bailey" suggests that there may be more than one.

Many European an Asian botanists today lean toward the 1898 classification made by Irish botanists; while American botanists more often follow the 1949 classification by "Bailey".

These positions however were challenged by taxonomic work in 1953 by Heiser and Smith, which recognised four cultivated species, as follows:

Capsicum annuum and *Capsicum frutescens* which are cultivated widely around the world

Capsicum pendulum and *Capsicum pubescens* were cultivated in Latin America only.

Tabasco was seen by Heiser & Smith as being a cultivar of *C. frutescens* and all other cultivars grown outside Latin America were considered to be types of C. annuum.

Even though there may be conflicting opinions about the taxonomy; it is still important to use the scientific names. This may not be a perfect system; and there may be changes from time to time; but it is still the most universally accepted and consistently accurate way to differentiate between different cultivars of capsicum.

CHAPTER 2 GROWING CAPSICUMS

Capsicums are small, bushy plants from 40 -90 cm tall, with shiny green leaves and green to orange, red and even purple fruit – some cultivars changing colour as they mature from green to red.

They are generally treated as annuals, although in warm climates they will die back over winter and reshoot in spring.

There are two main types - the sweet or mild ones that are eaten raw in salads and the hot (or chilli) ones that are used as flavourings in Asian, Mediterranean and Mexican cooking.

In many respects, to grow well and produce good crops, capsicums require similar conditions to tomatoes.

Capsicums grown in a garden bed

GROWING REQUIREMENTS FOR CAPSICUMS

Temperature Requirements

Sweet peppers (i.e. 'bell pepper' cultivars) grow best at temperatures between 21-24°Celsius (70-75° Fahrenheit).

Hot peppers (chilli types) include cultivars that grow just as well in warmer conditions. The optimum temperature range for hot peppers is 21-29°Celsius (i.e. 70-85° Fahrenheit).

Some experts recommend avoiding night temperatures below 18°C, others suggest anything below 16°Celsius is unwise. However if day temperatures rise above 32°C, there can be a problem with fruit setting; fruit will not set at temperatures under 15°C or above 32°C.

Protection from strong winds is necessary as peppers are brittle. Wind can also cause chilling in cold weather. Windbreaks might be needed for row crops on exposed sites. Rows of corn are sometimes grown for wind protection.

Plants are likely to burn and die in frost.

Fruit can suffer sun burn from direct intense sunlight when temperatures are low; shade may be required in mid summer.

The plant can exhibit an under-supply of water, even when moisture levels in the soil are adequate especially if there is low humidity and high temperatures. This can result in water transpiring from the plant faster than it can be taken up through the roots, and when this happens water deficit can occur and that in turn results in abscission (i.e. dropping) of buds flowers and small fruits.

Light Requirements

Capsicums are more tolerant of some shade than many other vegetables. Shade is definitely advantageous when days are long and light intensity is high; but the value of shading crops also depends upon the cultivars being grown. Some like shade more than others, and even though shading is commonly used in some places, it is rarely used in many other places and is worth considering in the home garden when you plant this species.

Research in Poland has shown that plants grown under lower light intensities have higher levels of both chlorophyll and carotenoids, but slower growth rate.

When grown under lights (e.g. in greenhouses) 50,000 to 60,000 Lux (Lux is a standard unit of the measurement of light intensity) is recommended for bell peppers by some growers.

As a comparison outdoor sunlight averages ranges from 32,000 to 100,000 Lux.

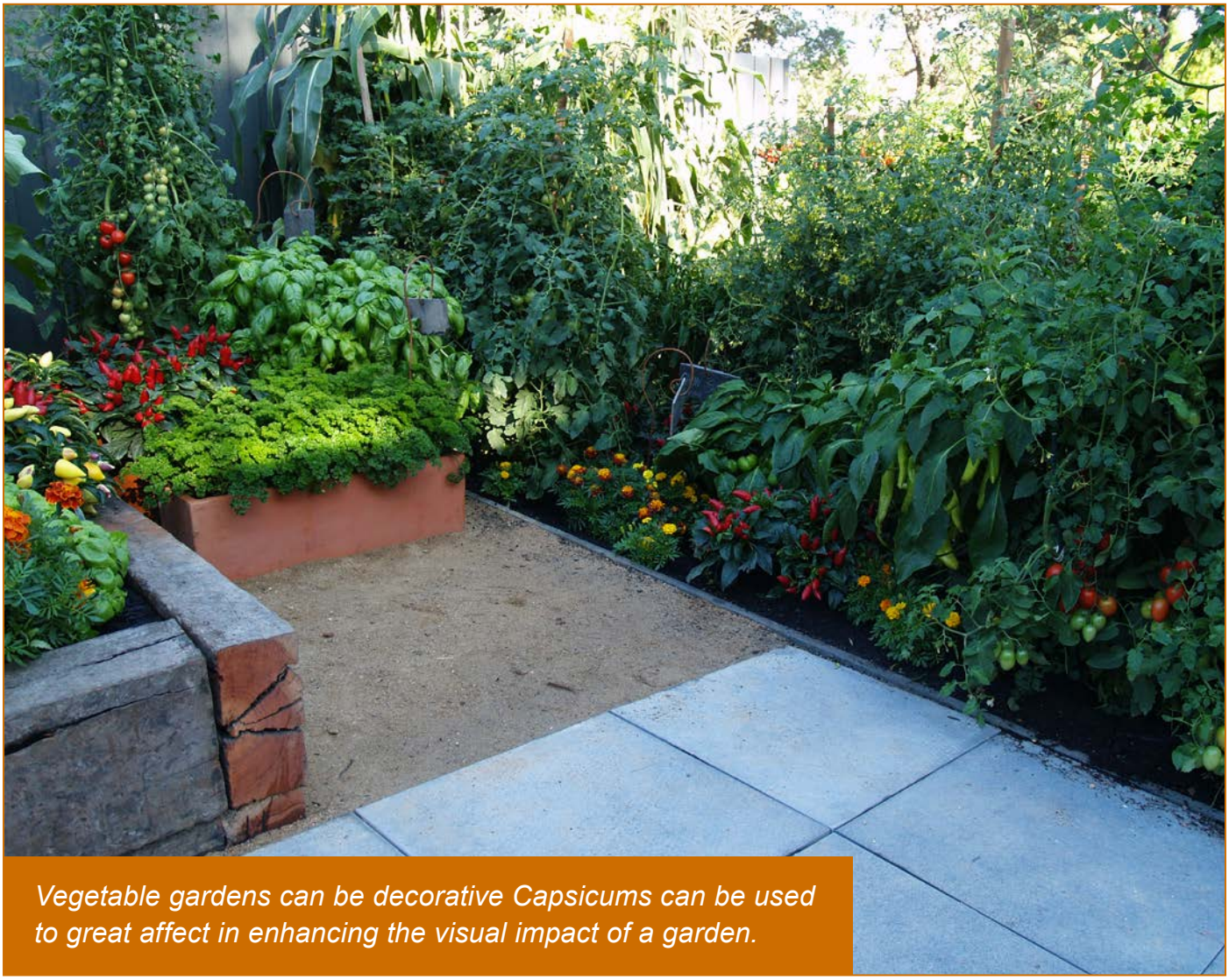
Research in Mexico found that *Capsicum annuum L. var. aviculare* grows better and produces the heaviest crops, with full or near full sunlight in the morning, but shade in the afternoon.

Research from Wyżgolik, Nawara and Leja; Dept Plant Physiology, Agricultural University, Krakyw, Poland (2008) concluded that:

- Lower light intensity increased stem elongation, leaf blade area and leaf area index.
- Lower PAR (Photosynthetically Active Radiation) intensity limited photosynthesis rate.

  Note: PAR (Photosynthetically Active Radiation) is a portion of the light spectrum that plants are sensitive to, namely 400 to 700 nanometers in wavelength.
- In lower PAR intensity, a higher LAI (Leaf Area Index) value compensated for the net photosynthesis reduction.

  Note: LAI (Leaf Area Index). LAI (although considered a dimensionless quantity or: m^2/m^2) is generally defined as one half of the total leaf area per unit ground surface area; however research suggests that different definitions can result in significant differences between calculated LAI values. There are also several ways in which LAI is calculated.
- Polyethylene films of lower light transmittance did not affect total and marketable yields of the sweet pepper ‘Spartacus’.



Vegetable gardens can be decorative Capsicums can be used to great affect in enhancing the visual impact of a garden.

Capsicums growing in troughs filled with good quality potting soil.

Plant Spacing Requirements

Traditional plantings are 15-30 cm (12-24 inches) between plants in a row, and 45-90 cm (18-36) inches between rows.

This spacing is not set fast though. For instance, in the sub-tropics, where humidity can become an issue and ventilation between plants can be therefore more important, a wider spacing has been used. Plants are grown as a row crop on raised beds, with two rows 1.5 metres apart to a bed and one plant every 40 cm in the rows. This will result in 27,000 to 30,000 plants per hectare (depending upon the distance between beds).

Typically, commercially grown peppers may take between 65 and 80 days from planting the plants, to when you harvest the first peppers.

Nutritional Requirements

Soil Conductivity and Nutrients

Conductivity is a measure of the rate at which a small electric current flows through a solution. (It is also known by the terms “E.C.” or “C.F.”). When there is a greater concentration of nutrients and salts, the current will flow faster, and when there is a lower concentration, the current flows slower. By measuring conductivity, you can determine just how concentrated a nutrient solution may be. A conductivity meter is used to make such measurements.

Note: EC (soil Electrical Conductivity) is the ability of soil to conduct electrical current and is a measurement of soil salinity (the amount of soluble salt in the soil. EC is expressed in milliSiemens per meter (mS/m) or milliMhos per centimetre (i.e. mMho/cm) (the first being the more commonly one used today).

To measure soil salinity we determine the electrical conductivity of a solution – this is done by saturating the soil with water and the sample is then measured usually with an EC meter. When this method is used the result determined is known as the ECe of the soil.

C.F. - short for “conductivity factor”; C.F. is expressed on a scale of 1 to 100, where 0 stands for pure water containing no nutrient, and 100 indicative of maximum strength of nutrient salts in solution.

E.C. is generally measured at 25°Celsius, and most literature and recommendations are based upon the nutrient solution being at that temperature. If the temperature of a solution is raised, the E.C. will increase,

even though there are no extra nutrients added. If the temperature drops, the E.C. will decrease. It is possible to calculate the change in E.C. when temperature changes, by multiplying the E.C. by a conversion factor for the temperature it is changed to (refer to table below).

Temperature conversion factors for determining E.C. at temperatures varied from the standard of 25 degrees Celsius.

°C	Conversion factor
15	1.247
20	1.112
22	1.064
25	1.0
27	0.96
30	0.907

Different plants have preferred conductivity levels at which they will grow their best. These levels can vary from early to later in a crop's life.

You should predetermine the desired conductivity for the plant being grown, and any changes in that desired level from one stage of a plant to the next.

As a soil loses nutrients, the E.C. will drop. When a drop is detected, nutrients should be added to soil to bring it back to the desired level.

Salt tolerance of capsicums is around half that of tomatoes (i.e. tomatoes tolerate more salt).

- Yield will decrease by 10% at a salt level of 2 ECe (mmho/cm at 25 degrees C). (ECe2 is considered average root zone salinity
- Yield will decrease by 25% at a salt level of 3 ECe (mmho/cm at 25 degrees C).

Cation Exchange Capacity and Nutrients

Cations are atoms which have lost electrons. As such they are particles which have a positive charge. Many important plant nutrients occur in a soil or nutrient solution as cations (i.e. potassium, calcium and magnesium). These particles will be attracted to particles which have a negative charge, hence staying in the soil, or other medium, and being available to the plant roots for a longer period of time.

Organic matter such as peat moss, and fine particles such as clay, have a lot more negative charges on their surface, hence a greater ability to hold cations (higher cation exchange capacity) than larger sand or gravel particles. Soil or media with a very low cation exchange capacity will require more frequent application of nutrients than ones with a higher cation exchange capacity. When a nutrient is applied to a soil (or growing medium) with a low cation exchange capacity, but high water holding capacity, the medium might remain moist, but many nutrients will be lost with drainage of excess irrigation water - so becoming leached more rapidly.

