CHAPTER 1 INTRODUCTION

Hydroponics is the technique of growing plants without soil. The roots grow either in air, which is kept very humid; in water, which is well aerated; or in some solid, non-soil medium, which is kept moist. The water around the roots contains a carefully balanced mixture of nutrients which provides food for the plant.

There are three main ways of growing plants hydroponically:

AGGREGATE CULTURE

Small particles of chemically inert substances provide a suitable environment for the plant roots to grow through.

ROCKWOOL CULTURE

A fibrous sponge-like material made from molten rock provides an environment for the roots to grow through.

WATER CULTURE

Water, perhaps mixed with air (with no solid material), provides the environment in which the roots grow.

The aggregate, rockwool or water which is used to provide the root environment, supplies the physical needs of the roots.

The roots (and in fact the whole plant) also have chemical needs which must be catered to. The chemical needs are supplied by adding a carefully calculated solution of nutrients to the root zone, and maintaining the balance of chemicals in that solution at appropriate levels.

Hydroponics has also been called ‘soilless culture’, ‘nutriculture’ and ‘chemiculture’.

rockwool culture

HISTORY

The word hydroponics comes from two Greek words: *hydro* meaning water and *ponos* meaning labour. This word was first used by Dr W.F. Gericke, a Californian professor who