A higher cation exchange capacity will reduce this tendency.

pH Requirements

pH is a measurement of the hydrogen ion concentration in a particular medium, such as soil. More simply it refers to the acidity or alkalinity of that medium.

The pH is measured on a logarithmic scale ranging from 0 to 14 with 7 being considered neutral, above 7 being considered alkaline and below 7 as acid.

The pH of a media or a soil is important to plant growth. Each particular plant has a preferred pH range in which it grows. If a plant is subject to a pH outside of its preferred range its growth will at the least be retarded, or it may even die. Very low pH (less than pH = 4.5) and very high pH conditions (above pH = 9) can directly damage plant roots.

Very high and low pH values can also affect plant as follows:

1. As the pH of a media changes so does the availability of nutrients. The majority of nutrients are best available at a pH range of 6 to 7.5. Somewhere in this range is generally considered to be the ideal for growing the majority of plants, although there are plants that prefer higher or lower pH conditions. In some circumstances, particularly at very low or high pH conditions some nutrients may become ‘locked’ in the media becoming unavailable for plant growth. The nutrients may be there in the media but the plant can’t use them. At very low pH conditions toxic levels of some nutrients such as manganese and aluminium may be released.
2. As the pH of some media is raised more negative charges are produced on some colloid (particle) surfaces, making them capable of holding more cations. This allows some media to hold larger quantities of nutrients. Soils media that contain clays or some of those derived from volcanic materials are most affected.
3. Like plants micro-organisms have a preferred pH range in which they thrive. Altering the pH may severely affect the populations of both beneficial and detrimental micro-organisms. For example the bacteria that convert Ammonium to nitrogen prefer a pH above 6. Most mycorrhizal fungi prefer a pH range of 4 to 8.

Adjusting pH

Before using a soil you should test the solution pH. Ready to use soil should normally have a pH between 6 and 6.5 (Though for some types of plants, the ideal pH is higher or lower than this).

If necessary the pH can be changed as follows:

- Add lime (or some other calcareous component) to raise pH.
- Add diluted sulphuric or nitric acid to lower pH.
- Ammonium salts will acidify (e.g. ammonium sulphate) as some nutrients are absorbed and others are left in the root environment the pH will change.
- Careful addition of caustic soda will increase pH.

Some additives also affect pH, for example peat is acidic and freshly mined scoria is alkaline.

Nutrient Availability and pH

The ease with which nutrients are able to enter a plant is greatly affected by pH. Extremely acid or alkaline soils can often stop the nutrients present being absorbed and used by the plant. The plant will suffer a nutrient deficiency, not because the required nutrient is not in the soil, but because the plant cannot get it. (ie. it is not available).

The ideal pH for nutrient availability is different for each nutrient. A pH that makes iron is very available will make calcium much less available. The only answer is to compromise - go for a pH in the middle, where no element is so available as to become toxic and the amounts of others can be increased to compensate for any loss in availability.

Optimum pH for nutrients:

Nitrogen	6 to 8	**Calcium**	7 to 8.5
Phosphorus	6 to 7.5	**Potassium**	6 to 10
Magnesium	7 to 8.5	**Sulphur**	6 to 10
Iron	4 to 6	**Manganese**	5 to 6.5
Boron	5 to 7	**Copper/Zinc**	5 to 7

Note: excess acidity may create toxic soil conditions due to the increase in solubility of such elements as aluminium and manganese. Soils which are too basic (alkaline) may cause deficiencies of essential nutrients such as boron, iron, zinc and manganese. Because the availability of many micronutrients is influenced by soil acidity, it is essential that accurate pH measurements be made.

Methods of Measuring pH

1. **Probe meters**

   Probe meters consist of a probe on top of which is mounted a small meter sensitive to electric currents. The probe is simply pushed into the wet medium and the ph read off on the meter. These instruments have been found to be very unreliable and their use is not recommended.

2. **Colorimetric methods**

   In these methods, the colour obtained when the soil is mixed with an indicator solution is compared with those on a colour chart to give the pH. Kits are available to carry out these measurements. They are cheap and reliable and give results accurate enough for most landscaping and garden situations. Colorimetric tests can be used for quick screening and checking in nurseries.

3. **pH meters.**

   Meters for reading pH consist of an electrode and an electronics system which provides a read-out on a dial or a digital display. pH meters are very delicate and relatively expensive. Care must be used in their operation and they must be calibrated with standard solutions.

The measurement obtained with a pH meter depends on the method of extraction of the soil solution. a. Saturated paste extracts are the most easily standardized method. A minimum amount of water is added to just flood the sample. The solution is then extracted and tested. b. Volume soil; volume water method. This is easier but the results can be influenced by the soil characteristics. The ratio most widely used is 1 soil to 5 water.

pH and Capsicums

The ideal pH for growing capsicums is 6 to 6.5; on acidic soils lime is often applied to raise the pH. Dolomite lime, which also contains calcium, is generally preferred. You are best to alter pH slowly with several applications, well prior to planting. On sandy soils, never use more than 5 tonnes per acre (half hectare approx.) of dolomite in one application.

Heavy clay soils that have a pH above 8 (and are sodium affected) can benefit from applying gypsum at 5 to 10 tonnes per acre. Do not use lime on alkaline soils because it will raise the pH even higher. Loamy soils tolerate higher rates of gypsum; gypsum works best when soil is wet and does not change the pH – it flocculates clay particles to make the clay soil less prone to drainage issues however the addition of gypsum should be researched first and only applied if there is likely to be benefit. Note though that not all soils respond to the application of gypsum – sodic soils respond best.

Soil Organic Matter

Soils with a good organic matter content are generally easily worked (we say they have a good tilth if they are easily worked). If you squeeze a handful of soil into a ball in your hand and it remains in a hard lump, then it has a poor tilth - hard clods will result when it is ploughed. If it crumbles, then it is well granulated -organic matter promotes granulation.

- Cultivated soils with good tilth are less subject to wind and water erosion.
- It is difficult to increase the % of organic matter in a soil, but it is important to try to maintain that %.
- The average mineral soil contains around 2 to 5% organic matter.

- Organic content will drop if you remove plant material which grows in a soil and don't return organic material to the soil. This can be done the following ways:
- The roots of plants grown once finished should be cultivated back into soil.
- Compost should be added regularly.
- Use of organic mulches on the soil.
- Feeding plants with manure (preferably well-rotted).

Soil Humus

Soil humus is the result of organic matter decomposition and microbial synthesis.

It has a high Cation Exchange Capacity (CEC) and moisture holding capacity.

95 - 98% of total nitrogen is held in the humus complex as is a large amount of phosphorus and potassium.

Fertilizer Requirements

There are a tremendous variety of different fertilisers available, and each one is different. Using the wrong fertiliser or the right fertiliser at the wrong rate can create problems in your garden rather than overcoming problems.

The variables include:

- Relative proportions of each nutrient.
- Actual concentration of the nutrient (This is different in different types of fertilisers)
- Solubility.
- Period of time over which the nutrient will be used.
- What else is with the nutrient? (For example: nitrogen applied as potassium nitrate will also supply potassium).
- Method of fertiliser application - to roots or foliage? Broadcast on the soil surface or buried in holes - in liquid or dry powder form - watered in or not?
- Type of soil (will the fertiliser hold in the soil or be leached out).
- Type of plant and time of year (will the plant use the fertiliser quickly - is it growing rapidly).

Capsicums and other vegetables frown as a green wall in a series of trickle irrigated troughs mounted on a wall.

Nitrogen

Nitrogen can be obtained naturally by growing leguminous plants alongside other plants or as a cover crop to be ploughed in before planting. Legumes (e.g. Peas, clover, wattles etc) have colonies of bacteria in small nodules on their roots. These bacteria don't damage the plant. In fact, they extract nitrogen from the atmosphere and make it available for use by the plant.

Nitrogen fertilisers include:

- Sulphate of Ammonia: 21% nitrogen.
- Potassium Nitrate: 34% nitrogen.
- Urea (cheap but can burn): 46% nitrogen.
- Blood and Bone, Fowl manure etc. (varies according to the source).

Phosphorus

- Rock Phosphate: insoluble.
- Superphosphate: this is a soluble phosphate plus gypsum. Excellent in dry, sandy situations.

Potassium

- Potassium Sulphate: 41.5% potassium - expensive.
- Potassium Chloride (muriate of potash): 50% - cheaper.

How Much to Apply

It is always better to apply too little than too much. You can always add more, but you can't take it out of the soil and put it back in the bag!

Always read the instructions on fertiliser bags. If applying to young plants or less hardy plants (e.g. some indoor plants) you are better to put on less fertiliser.

Nutritional Requirements of Capsicums

Capsicum crops inevitably produce better crops when fertilized; but the ideal quantities and proportions of nutrients applied can vary greatly from one soil to another, and depend upon environmental conditions and cultural techniques. Sandy soils therefore will need to be treated differently to loam soils.

Note: when too much nitrogen is used it can result in leafy plants with reduced yield. Too much potassium has been shown to reduce wall thickness without increasing yield.

The best way to determine the ideal requirements is to have the soil analysed by a laboratory, and based on that analysis, receive recommendations from an expert in soil science and crop production. This is often not possible or viable though.

Fertiliser can be applied before planting, and again as repeated dressings after planting as the crop grows.

A typical pre-planting treatment on low fertility soils (as is often the case

with sandy soils) may be: 60kg of nitrogen, 70 kg of phosphorus, 60 kg of potassium - per hectare. Apply this fertilizer as a band in the rows before planting.

This equates with around 3.5 kg of 5-6-5 NPK fertilizer per 20 metres, as a band between two rows of capsicums; or 1.4 kg of 14-15-12 NPK fertilizer between the two 20 metre rows.

Note: NPK refers to the ratio of Nitrogen, Phosphorus and Potassium concentrations in a fertilizer.

If you have not had the soils tested, then a lower rate of fertiliser application is advisable as follows: 45Kg nitrogen, 50kgs Phosphorus and 50kgs potassium per hectare.

On fertile soils this should be lowered to a minimum of: 30kgs nitrogen, 30kgs phosphorus and 40kgs potassium per hectare.

Other important major elements required in relatively high amounts are calcium, magnesium and sulphur.

- Calcium is sourced from: dolomite, gypsum and lime.
- Magnesium is sourced from: dolomite.
- Sulphur is sourced from: NPK fertilisers, superphosphate, sulphate of potash and gypsum.

Trace elements are also important and if these are deficient in the soil after testing then they are best applied to the soil pre-planting and will last for several years; however if trace element deficiencies become noticeable after plants are growing then foliar sprays can help but are only beneficial to the plants that are sprayed and won't correct the soil deficiency.

Boron deficiency: most common on sandy, low fertility soils with a neutral to alkaline pH. Recently limed soils can therefore be low in boron – apply as a foliar spray in this case. Use 5kgs per hectare.

Zinc deficiency: for best results apply to the soil 3 weeks before planting as zinc sulphate monohydrate (35.5%Zn). You can also use Zinc sulphate heptahydrate but note that it is not compatible with some boron products.

Once a crop is growing, side dressings of fertilizer will benefit the plants every 4 to 6 weeks.

Blood and bone or urea (nitrogen) fertilizers are a good side dressing, particularly in early growth stages. Avoid burning plants with high nitrogen fertilizers.

Furrow irrigated crops can be side dressed with 300 gm per 20 m row of urea or 750gm per 20 m row of 15-4-11 NPK fertilizer

Trickle irrigated crops may have calcium or potassium nitrate delivered through irrigation water at a rate of 10 to 25 kg per week per hectare until fruit set. After fruit set a single application of urea at 50kg per hectare can be applied. After that, alternate applications of urea and calcium nitrate at 10-20kg per hectare weekly until cropping finishes.

Applying calcium nitrate early in the growing season helps reduce

the chance of blossom end rot and improves overall fruit quality.

Capsicums can be readily planted with, and treated the same as for tomatoes. Crop rotation is important.

Plant Tissue Analysis for Nutrients

If inadequate nutrients are present in the soil, plant growth is stunted. This affect is subtle and not usually noticed until it becomes severe. It can be that nutrient requirements drop to as low as 30% of optimum level before deficiency symptoms (such as discolouration) appears in the leaves. By this time, the overall growth rate and general health of the plant has been affected significantly.

Every plant variety has its own unique set of nutrient requirements. Some plants need more iron and less phosphorus than others, while others need more phosphorus and less potassium. There are tens of thousands of different “ideal” nutrient conditions, one for each different plant.

We can get a guide to the individual requirements of a particular plant variety by chemically analysing the nutrients found to make up the leaf tissue of a very healthy specimen of that particular variety. Analysis of sick plants can also be carried out and compared with the analysis of healthy plants to make comparisons...this can tell us what nutrients are missing in the sick plants.

REFERENCE: Plant Analysis: An Interpretation Manual by Reuter

In addition to chemical analysis (pH etc.), tissue analysis can also be undertaken. Before taking leaf samples for analysis, contact your analytical laboratory to find out what their requirements are e.g. which leaf to take as a sample, what type and timing of when fertiliser was applied, etc. The fertiliser company will usually interpret the results and recommend the appropriate fertiliser and application rate.

The following is the normal range of each of each nutrient found in plant tissue:

- N 2-5%
- P 0.2-0.5%
- K 0.5-5.0%
- Mg 0.3-0.6%
- S 0.2-0.5%
- Ca 0.5-2.0%
- Fe 50-150ppm
- Zn 15-100ppm
- Mn 50-100ppm
- Bo 25-100ppm
- Cu 5-15ppm
- Mo 0.1-1ppm

Plant Analysis Guide for Sampling Time, Plant Part and Nutrient Levels of Capsicums

Vegetable	Time of Sampling	Plant Part	Nutrient	Nutrient level Deficient	Nutrient Level Sufficient
Hot/Chilli Pepper	Early Growth	Petiole Young, mature leaf	NO_3-N (ppm)	5000	7000
			PO_4-P (ppm)	2000	3000
			K (%)	4	6
	Early Fruit Set	Petiole Young, mature leaf	NO_3-N (ppm)	1000	2000
			PO_4-P (ppm)	1500	2500
			K (%)	3	5
Sweet Pepper	Early Growth	Petiole Young, mature leaf	NO_3-N (ppm)	8000	12000
			PO_4-P (ppm)	2000	4000
			K (%)	4	6
	Early Fruit Set	Petiole Young, mature leaf	NO_3-N (ppm)	3000	5000
			PO_4-P (ppm)	1500	2500
			K (%)	3	5

(Table reference: Knotts Handbook for Vegetable Growers, by Lorenz and Maynard, 2nd edition 1980 Pub. Wiley Interscience)

Note – in reference to the previous table:

- Nitrogen is available to plants as either ammonium (NH_4^+) or nitrate (NO_3^-)
- Phosphate or PO4 is a compound of Phosphorus (P).
- K is Potassium.

Past research on fertiliser requirements for capsicums that is still relevant today:

Fertiliser recommendation rate for Capsicums grown on Low Fertility Soil in Massachusetts, based on Massachusetts Extension Publication in 1970:

- 24-40 lb per acre Nitrogen
- 50-80 lb per acre P_2O_5
- 50 to 80 lb per acre K_2O

Average Fertiliser rates for Capsicums grown in California (from University of California, Agricultural Science Division, 1978)

- 162 lb per acre Nitrogen
- 90 lb per acre P_2O_5
- 60 lb per acre K_2O

Fertiliser rates recommended for Capsicums grown in Florida on Irrigated Mineral Soils (from Florida Cooperative Extension Service, 1978)

- 200 lb per acre Nitrogen
- 145 lb per acre P_2O_5
- 200 lb per acre K_2O

Micronutrients Requirements

Sweet Peppers are semi tolerant to high levels of boron

Boron deficiency can still occur in Capsicums, but is much more likely on alkaline soils

Boron deficiency is corrected with a one or two foliar sprays of borax (330gm borax in 100 litres water)

- Capsicums are intolerant to low levels of magnesium
- Magnesium deficiency is more likely in high rainfall areas; in acid soils or over wet soils. When acid soils are treated with dolomite before planting not only is acidity reduced, but magnesium levels increase and drainage can be improved.
- Magnesium deficiency is indicated by yellowing between veins of older leaves (note: leaf veins remain green).
- Foliar sprays of magnesium sulphate (2kg/100 litres) can be used as a treatment for magnesium deficiency.
- Molybdenum deficiency is more likely in acidic coastal soils. Treat with a foliar spray (100g/100 litres of sodium molybdite) around 2 weeks after planting.

- Calcium deficiency can occur with capsicums, even when there is adequate calcium in the soil. It may be a problem of calcium not being absorbed into plant tissues.
- Calcium deficiency tends to be associated with increased disease issues; notably blossom end rot and green pitting or yolo spot.
- Treat calcium deficiency with a foliar spray of calcium nitrate (200 gm per 100 litres)

A pot of chillis can be both decorative and productive in a courtyard or on a veranda.

SOIL WATER

The soil texture and structure will greatly influence the entry of water into the soil and its subsequent rate of movement through the soil profile i.e. it moves more rapidly through a sandy soil but more slowly through a clay soil. An open structured soil has many more pore spaces through which the soil water can move.

Once the free water has drained out of the root zone, then the soil is said to be at **Field Capacity.**

Plant roots can extract water in the soil- but not all of it. They can extract the water held more loosely round each soil particle than the suction of transpiration. Most plants will wilt when soil water is exhausted to suction of 15 times atmospheric pressure, or minus 15 bars.

This is the **Temporary Wilting Point** i.e. if water is added to the soil, then the plants can extract more water and so revive. Should water (as rain or irrigation) not replenish the soil water, then the plants will go beyond the recovery point and enter the Permanent Wilting Point and die.

Watering Capsicums

Soil needs to remain moist in the top 30cm where the roots are growing; and to achieve this in warm conditions when capsicums are growing best, will often require regular watering. Watering is best applied by trickle or flood; or in a hydroponic system; where wetting the foliage and fruits is minimized.

Commercial capsicum crops that are grown in well drained soils may need water reserves of 2megalitres per hectare or more over the summer. (NB: this figure might relate to a crop irrigated with trickle, in a warm temperate climate with some but minimal rain over summer).

All types of irrigation are used on capsicums:

- Furrow irrigation is popular, but it requires a heavier soil with a shallow gradient in order to make optimum use of the water: allowing it to move slowly down the furrow and soak out under the plant roots to the side.
- Sprinkler irrigation is more appropriate on sloping land; but can increase disease problems. Good quality (clean) water is less likely to create disease problems
- Trickle irrigation can be extremely effective; but is more expensive to install and does require a higher level of technical expertise to manage well.
- Plastic mulches are sometimes used with trickle. This can reduce the quantity of water needed, as well as controlling weeds.

Ideal humidity for bell capsicums is considered to be 60 to 65%

Jalapeno Chillis growing in pots. Keep them in the greenhouse till they fruit, then bring them into the kitchen where they can be picked and used fresh, whenever needed.

CULTURAL TECHNIQUES

Capsicums are along with tomatoes, lettuce and cucumbers; one of the most suitable and widely grown vegetables for hydroponics. They are also grown using organic, biodynamic and traditional market gardening methods.

Capsicums being grown hydroponically in gravel culture.

Cover Crops

Cover crops used with capsicums might include oats or forage sorghum – it should be noted though that the incorporation of organic matter in this form will cause a temporary draw-down of nitrogen as the green manure decomposes. An addition of a nitrogen fertiliser such as blood and bone to help alleviate this problem is recommended.

Crop Rotation

To avoid build-up of pest and disease; it is best to avoid growing capsicums (or related crops including tomatoes and egg plants); on the same ground for two consecutive years It is preferable to leave a gap of 3 to 4 years between planting in warmer climates; and 2-3 years in colder climates.

Companion Plants

The concept of companion planting would suggest that some plants are beneficial when planted close to capsicums; while others are not going to help the growth or health of the capsicum.

In general it is not good to locate plants nearby that attract pests or diseases which might attract pests or diseases which cold attack the capsicums. Also avoid growing plants with extra vigorous root systems that might compete strongly with the capsicums. Large plants that provide a windbreak can benefit the capsicums; but excessive shading may create problems if it reduces light too much or prevents the environment around the plants reaching optimum temperatures for growth.

Other more specific suggestions, such as the following, are sometimes made for companion planting; however these ideas are often anecdotal, rather than being based on any sort of extensive scientific testing.

- Marigolds are said to improve growth and fruiting. Marigolds will also deter nematodes.
- Basil is said to improve flavour.
- Other herbs which might be beneficial are valerian, tarragon, thyme and peppermint.
- Capsicums also grow well with okra; okra serving as a wind break.
- Garlic is said to help reduce aphids and some fungal diseases.

Propagation

Seedlings planted out in spring after frost danger is past. Seed is often planted in late winter under cover, and seedlings grown on under protection from frost, and then planted out once frost danger is past. This helps ensure the plants get a good early start. Plant about 45 - 60cm apart in rows, with about 60 - 90cm between rows.

- The optimum temperature for germinating capsicum seed is around 29°C (85 degrees Fahrenheit). The best night to day temperature range is18-35°C (65 – 95 Fahrenheit).
- Germination of seed might not occur at all if temperatures remain below 15°C. At 15°C seed can take 25 days or more to germinate.
- At 20°C seed can take 13 days to germinate.
- At 25° to 30°Cseed takes 8 days to germinate.
- At 35°Cseed takes 9 days to germinate.
- Above 40°C germination is problematic.

There are around 4,500 seeds per ounce (i.e. 160 seeds per gram).

You require around 2 to 4 pound of seeds per acre (i.e. approx.1-2 kg per acre).

In hot climates, seeds might be sown directly into the open ground; but more commonly it is started in a cold frame, hot bed or greenhouse, 7 to 10 weeks before planting out seedlings into the ground.

Capsicums are sometimes grafted onto tomato rootstocks in order to avoid soil borne diseases that affect capsicums but not tomatoes.

PEST AND DISEASE PROBLEMS

Many problems can occur.

If you are lucky, you may grow a small number of capsicum plants over a full season, with little or no serious pest or disease problems occurring at all. When capsicums are grown year after year in the same location though; or in large numbers on a commercial farm; the likelihood of pest or disease problems, becomes much higher.

Pests

- Cutworms (*Agrotis spp.)*: very young plants are most susceptible, when these pests can bite off the seedling at ground level

- Heliothis caterpillars (*Helicoverpa spp.*): eggs laid on shoots, flowers and young fruits; hatch within days and grow into grubs up to 3cm long, eating fruit and other tissues. Young grubs can cause pinholes in fruits; larger grubs can be very destructive.

- Caterpillars can feed on fruits and cause serious crop reduction.

- Fruit Fly: There are many species of fruit fly in Australia but only two attack plants: the Qld fruit fly *Bactrocera tryoni* and the Mediterranean fruit fly Ceratitis capitata; they usually only attack ripening fruits on capsicums – adults are wasp like insects, red to brown, and yellow and to 8mm long. Eggs are laid just below the fruit skin. They hatch to white maggots that then eat the fruit flesh. These occur commonly after rain in spring or summer.

- Aphids: tend to feed on tender growth tips or the protected under sides of leaves. They use a syringe like mouth piece to suck food from the plant and secrete a sugary substance that in turn encourages the growth of a sooty mould over the plants and attracts ants. The aphids can spread other diseases, the ants can physically move the aphids around the plant; increasing their impact; and the sooty mould can inhibit photosynthesis, and cover the fruits, decreasing their value.

- Vegetable thrips: small yellow to brown insects that feed by rasping the surface of leaves, flowers or fruits. Scar tissue then forms over places where they feed. They can also spread viral diseases.

- Green Vegetable Bugs (*Nezara viridula*): green shield like insects to 1.5cm long. The younger insects move slowly through five nymph stages of varying colours (grey with white spots through to green as an adult). Only one life cycle occurs in the crop through. Adults and nymphs feed by sucking sap from the plant tissue, seeds and fruit this causes distorted growth and corky dry flesh.

- Vegetable Leaf Hopper (Jassids) (*Austroasca viridigrisea*): small hopping insects. Adults and nymphs suck the sap from young shoots and the leaves and fruit, they often leave white spotty markings; if infestation is large it will significantly compromise plant growth.

- Mites (*Tetranychus spp*): cause a stippled discolouration on the leaves, (a bronze like affect), between leaf veins. These are tiny spiders that feed by sucking juices from the plants.

Other pests known to affect capsicums include weevils, various beetles and wireworms.

Diseases

- Bacterial Spot *(Xanthomonas campestris, X. vesicatoria)*: leaves develop brownish spots to 5mm diameter. Fruits can develop dark brown to black scabs. Leaf infection is most common and can cause affected leaves to fall. Disease is often spread in seeds or by wet and windy weather. It is most common in warm and humid conditions. It can also affect the stem. This is a very destructive problem

- Bacterial Canker: pale green raised areas develop on the fruit surface, then develop into cork like lumps with a brownish centre. Particularly affects bell peppers.

- Bacterial Wilt: usually growth becomes stunted, then eventually sudden wilting of foliage, usually in hottest part of the day. If the stem is cut at ground level, the water conducting tissue has turned brown.

- Powdery Mildew (*Leveillula taurica*): patches of yellowing occurs on older leaves then pimple like patches can develop on the under sides of the leaves. This is more common where nitrogen is low in soils; and in dry tropical climates.

- Alternaria Fruit Rot: dark sunken spots up to 3cm across

- Anthracnose: circular, sunken spots on fruits. Sometimes on leaves and stems

- Grey Mould (*Botrytis cinerea*): greyish velvet like mould on stems & fruits –can also start as pale ring like spots on fruits

- Wilt: this is where the foliage of an apparently healthy plant wilts and sometimes dies. The fungus Pythium is often considered to be the main cause, attacking and causing deterioration and perhaps death of one or more large roots. It is more likely to occur in warm, wet conditions.

- Sclerotinia Rot: white fine cottony growth on stems that can cause tissues to collapse

A wide range of other diseases have occasionally been detected on capsicums including bacterial rots, damping off, downy mildew, leaf and fruit spots, leaf mould and a variety of rots other than sclerotinia rots.

Other Problems

- Viruses: viral damaged plants must be removed and destroyed - do not compost infected plant material. Mosaic virus presents as puckered leaves with discontinuous narrow dark green bands along the main veins. Fruits can sometimes become distorted in shape.

- Nematodes: are not as much of a problem as with tomatoes or potatoes; but nematode control might be needed where high risk of nematode infection exists.

- Green pitting: is a condition where the fruits develop dark green, slightly sunken patches as they are starting to turn red. The pots are commonly around 5mm diameter and tissue below them turns brown. The spots do not grow in size and

the fruits do not begin to rot. The condition appears to be caused by slow growing bacteria, and occurs when there is an imbalance of calcium in the plant tissues. It is also called Yolo Spot.

- Blossom end rot occurs as a patch of collapsed tissue at the bottom or on the side of the fruit; this is most often associated with irregular moisture levels and lower than optimum levels of calcium in the plant tissues. Plants that are irrigated irregularly and experience periods of very dry, then quite moist soils, may be most susceptible. The first fruits to set on a new plant are the most susceptible. Calcium nitrate (200gm per 100 litres) can be sprayed on plants when fruits have started to form but are very small

General Guidelines to Control Pest and Disease Problems

1. Monitor your crops: weekly inspections for symptoms of pests and diseases, means you can control problems through early intervention.

2. Ensure plants are growing in fertile, well drained soil, with constant, but not excessive, moisture in the soil. Do not work wet soils as this will damage soil structure.

3. Hygiene: destroy infected plants (burning works. If you compost them, don't use the compost on capsicums, tomatoes or other related plants). If an infestation is severe or widespread throughout the crop, then it will be best to remove and destroy the crop immediately. Don't work plants in wet conditions – bacterial leaf spot can be spread through water droplets and also through contact as you work from one plant to the next.

4. Use resistant varieties (check plant breeder and seed supplier information against any cultivars you are considering growing).

5. Buy seed from a reputable supplier; make sure that the seed has been tested for certain diseases e.g. bacterial spot, or treat seed with hot water (50°C for 30 minutes) to destroy this pathogen.

6. Provide the right amount of fertiliser during the growing season – plants with reduced access to the right amount of nitrogen tend to be prone to diseases.

7. Do not allow plants to self-sow; if they have, remove all seedlings that are self-sown to prevent spread and protect next year's plantings.

8. Control weeds: weeds can harbour pests and diseases and transfer then to the crop -especially those in the same plant family (Solanaceae) e.g. Deadly Nightshade.

9. Practice crop rotation: 3 years is a typical crop rotation; this means it is less likely that you will build-up a disease and pest problem. Make sure that you do not grow plants from the same family in that position (or together); capsicums potatoes, eggplant (aubergine) and tomatoes are all in the same plant family. Plant

tall plants such as corn between the rotation beds, so new beds are separated from the previous year's plantings by a tall crop.

10. Disinfect all equipment used after use – especially if you have used it to remove an infected crop. You don't want to spread it to other areas that may be clean.

11. Refer to advice from any pesticide suppliers for the latest recommendations. The natural and chemical controls that are both recommended and available are different in different places; and also keep changing the method you use. The only real way of getting the best and most up to date advice on products to use, is to consult people who supply products. Some problems may also be addressed using biological control.

HARVESTING

The first fruits are harvested 8 to 16 weeks (or sooner) after planting the young plants; depending upon where they are grown and the cultural techniques used. Greenhouse grown plants may produce even earlier. Home grown crops may be picked when plants only carry an occasional fruit; but commercial crops may be left until there are sufficient numbers of fruits present to make picking viable.

Successive flushes of fruit continue being produced at around monthly intervals as long as temperature and other growing conditions remain favourable.

Bell capsicums are either harvested when fruits are still green; or just beginning to turn red.

Red fruit often bring a higher price; but take longer to produce.

Pick fruits by snapping off the stem, being careful to not detach too close to the fruit. If too little, or no stem is left on a fruit, it will deteriorate faster after harvest. Fruit that is harvested in heavy rain periods can rot faster. Water can even be contained inside the fruit cavity, further increasing the rate of rotting.

After harvesting, fruits should be gently cooled to between 5° and 10°C to optimise quality and shelf life. The best way of cooling large quantities commercially is with forced air fans in a room at between 5° and 10°C.

If necessary, fruits may be stored in a cool room at 7-10 °C for up to 3 weeks.

Yield depend on density of planting and length of growing season for example: hybrid bell capsicums grown under plastic mulch and with trickle irrigation, in Queensland, Australia are reported to produce up to 8,000 X 18 litre cartons (half boxes) in a season. Under such a system, the fruits might be picked up to 25 times throughout a season.

Note: capsicums cannot be ripened artificially using ethylene treatment!

CHAPTER 3 SPECIES AND CULTIVARS

The taxonomy of the genus Capsicum can be confusing; largely because different well respected authorities have had differing opinions. According to some authorities, the *Capsicum* genus is made up of up to approximately 40 accepted species; however others suggest fewer, and some as few as two or three.

- Hortus Third (from Cornell University in the USA) suggest around 20 species.
- The Royal Horticultural Society Encyclopedia of Garden Plants (UK), suggests around 10 species
- Manual of Cultivated Plants by Bailey, suggests 1 Japanese species and either 1 or many American species.

Species that you may encounter are those more commonly grown for culinary purposes including:

Capsicum annuum: most commonly grown species that includes at least 20 varieties (e.g. *Capsicum annuum var. annuum;* several forms e.g. *C. annuum F. erectom* and numerous cultivars.

Capsicum baccatum: a well flavoured fruity species that is usually dried and ground into a powder.

Capsicum chinense: although the name suggests Chinese origin this is not correct – this species originates from the Americas. Cultivars in this species are all very hot including the well-known 'Scotch Bonnet.

Within these species there are many different types of capsicum cultivars. Three of the broad groups which they fall into are:

- Bell types
- Long sweet yellow types
- Hot red types

Long Sweet Yellow Pepper

Bell Peppers

Bell Peppers

These have fruits that are more rounded or bell like than long. They are called bell peppers because their shape looks a little like a bell and are also most commonly referred to as ‘capsicums’. These fruits commonly have a thick skin with three or four lobes. They can be green, red, orange, yellow or purple. Bell peppers are generally sweet tasting. Hybrid cultivars that are bred for disease resistance and other benefits are most commonly cultivated on commercial farms.

Long Sweet Yellow Peppers

These produce long tapered fruits to 20cm in length that start green and change to yellow then red as they mature. They bear heavy crops. They are harvested usually when fruits are yellow.

Hot Red Capsicums

These peppers are most commonly called “chillies”. The fruit shape can vary from long tapered (fatter at the top than the bottom), to very thin and long and even flat such as “Scotch Bonnets” *(Capsicum chinense).* Some cultivars have long twisted fruits. Many start out as dark green in colour and change to bright red as they mature. This group includes cayenne pepper.

Chilli Habanero

HERITAGE OR HEIRLOOM VARIETIES VERSUS HYBRIDS

We read a lot these days about ‘heritage’ or ‘heirloom’ varieties of many vegetable plants. Many people prefer the taste of the old varieties. Others like the idea of seed saving and seed banks and not relying on large seed companies for their seeds – heritage varieties gives them this opportunity.

Heirloom varieties are ‘open-pollinated’ - that is they are pollinated in nature through the activity of insects or through wind or water.

Commercial growers often choose hybrids for their consistency in both quality and outcomes; hybrids have been crossed for vigour which often improves yields.

Hybrids are cross-breed plants – these may occur naturally (as in the case with botanical varieties) or more usually bred under controlled conditions by people (as is the case with cultivars) – they are often hand pollinated, which can make them quite expensive.

Hybrids are usually marked as F1 hybrids or just hybrids on the seed packet. They are cross-bred under strictly controlled conditions, so that the resultant seedlings are genetically identical. As such hybrids are usually bred for purpose e.g. for certain climatic conditions, to obtain certain colours or forms, to withstand diseases – this is achieved through careful selection of the parent material and after years of trial and error. However even the progeny of heritage or heirloom varieties, which are open-pollinated in nature, will (over time) have adapted

to local conditions and may also have developed some disease resistance.

Hybrids are often sterile and may also not grow ‘true to type’ - this means that the resultant seedlings will not be alike and will also differ to the original parent plants i.e. if you save their seed and then grow seedlings from that seed - there is also no consistency in quality.

Heirloom varieties (or open-pollinated plants) produce viable seed and are fairly stable in their characteristics; the seedlings you grow from saved seed will be much like the parent plants – but not quite as consistently uniform as first generation hybrids.

Which you chose to grow is very much up to your own discretion and preferences; but always choose those varieties or cultivars that are suited to your local conditions e.g. some may prefer cooler conditions, others tolerate hotter conditions.

Chilli Jalapeno

SOME CAPSICUM CULTIVARS

There are more cultivars available than what can be covered in any book; and the availability of cultivars is both different from one country to another, and from one point in time to another. New ones are constantly being developed, and old ones continually disappearing from cultivation. Those listed below, include both common and less common cultivars.

- ‘Beja’: a high yielding F1 hybrid, mild, fleshy, juicy, sweet pepper from Eastern Europe; fruit are large and wedge-shaped changing from light green to red at maturity.

Capsicum annum Beja

- ‘Birds Eye Mixed’: tiny and very hot chillies in green or red sometimes referred to as ‘Thai Chillies’

Chilli Birds Eye mixed

- ‘Black Prince’: a chilli with very dark to almost black foliage with fruit that matures from black to red; a very hot chilli often used as an ornamental plant.

Capsicum Black Prince Chilli

Capsicum Caldero

- ‘Caldero’: a mildly hot cultivar from Mexico with small through to medium sized tapering fruit 5cm – 7.5cm long; used fresh, dried or pickled. These turn ivory, to yellow, to apricot - orange, and maturing red.

- ‘Dorset Naga’: a cultivar within the *C. chinense* species. Considered one of the hottest chillies in the world it also has a fruit scent and tapering fruit 5cm – 7.5cm long green changing to red at maturity.

Capsicum annum Dorset Naga

Capsicum annum Draky

- ‘Draky’: an early cultivar from Eastern Europe, mildly hot with cone shaped fleshy fruit great for stuffing and roasting.

- Habanero: this is the common name for a type of very hot chilli, covering many cultivars, in the *C. chinense* species; they are typically 2-6cm long start out green, and change colour as they mature; orange and red are common, with white, brown, and pink also available.

Chilli Habanero

- Jalapeno: like Habanero, Jalapeno is the common name for a type of chilli, covering many cultivars that of many cultivars included in the *C. annuum* species; 5-9cm pods that taper at the tips; usually sold as green but will mature to red. It varies from mild to hot.

Chilli Jalapeno Mixed

- 'Long Sweet Yellow': bright pale yellow fleshy, tapering, sweet, fruit; heavy cropper and disease resistant.

Capsicum Long Sweet Yellow

- ‘Mini Maria’: Ornamental cultivar with attractive small red, edible fruits (seen at Melbourne International Flower and Garden Show in 20012)

Capsicum Mini Maria

Capsicum annum Prarie Fire

- ‘Prairie Fire’: this plant produces lots of tiny, very hot chillies, often used as an ornamental pot plant.

- ‘Purple Haze’: a hot cultivar and attractive cayenne chilli; fruit is elongated to 75mm long starts out dark lilac turning purple-tinged red at maturity.

Capsicum Purple Haze

Capsicum annum Samba

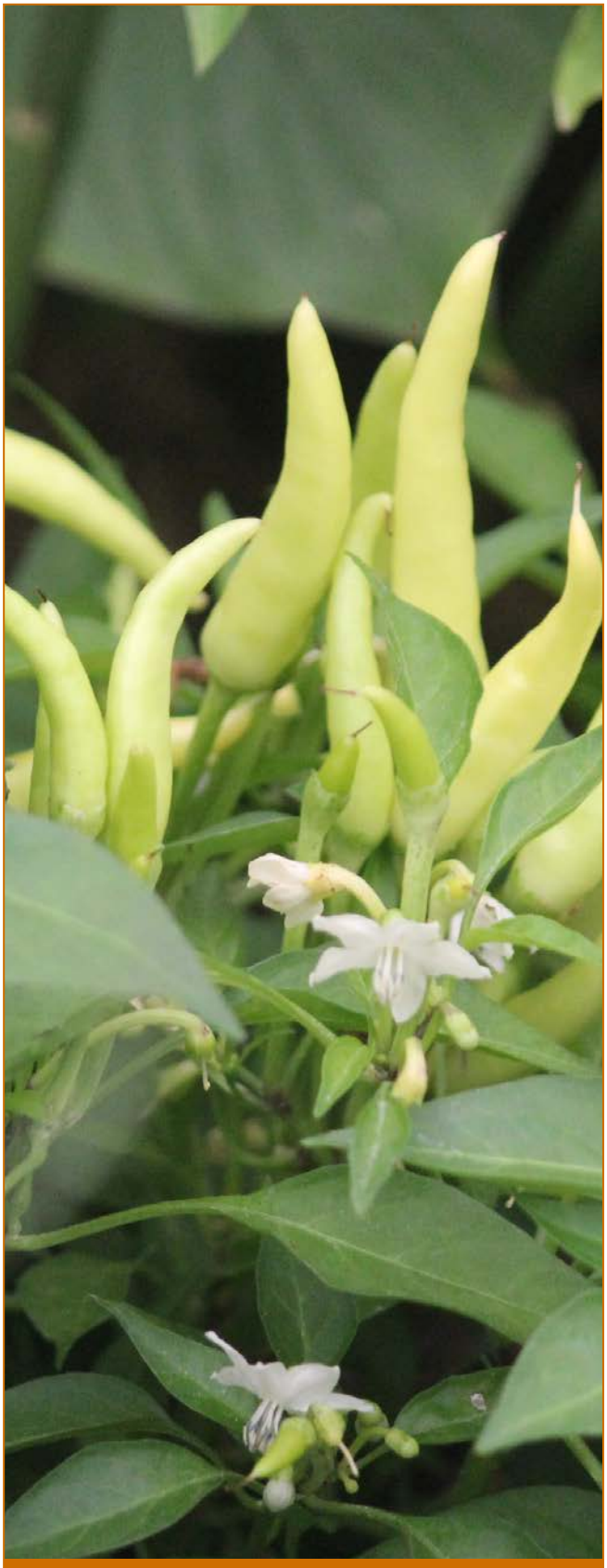
- ‘Samba’: a moderately hot chilli with tapering fruit green changing to red at maturity.

Chilli Seville

- ‘Saville’: Ornamental cultivar with attractive small yellow edible fruits (seen at Melbourne International Flower and Garden Show in 20012)

- ‘Spike’, ‘Gold Spike’: a hot chilli of medium size (10-15cm long); green changing to orange at maturity.

Capsicum Spike



Capsicum annum Superchill

- ‘Superchilli’: very hot chilli often used as an ornamental pot plant; fruit is small an tapering green maturing to red.

- ‘Tabasco Chilli’: a very hot cultivar within the *C. frutescens* species; used to make Tabasco sauce.

Capsicum Tabasco

Capsicum annum Tecquila

- ‘Tequila’: a hybrid from Holland; fruit is blocky 12cm wide by 4cm long; early fruit set starting out as lavender and eventually fading to orange and at maturity red.

Chilli Thai

- ‘Thai’: a hot chilli with tapering green fruit that matures to red.

- ‘Thai Green Curry’: a chilli pepper that as the name suggests is used in Thai green chilli recipes.

Capsicum annum Thai Green Curry

- ‘Twilight’, ‘Numex Twilight’; colourful ornamental chilli with lavender/ purple, cone shaped fruit that eventually changes to yellow, orange and finally red. A very colourful plant that is often used for ornamental purposes and pot culture.

Capsicum annum Twilight

Suggested Varieties to Grow

Not all of these cultivars may be available where you live; but amongst the following (in addition to those mentioned previously), you may find some that are worth trying in your garden; or on your farm. These cultivars are, or have been, amongst the more important ones grown both now and in the past

Sweet or Bell Peppers

- ‘Ace’: sweet red (bull’s horn type) capsicum with long red tapering fruit to 25cm long – high yielding.

- ‘Bell Boy’ hybrid: a mild, medium-long, large blocky deep glossy green that matures to red; plants are sturdy so ideal for commercial growing; fruit is great for preserves.

- ‘Bomby’: popular red cultivar in India with good fruit weight.
- ‘California Wonder’: an extremely popular cultivar 10 – 15cm, sweet, fleshy fruits start out green turning red.
- ‘Canape’; produces small (4-10cm) typical bell pepper fruits; reen changing to red at maturity
- ‘Chinese Giant’: heritage variety; very large, sweet bells maturing emerald green to ruby red.
- ‘Corno di Toro’ (Bull’s Horn’): an Italian heirloom variety; a sweet pepper with long tapering fruit (15cm – 20cm log) that matures to bright red or yellow; great producer - good for cooler areas too.
- ‘Diablo’: long, sweet, tapering fruit, high yielding. Matures to an intense red.
- ‘Diamond’: white bell pepper turning creamy pale yellow at maturity; great for salads and stuffing.
- ‘Emerald Giant’: a high yielding sweet pepper, 10cm long x 7.5cm wide; very sweet with thick fleshy fruit.
- ‘Golden Calwonder’: very sweet, fleshy, bell type capsicum; medium green maturing to golden yellow.
- ‘Indra’: popular green cultivar in India.
- ‘Kaibi Round’: fast producer, early season from Bulgaria with medium-sized juicy, thick crispy fleshed red bells; great flavour eaten green or red.
- ‘Keystone Giant’: a heavy producing heirloom variety; large, blocky, thick, crunchy, green fruit.
- ‘King of the North’ an outstanding short, cool summer variety with large dark green bells.
- ‘Lany’: extra-large fruit to 25cm long and about half that width; tasty flesh.
- ‘Marconi Red’; Italian heirloom heavy producing variety, sweet flavour with medium thick flesh, fruit are long and slim 6cm wide by 17cm long.
- ‘Lipstick’: a 10cm, fleshy, pointy variety that does well in cool climates. Green turning red.
- ‘Merrimack Wonder’: a bell type C frutescens cultivar to 10cm long and wide green maturing to red. A short season cultivar.
- ‘Neapolitan’: a large, tapering, mild, sweet, fleshy cultivar that is very productive; bright red.
- ‘New Ace’: dark green, sweet pepper 10cm x 10cm suited to stuffing; ripens early.
- ‘Orange Bell’: a great orange pepper with very sweet flesh that is fast producing and suits cool climates.
- ‘Nova’: a lime green, bell shaped with a pointy end; turn red at maturity. Bred for early picking.
- ‘Orobelle’: popular yellow cultivar in India.

- ‘Pimiento’: mild spicy, grown on a large scale mostly for canning.
- ‘Purple Beauty’: a short plant producing lots of blocky bells green bells that become purple and maturing to red. Heritage variety.
- ‘Quadrato D’asti Giallo’: Italian heirloom variety, blocky, sweet pepper with thick crisp flesh that ripens to yellow.
- ‘Ruby King’: large, sweet, fleshy bell pepper 15cm by 15cm; ripens to ruby red.
- ‘Slim Pim’: a Japanese sweet red pepper growing to 10cm.
- ‘Slovakia’; from Eastern Europe; thick pale green. Narrow point fruits turn red at maturity.
- ‘Spartacus’: a large blocky bell pepper that matures to a deep red.
- ‘Sweet Banana’: highly productive plant producing sweet yellow banana shaped fruit that ripen to red but remain sweet.
- ‘Sweet Chocolate’: chocolate coloured bells that are deep burgundy inside at maturity, small blocky, sweet pepper. Heirloom variety.
- ‘Sweet Cubanelle’: Long tapering, slightly wrinkled, sweet pepper; easy to grow and a lovely variety that is yellow/green ripening to a very deep red; very productive and great for home gardeners.
- ‘Sweet Paprika’: long, narrow tapering fruit to 12cm long’ dried flesh makes a lovely sweet paprika.
- ‘Topepo Rosa’; a pimiento variety that is peppery yet sweet; produces long tapering fruit up to 25 cm long. An Italian heirloom variety.
- ‘World Beater’: small, glossy sweet pepper to 7.5cm x 7.5cm; matures to bright red.
- ‘Yolo Wonder’: related to ‘California Wonder’; glossy green very sweet pepper; emerald green maturing to scarlet red.

Chilli Peppers

There are many types of chilli peppers and each type includes many cultivars – here is a list of some more popular types:

- Anaheim chilli peppers: these are a mild type of long chilli pepper that is generally used for stuffing or canning in its light green form (before it turns red). It grows from 15 – 20cm long. ‘New Mex’ and ‘Sonora’ are well-known cultivars.
- Bird Pepper/Bird Beak chilli peppers, also known as Pequin: small chillies to 2cms long; a very hot type that is generally dried and ground and used as a spice.
- Cayenne peppers: fruits are generally dried and ground to a powder; cayenne peppers are fleshy and come in both long, thin (to15cm) and long thick types. Cultivars include ‘Cayenne Pencil’

- Fresno peppers: conical shaped chilli peppers starting green turning orange to red at maturity 5cm by 2.5cm not as fleshy a jalapeno but similar in appearance.

- Gaujillo chilli peppers: deep red flesh that is mildly hot and a fruity flavour (some people find it reminiscent of green tea and berries); used in Mexican cooking.

- Habanero chilli peppers: very hot chilli type that starts out green and colour as they mature orange through to red but other colours are available 'Trinidad Perfume' is an extremely hot Habanero cultivar; 'Aji Limo' is a milder version and 'Apricot' milder still and 'Bellaforma' only slightly hot.

- Jalapeno chilli peppers: usually 5- 9 cm long picked and used when green; heat varies from mild through to hot. A purple variety is also available.'Telico' is a common cultivar.

- Mirasol chilli peppers: conical, wrinkly chilli peppers 7.5 to 12.5cm long that can be used fresh or dry; medium hot - inconsistent fruits i.e. appearance can vary.

- New Mexico chilli peppers: very widely known and used – starting out a mid-green and turning red at maturity. Often dried when mature but also used green or smoke dried. Cultivars include 'Big Jim'.

- Pasilla chilli peppers: long thin peppers 17.5 – 30cm long and 2.5cm wide; usually used green but they turn dark brown at maturity.' Pasilla Bajio' is a well known cultivar.

- Pablano/Ancho chilli peppers: fruit size is 10cm by 5cm often used green but also used at maturity when red and then dried to produce what is called Ancho; 'Ventura Pablano' is a common cultivar.

- Peperoncini/Friggitello or Tuscan chilli peppers: used in both Italy and Greece – a mildly hot type of chilli pepper. 'Robostino' is a well-known cultivar.

- Rocatillo chilli peppers: these look like very small bell peppers but have a similar heat to Habanero.

- Scotch Bonnet: very similar to habanero only somewhat shorter (more squat). Very well- known type. There are very hot but also sweet varieties. 'Burkina Yellow', 'Chocolate', 'Orange Scotch Bonnet', Scotch Bonnet Pink' and Scotch Bonnet Red' are some cultivars.

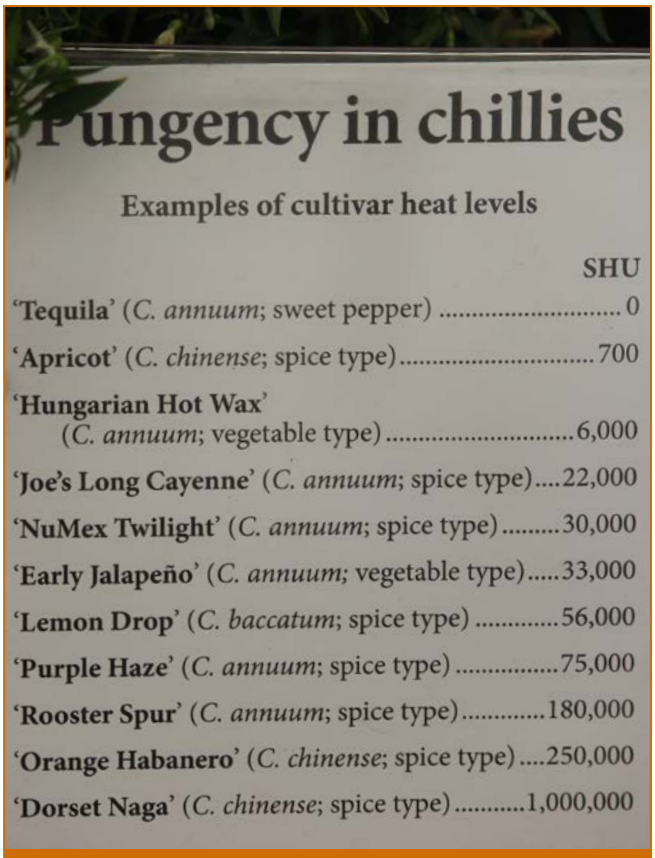
- Serrano: a spicy, hot, small version of the Jalapeno - from 2.5 to 5cm long and 1.25cm wide.

- Thai Bird's Eye chilli peppers: tiny small tapering chillies that often grow in bunches of 2 or three on the plant. Very hot and used in oriental cooking.They come in a variety of colours although green and red are most common.

Note: you may see references to chipotal chilli peppers – chipotal is not actually a variety of chilli but refers to the dry chillies; a process is commonly used to smoke dry red jalapeno peppers the result is chipotal peppers..

Other Chilli Pepper Cultivars:

- ‘Heat Wave’: a select mix of long, thin and hot chillies in orange, red and yellows.
- ‘Joe’s Long’: a fiery hot, long, very narrow, thin walled, cayenne pepper type.
- ‘Large Red Cherry’: round red fleshy fruit 3 -5cm with a flattened base and a bright red shiny red at maturity.
- ‘Long Red Cherry’: a very well-known chilli cultivar to 15cm long; great performer and dries well too.
- ‘Long Red Slim Cayenne’: a very long cayenne cultivar.
- ‘Mexican’
- ‘Naga Jolokia’: officially the world’s hottest chilli pepper! Produces pale lime green chillies that turn a fiery orange red at maturity.
- ‘Padron’: a well-known Spanish favourite for tapas, mild when green but hot once they mature to red.
- ‘Red Savina’: a habanero type, squat, chilli that is also very hot.
- ‘Santa Fe Grande’: a mildly hot chilli, fruit is 10-12cm they start out pale yellow becoming fiery orange and red; fruits harvest at different rates making the plant very ornamental as it has this range of colours over the plant (at any one time) as they mature.



Pungency in chillies

Examples of cultivar heat levels

	SHU
‘Tequila’ (*C. annuum*; sweet pepper)	0
‘Apricot’ (*C. chinense*; spice type)	700
‘Hungarian Hot Wax’ (*C. annuum*; vegetable type)	6,000
‘Joe’s Long Cayenne’ (*C. annuum*; spice type)	22,000
‘NuMex Twilight’ (*C. annuum*; spice type)	30,000
‘Early Jalapeño’ (*C. annuum*; vegetable type)	33,000
‘Lemon Drop’ (*C. baccatum*; spice type)	56,000
‘Purple Haze’ (*C. annuum*; spice type)	75,000
‘Rooster Spur’ (*C. annuum*; spice type)	180,000
‘Orange Habanero’ (*C. chinense*; spice type)	250,000
‘Dorset Naga’ (*C. chinense*; spice type)	1,000,000

Compare the varying hotness of different cultivars

Hungarian Varieties

- ‘Alma Paprika’: heritage open pollinated, cherry type, thick fleshy, peppery peppers - shaped as small squat bells; makes a great Hungarian paprika.
- ‘Amy’: sweet Hungarian wax pepper; early variety with yellow/white, cone shaped, pointed and tasty fruit.
- ‘Hungarian Yellow Wax’: long tapering fruits to 15cm, start out yellow/green maturing to red.
- ‘Hungarian Hot Wax’: a medium heat, tapering, long, pepper that starts yellow turns orange and then red at maturity.

CHAPTER 4 USING CAPSICUMS

Peppers can be cooked or eaten raw and are commonly used in salads or to add flavour to meat dishes or Asian and Mediterranean cooking. They can be frozen or eaten fresh. The peppery versions can also be used as a dust or mashed, soaked in water and then strained to produce a spray which is said to control insects. 2-3 plants will feed the average family. Fruit are ready for harvest about 12 - 14 weeks after planting. The sweet peppers can be picked at any stage of development. The hot peppers can be picked at near to full size, even if they are immature, or they can be left to dry on the bush.

The hot, pungent flavour in peppers comes from the alkaloid compound “capsaicin”. This chemical is most intense in the capsicum seed and tissues surrounding the seed. If you want to have a milder food, you can do so by removing this part of the fruit. As a general rule, bell peppers contain half as much capsaicin (per unit weight) as the mildest cultivars of chillies.

Capsicum annum Bell Peppers

NUTRITIONAL VALUE

Capsicums fruits are a source of carotenoids, vitamins A, C and E, mineral salts and the antibiotic capsidicin. Sweet peppers are generally higher in vitamins than hot peppers or chillies.

- 1 ounce of sweet pepper (approx. 28,000 mg) contains 40 mg of vitamin C.
- 1.5 ounces (42 gm) of sweet pepper can supply the recommended daily intake of vitamin C for an average person.

Note: vitamin levels drop dramatically when peppers are cooked or canned; or if they get too ripe.

According to Commercial Vegetable Growing by Tindall, pub. Oxford University Press, 1979: the composition of a capsicum fruit, excluding seeds, was analysed as follows:

- Water 90ml
- Protein 2gm
- Carbohydrate 6 gm
- Fibre 1 gm
- Calcium 20 mg
- Iron 1 mg
- Vitamin A potency very variable (100-1200 I.U.)
- Thiamine 0.06 mg
- Riboflavin 0.08 m
- Nicotinamide 1 mg
- Ascorbic acid 150 mg (variable)

Growing Capsicums as Commercial Crops

When considering capsicums as a commercial crop consider:

- Where are you going to sell the produce? Make sure there is a market, both in terms of quality and quantity you produce
- How are you going to sell it? (through a farm shop, to retailers, to distributors, to factories, farmers markets?)
- Is transport, packaging, storage facilities, processing facilities required?

Commercial crops can be produced either under glass, or outside. They might be grown on a large or small scale, in hydroponic systems or in the ground; organically, bio-dynamically, or using agricultural chemicals. Depending upon where you are, and the scale of production; you might or might not use mechanisation in capsicum production.

Growing Capsicums for Ornamental Purposes

There are many ways to use capsicums and chilli plants for ornamentation here are some suggestions:

- The colourful fruits of peppers make them very decorative. They can be used fresh in floral arrangements or added to a fruit bowl to add colour.

- Bunches or strings of dried peppers may be hung in the kitchen for both decoration; and to be taken and used when needed.

- Plants can be used indoors as a pot plant; in the kitchen or even in a sitting or dining room as an attractive table centrepiece.

- They may be used as a pot or tub plant, or even in a hanging basket outside. The colourful fruits can be long lasting and add splashes of colour to a courtyard or conservatory over the warmer months of the year.

- Some cultivars have been developed specifically to be grown as annual bedding plants; or for splashes of colour in a garden bed. The fruits can add colour for extended periods from spring, through summer and into autumn. Some cultivars have colourful foliage as well (varying shades of green through to darker purplish leaves.

Capsicums as Preserves

Capsicums and chillies are used in a variety of ways - they are dried as long or short chillies and threaded onto string for later use. They are also smoked dried to give a lovely smoky flavour to both chillies and also as smoked paprika. They are pickled; both chillies and bell peppers are pickled ad they used to stuff olives and other preserved foods. Here are some other uses:

- Sweet chilli sauce

- Chutney/jam , etc

- Bottling/canning although this retains flavour it reduces vitamin content.

- Dried whole chillies

- Chilli powder dried powdered chilli mixed with other dried and powdered ingredients (often one or more of the following: garlic, marjoram, caraway and so on).

Freezing Capsicums

Peppers can be frozen - to do this, wash the peppers, remove seeds, cut into halves then either slice or dice them. If the frozen produce is to be reused raw; it is best to blanch for 3mins in steam before freezing. If produce is to be used in cooking, they can be frozen as slices in air tight bags, without blanching. For best results, clean, cut, pack, seal, label and freeze bags of capsicums as soon as possible after picking. Fresh produce freezes best although once frozen they are best eaten cooked rather than raw as they do go watery when frozen fresh (un-cooked).

Drying Capsicums

Peppers can be dried using any of the following techniques:

- Air Drying –only works in dry climates. If humidity is high, you must use other techniques.

- Sun Drying –slice chillis into strips, remove seeds; place upside down on a metal tray and put in a hot sunny spot on a clear sunny day for at least 8 hours. Turn over once the

top is dried. Cover with a tea towel at night, then remove tea towel and continue drying the next day.

- Oven Drying – Place sliced chillis in an oven for six to eight hours on a metal tray. Turn once half way through the process. A fan forced oven can be set at 40 degrees Celsius; or a standard oven at 70 to 80 degrees Celsius.

- Hanging in a well ventilated room – In dry climates, chillis can be tied onto strands of thread or string and hung up in a well ventilated room for at least 3 weeks. If humidity is not low enough though, the chillis will rot or become mouldy, and must be discarded.

- Once completely dried, store in a sealed jar.

- You will know when chillis are dry if two chillis that were touching while drying, are able to be broken apart extremely easily because there is insufficient moisture left where they are touching to cause them to stick together.

Cooking

Much used in regional dishes: Mediterranean, Mexican, Spanish or Asian e.g. stir fry, chilli powder or chopped sweet capsicum.

- Chilli Con Carne

- Casseroles/stews

- Soups

- Stuffed capsicums.

- Fresh salads: healthiest way to eat them as it retains maximum nutrition.

Creamy Pumpkin soup garnished with capsicum and shallots

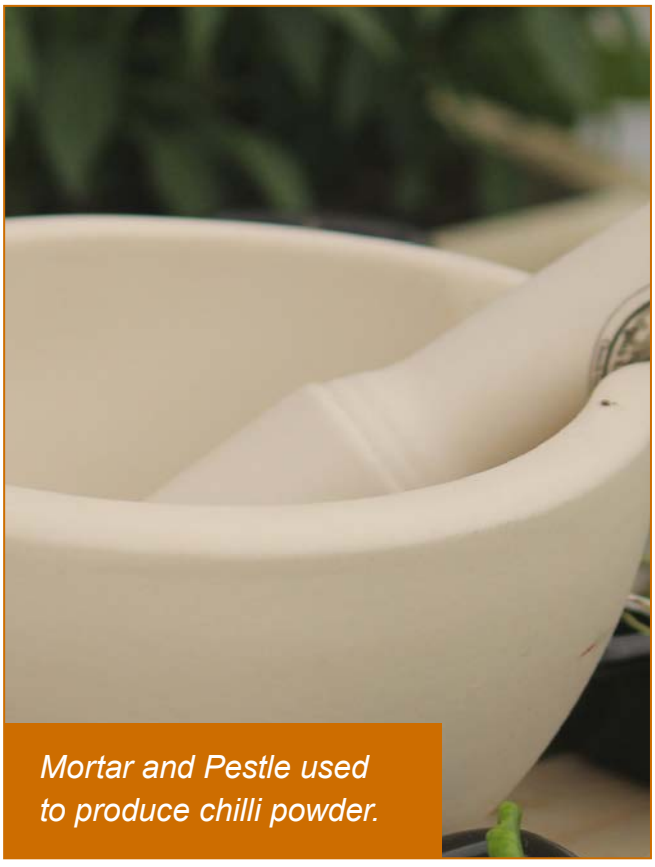
Add capsicum to meat and onion on a skewer then bbq

Adding chilli to sausages is common - Chorizo sausage is made very hot with the addition of ground chilli.

Handling Peppers

If you plan to eat peppers fresh (eg Sweet peppers in a salad), they are best harvested and used as soon as possible. If the skin is crisp and shiny it will be crisp to bite, and have the best taste. Once the skin begins to wrinkle, it is becoming dehydrated. The flavour will linger and even intensify as a fruit dries out, but the crispness disappears. This process of deterioration can be slowed by storing cold.

- A bell pepper should keep for at least a week in the refrigerator. Once cut it may deteriorate a little faster.
- Green bell peppers can sometimes be turned red by wrapping it in tissue paper and storing in a cool place for a couple of days.
- The skin on a capsicum is usually more bitter than the flesh below. Skin is sometimes removed in order to enhance the culinary experience
- Ground, dried chilli powders such as cayenne or paprika, will taste better when fresh. If they are going to be stored, keep them in an air tight container and store in a pure form. Once you mix chilli powder with other things such as herbs, the potential for flavour to deteriorate may increase.
- Whenever you handle peppers, particularly the hot ones; be very careful to never touch your eyes, nose or mouth until your hands have been thoroughly washed. It is a good idea to wear rubber gloves if handling a lot of chilli.
- For less hot chilli dishes, remove and discard all seeds from the chillis before cooking. If you want an extra hot chilli sauce, you can use the seeds, but be sure they are pulverised completely and mixed thoroughly with the rest of the chilli. This may be done with a mortar and pestil.



Mortar and Pestle used to produce chilli powder.

Medicines

Both credible and suspect medical practitioners, herbalists and others have been recommending capsicum to treat various complaints, for hundreds of years. Some of these may be valid treatments, and others might not. Many though still often used in some parts of the world, have not been explored scientifically and properly.

Disorders that capsicums have been suggested for include: digestive complaints, catarrh, rheumatism, weak circulation, poor eyesight, skin complaints, chilblains and even alcoholism. Our research has found all of the following claims; but adopting and using any of these facts for treating a serious health issue, should be approached with caution and further advice from a knowledgeable practitioner.

- Chilli fruits have a variety of medicinal uses: stimulant, digestive, bacteriostatic properties; unlike some other types of stimulants, capsicum has no narcotic affects.
- As a stimulant, chilli may increase heart rate; pumping the blood faster, and increasing sweating. This helps may help cool the body faster; which may be partially why chilli is more widely used in tropical climates than very cold climates.
- Used externally as rubefacients.
- If used in excess, capsicums can damage the mucous tissues in the mouth and tissues in the digestive and renal systems.
- Oil derived from capsicum when dissolved in ether, is said to be effective as a rub to relieve rheumatism.
- Chilli peppers are sometimes taken in moderate quantity to stimulate slow digestion. Recipes containing chilli are sometimes found in homeopathy and herbal medicine, as a treatment for slow digestion.
- West Indians use cayenne powder mixed with boiling water to make a gargle for treating throat complaints.
- There are suggestions that eating chilli peppers can lower blood cholesterol, though substantiated proof cannot be found.

Pesticides

Chilli powder will repel animals with a heightened sense of smell such as rodents, dogs and possums. While it may be readily washed away; it can sometimes be useful when dusted in places where you want to discourage these animals. It can be particularly useful in breaking a habit, where an animal keeps returning to the same place

Capsicums have been used as insectifuges

Other

Sweet peppers contain large amounts of stearic and palmitic acids which produce essential oils that can be used in manufacturing soaps and candles.

RECIPES

Traditional Italian Classics

Roast Capsicums with Parsley, Garlic and Olive Oil

4 large sweet, red capsicums

A handful of chopped flat parsley

I grated or minced clove garlic

A pinch or two of flaked sea salt

80ml extra virgin olive oil

Cut the peppers in half and remove the seeds; put them inside down on a board and flatten with your hands. Rub with some olive oil (just enough to make them glisten). Roast the peppers or under a grill on a piece of foil (skin side up) until the skins blacken – remove from heat and quickly wrap the foil around the peppers (this softens the black skin and makes it easy to remove). Cook the garlic very gently in a teaspoon or so of the olive oil (don't let it brown or it will go bitter). A minute or so is enough – take off the heat and combine with the rest of the oil. Remove the blackened skins from the peppers, cut them into strips and toss with the oil, parsley and sea salt. These peppers will keep for several days in the fridge in a sealed container. Use them as an accompaniment to a main meal, in salads or antipasto.

Peperonata

2 large red capsicums

2 large yellow capsicums

2 large green capsicums

1 medium onion

2 cloves of garlic grated or chopped

3 medium, fleshy, ripe tomatoes, skinned and cut into chunks

Fresh basil leaves – 5 or 6 large leaves should do

Chopped anchovies (optional) half a small can

A tablespoon of salted capers (rinsed and drained)

A handful of chopped, fresh, flat parsley

3 tablespoons of olive oil

- Cut the capsicums in half and remove the seeds and white fleshy fibrous parts and cut into lengthwise strips.
- Heat the oil in a heavy pan and sauté until it is a pale golden colour.
- Add the garlic and cook gently for about one minute and then add the capsicums.
- Cook for about 15 minutes on medium heat to soften the peppers.
- Add the tomato chunks and a cup of water. Add the anchovies if you are using them.

- Simmer for about 40 minutes (you may need to add some extra water (don't let it get too dry).
- Remove from heat and stir in the basil, pour into a dish and top with the parsley and capers.
- Serve this as a side dish to a main meal, as part of an antipasto dish or mixed in pasta.

Pepperoncini Oil

Fresh red chillies - about 20 medium sized chillies to 200ml of olive oil

- Using gloves: cut the chillies into 2mm rounds – remove most of the seeds by placing them in a colander and tapping it on the side of an object (e.g. the sink).
- Sprinkle with salt and place a heavy plate on top of the chillies i.e. one that fits in the colander. Place in a cool place such as your fridge for 24 hours. You will need to suspend the colander in a bowl so that any excess moisture can escape.
- Again using glove squeeze the excess moisture from the chillies and pack them into clean, sterilised jars. Top with olive oil.
- Store in a cool spot; the chilli oil can be used in about 2 weeks – cover with more oil if it is too strong and make sure that the chillies are always covered with oil.

Spaghetti with Chilli and Bacon

500 grams of dried spaghetti

2 red chillies seeded and chopped

6 rashers of chopped, hickory smoked bacon (or other smoked bacon)

A good handful of shredded fresh basil leaves

Black pepper to taste

125grams of soft goat's cheese

1 tablespoon of olive oil

Parmesan cheese to serve

Boil spaghetti for 12 minutes (or follow directions of the packet)

Heat a frypan and fry the bacon, in the olive oil along with the chopped chillies for about 4 minutes – the bacon should be crisp (but don't blacken the chillies).

Drain the pasta and return to the hot pan over low heat. Add the bacon and chilli mix along with the goat's cheese and torn basil leaves.

Serve with the parmesan cheese.

Serves 4.

Thai Style

Green Chilli Curry with Chicken

3 green, chopped chillies with seeds removed.

1 cup fresh coriander (cilantro)

I tablespoon of fresh chopped ginger or galangal

I red onion or 3 shallots

1 tablespoon of fresh lemon grass finely chopped

2 teaspoons of powdered cumin

4 fresh kaffir lime leaves - torn

I tablespoon of fish sauce

Half teaspoon of crushed white peppercorns

2 tablespoons peanut oil

270ml can of coconut milk

1 cup of chicken stock

500grams of chicken thigh meat cut into small cubes

Place the ingredients (excluding the kaffir lime leaves, chicken, stock and coconut milk) in a food processor and process to a fine paste.

Heat a heavy pan, add the paste, cook stirring for about 5 minutes until fragrant.

Add the chicken and coat with the paste – stir for about 2-3 minutes. Add the coconut milk, the kaffir lime leaves and chicken stock and cook for 25 minutes, the chicken should be tender and the sauce thickened. Remove the lime leaves. Serve with jasmine or basmati rice. Sprinkle some fresh coriander leaves on top.

Spanish Style

Ratatouille

2-3 tablespoons extra virgin olive oil

2 diced eggplants (2.5cm cubes)

3 cloves garlic

2 medium onions chopped

4 medium zucchini (2.5 cm cubes) or slice smaller ones about 2cm thick

A handful of fresh thyme

A handful of fresh basil

2 red capsicums chopped (2.5cm)

1 kg ripe red tomatoes skinned, seeded and chopped – plus 2 cups of extra tomato juice. Or use 2 - 3 x 420g cans including juice.

Sea salt and black pepper to taste

Traditionally the vegetables are slowly stewed separately rather than fried brown - so keep your temperatures low.

- Heat the oil in a heavy based pan over low heat and gently sauté the onions, capsicum, garlic and thyme gently on low heat (you are not trying to brown the onions). This should take about 10 minutes or so. Remove to a bowl

- Reheat the fry pan – add another splash of oil now sauté the eggplant and 1 clove of garlic season with a pinch or two of salt and a twist or two of black pepper - gently until tender – this may take 10-15 minutes. Remove from heat and put into a bowl.

- Return the pan to the heat and do the same with the zucchini and 1 clove of garlic – gently sauté until tender (10 minutes) – add the vegetables set aside in the bowl plus the tomatoes and cook very slowly covered for about 1½ hours. Add the basil in the last 10 minutes or so. Check and adjust seasoning if needed.

- Delicious served with pasta or as an accompaniment to meat dishes or fish. Drizzle a little fresh extra virgin olive oil and some fresh black pepper, garnish with a fresh basil leaf and serve it. You can also freeze into meal sized portions.

Stuffed Peppers

175 g long-grain white rice

350ml chicken stock

6 medium sized sweet bell peppers

60 grams of pine nuts

1 large chopped onion

½ cup tomato passata (see recipe below)

60 grams currants

3 tablespoons chopped, fresh parsley

3 tablespoons fresh mint leaves

½ teaspoon cinnamon (ground)

2 tablespoons olive oil

- Preheat the oven to 180°C

- Place the rice and stock in a saucepan or small fry-pan with tight fitting lid

- Bring to boil, reduce heat to low and allow the rice to absorb the water (about 10 minutes). Set aside.

- Cut the tops off the peppers and set aside; remove the seeds and white fibrous material inside.

- Place in a pot of boiling water and blanch for 2 minutes; drain and upturn the peppers to drain off any liquid.

- Place pine nuts in a dry fry pan and fry (dry) until toasted and golden – remove and set aside

- Heat the olive oil in the fry pan over low heat and cook the onion until soft

- Add the tomato passata, parsley, currants, cinnamon, pine nuts and cooked rice – season with salt and pepper to taste.

- Divide the mix evenly between the peppers and stand in a baking dish (make sure they fit together snuggly so they don't topple over). Replace the reserved capsicum 'lids'.

- Pour in 100ml of hot water into the bottom of the dish and drizzle the peppers with olive oil

- Bake for 40 minutes or until tender.

You can also add minced meat to this recipe or top with cheese or add some chillies to the mix for a spicier version.

Quick and Easy Tomato Passata

2kg tomatoes

1/2 cup quality extra virgin olive oil

2 tablespoons low salt tomato paste

12 - 20 basil leaves (preferably home grown organic)

I teaspoon sugar (brown for richer flavour)

- Peel or leave skins on and finely dice tomatoes (I cm size).
- Simmer all in a saucepan on gentle heat, stirring occasionally (30-40 mins).
- As soon as it has thickened, pour into sterilised clean jars.
- Keeps 1- 2 weeks sealed in fridge or freeze and thaw when needed.

Chilli powder can be made by grinding dried chillis with a mortar and pestle

Mexican Style

Slow Cooked Chilli Con Carne

Serves 4

Ingredients

750g gravy beef cubed

2 onions chopped

2 cloves of garlic minced

400g can diced tomatoes

2 tablespoons olive oil

2 tablespoons tomato paste

2 teaspoons Mexican chilli powder blend (Chilli, paprika, cumin, oregano, pepper & garlic)

2 teaspoons sugar

400g dried kidney beans soaked in water overnight (or 400g can kidney beans drained)

- Heat oil in a pan and cook onion and minced garlic until tender and golden.
- Place onion and garlic in a slow cooker.
- Brown meat in the pan and then add to slow cooker.
- Add remaining ingredients to slow cooker, stir and cook on auto or low for 4-6 hours.

Serve with corn bread and a fresh salad

Huevos Rancheros (Ranch Style Eggs)

150gram fleshy type tomatoes (e.g. Roma) chopped

¼ small red onion chopped

I small clove garlic crushed

½ small green or red chilli

Tablespoon of lemon juice

Small can chopped tomatoes

1 small bell pepper chopped

½ teaspoon cumin seed

2 teaspoons chopped oregano

1 tablespoon vegetable oil

Salt and pepper to taste

4 eggs

4 corn tortillas

½ cup of grated cheese

- Heat a medium sized saucepan over a medium to high heat add a tablespoon of vegetable oil then add the onions and bell peppers and sauté until soft and the onions are lightly browned.
- Add the whole cumin seeds and the oregano and cook for a further minute
- Add fresh tomatoes, can of tomatoes plus the green or red chilli

- Bring to boil, stir frequently.
- Simmer over low to medium heat for about 30 minutes or until it has reduced by about one half. (You may need to add a bit of water to make sure it doesn't get dry).
- While this is cooking you can prepare the eggs and tortillas
- Heat a few tablespoons of oil in a fry pan to cook the tortillas. Fry them all at once if you have a large fry pan or two at a time if it is too small for 4. Fry for about 2 minutes until crisp and golden, drain on a paper towel to absorb the excess oil and then place on warmed plates (two for each person). Lightly season with salt.
- Place the tomato, onion, garlic and chilli in a blender jug and puree until smooth.
- Gently cook the eggs (usually sunny-side up) in a fry pan – whites should be set but yolks runny.
- Place the eggs on the tortillas, top with about ½ cup of sauce per egg, top with grated cheese.
- You can serve this with a side salad if you like
- Serves 2.

Chilli Chicken Burritos

2 tortillas

1 chicken breast fillet (about 200 grams)
6 chopped red chillies

½ cup sugar

¼ cup water

1 tablespoon lime juice

½ teaspoon cumin seeds

1 juicy red chopped tomato.

Salad greens to serve

- Cook the chicken breast gently by simmering in some stock for no more than 10 minutes then switch off the heat and leave the chicken in the stock until you are ready to use it.
- Place the chillies, lime juice, cumin seeds, sugar and water in a small saucepan and cook over medium heat; stirring until the sugar dissolves then simmer gently for a further 3 minutes or so, add the tomatoes and simmer until it thickens.
- Shred the chicken.
- Place the tortillas on plates: I per person
- Top with the salad greens
- Place the chicken on top of the greens and soon the sauce over the top. Fold over each tortilla and serve.
- Serves 2.

Chilli can be added to avocado to make guacamole, and used with meat and beans for chilli con carne – for the perfect nachos.

Chilli Con Carne

Indian Style

Capsicum Curry

1 medium sized red onion

2 small roughly chopped tomatoes

1.25 cm grated ginger

2 cloves garlic minced or grated

3 green chilies chopped with seeds removed

1 teaspoon coriander seeds

1 tablespoon peanuts

1 tablespoon cashew nuts

2 tablespoons oil
(approx. 6 teaspoons) oil

1 large green bell pepper (capsicum) cut into cubes

1 bay leaf

3 cloves

1 teaspoon cumin seeds

1 or two hot red chillies

½ teaspoon garam masala

Salt – to taste

375ml water

- Place a heavy based pan on medium heat. Dry roast the peanuts and cashew nuts till they get light brown and then grind to fine powder. Remove and set aside.
- Put 2 teaspoons oil into the pan and gently fry the onions gently until soft, add the garlic, ginger and coriander seeds and cook gently until fragrant – add the roughly chopped tomatoes and cook gently until it becomes thick sauce.
- Cook the capsicum in 2 teaspoons of oil until they are almost done (still slightly firm). Remove them and place in a bowl.
- In the same pan fry place the remaining 2 teaspoons of oil and fry the cloves, cumin and bay leaf until the cumin seeds start to sizzle. Add the chillies and fry gently then add the tomato mixture, add salt to taste and cook until the tomato mix is very thick and you can see the oil starting to float to the top. Add 250ml of water and boil then stir in the nut powder and the capsicums – cook for a further 5 minutes.
- Mix in the garam masala off the heat.

Powdered chillis can be stored in sealed containers or packets, like any other dried spices or herbs; but the flavour does deteriorate over time. If you can use it fresh; that will always be better.

Fresh Sweet capsicum in strips or chunks can be a great addition to any salad.

Modern Style

Capsicum Salad

2 red capsicums – cut in half seeds and fleshy white parts removed

2 cloves garlic 4 chopped anchovies

4 ripe, fleshy, red tomatoes

I handful of flat-leafed parley (remove stalks)

I small butter lettuce or crispy young iceberg (your preference)

2 boiled free range eggs, chopped.

I tablespoon salted, rinsed and drained, capers

75ml of extra virgin olive oil

Crusty bread to serve

- Preheat oven to 200°C.
- Place capsicums skin side down in a baking tray, scatter anchovies and garlic inside the shells and drizzle with olive oil, season with sea salt and freshly ground, black pepper, Bake for 1 hour.

Place the crispy salad leaves on a plate and sprinkle with the parsley leaves and chopped eggs and capers. Drizzle the juices from the baking dish over the capsicums and serve with crusty bread. Serves 4.

DRINKS

Chilli Sherry

30 gm of dried chillis

1 litre of sherry

Put chilli in the bottom of a bottle. Pour sherry over the top. Seal the bottle. Store for at least

6 months, and no longer than 25 years before opening and drinking.

Chilli Coffee or Chilli Chocolate

A wide variety of recipes can be found on the internet for hot chocolate and hot coffee drinks

that have chilli powder or essence added to them.

It is easy to use too much chilli though. Most recipes would suggest a dash or pinch in a cup.

Some suggest adding other things such as cinnamon, nutmeg, or even a liqueur to the mix

along with the chilli and coffee or chocolate.

Try adding a small dash of chilli powder to hot coffee or hot chocolate

APPENDIX

DISTANCE LEARNING AND ONLINE COURSES

The authors of this book have developed a large variety of distance learning courses, online, on CD or by correspondence, which are available through various colleges that are part of the ACS Global Partners Network.

There are over 600 different courses offered by ACS Affiliates, through colleges across seven different countries. Short courses are generally 100 hours in duration. A range of qualifications such as certificates and diplomas are also available.

These courses cover a wide range of disciplines, including Business, Management, Marketing, I.T., Biological Sciences, Health, Fitness, Nutrition, Psychology, Counseling, Writing, Photography, Hospitality, Tourism, Education, Construction, Horticulture, Agriculture, Environmental Management and more.
See **www.acs.edu.au/about-us/affiliates.aspx**

Courses that may particularly helpful to readers of this book include:

- Home Vegetable Growing
- Commercial Vegetable Production
- Commercial Organic Vegetable Production
- Self Sufficiency
- Permaculture
- Food Preparation
- Food and Beverage Management
- Human Nutrition
- Horticulture
- Agriculture
- Certificates and Diplomas (across many disciplines)

E BOOKS BY JOHN MASON AND ACS STAFF INCLUDE:

Starting a Business
Project Management
Business Operations
Psychology Dictionary
Counselling Handbook
How Children Think
Farm Management 2nd edition
Profitable Farming 2nd edition
Working in Horticulture
Commercial Hydroponics 3rd edition
Trees and Shrubs for Warm Places
Organic Gardening
Climbing Plants
Growing Conifers 2nd edition
Roses
Herbs
Trees and Shrubs
What to Plant Where
Fruit, Vegetables and Herbs
Growing Tropical Plants 2nd edition
The Environment of Play 2nd edition
Garden Design Part I
Garden Design Part II
Tropical Landscaping
Starting a Garden or Landscape Business 2nd edition
Starting a Nursery or Herb Farm 2nd edition
Aerobic Fitness 2nd edition
Aquafitness 2nd edition
Nutritional Therapy
Human Nutrition
Animal Health
Horse Care
Dogs –Caring for Dogs
Marine Animals
Professional Writing
English Grammar
Getting Work in a Modern World
What to Plant Where
How to be a Life Coach
Fruit, Vegetables and Herbs
Psychological Profiling
Getting Work in Horticulture
Scented Plants
Modern Marketing
Poultry
Growing Ferns
Human Biology Dictionary
Leadership
Palms
Creative Writing
Weeds
Medical Terminology
Food Preserving

PRINTED BOOKS BY JOHN MASON

John Mason has been writing books since the 1970's and has over 40 titles published, some as printed books, others as ebooks. Some (print) titles are out of print, and now only available as second hand books or e books. If you have difficulty finding any of Mr Mason's titles, you can enquire by email to **admin@acs.edu.au**

Print Books by John Mason include:

Fun and Fitness Trails, Victorian Dept. of Sport and Recreation, 1978
Starting a Nursery or Herb Farm, Night Owl, 1983 (revised 1994)
The Environment of Play, Leisure Press, New York, 1982
Herb Review, self published, 1987
Landscaping with Herbs, self published, 1988
The Native Plant Expert, self published, 1989
Let's Grow Gardens, self published, 1990
Growing Ferns, Kangaroo Press, 1990
Commercial Hydroponics, Kangaroo Press, 1990, 2007
Growing Vegetables, Kangaroo Press, 1991
Growing Herbs, Kangaroo Press, 1993
Nursery Management, Kangaroo Press, April 1994
Tropical Gardening, Bay Books, October 1994
Yates Guide to Pests & Diseases, Angus & Robertson, February 1995
Growing Pelargoniums & Geraniums Hyland House 1996
Farm Management Kangaroo Press 1996
Growing Australian Natives Kangaroo Press 1997
Starting a Nursery or Herb Farm (Revised ed) Kangaroo Press 1997
Sustainable Farming Simon & Schuster (Kangaroo Press) Spring 1997
Growing Tropical Plants Simon & Schuster (Kangaroo Press) 1997
Starting a Landscape or Garden Business Kangaroo Press 1998
Aqua Fitness Kangaroo Press 1999
Growing Conifers Kangaroo Press 1999
Profitable Farming Kangaroo Press 1999
A Beginners Guide to Orchids Hyland House
Aerobic Fitness Kangaroo Press
Trees & Shrubs for Small Places Kangaroo/Simon & Schuster 2000
Propagating from Cuttings Kangaroo/Simon & Schuster 2002
Growing and Using Vegetables and Herbs Kangaroo/Simon & Schuster 2007

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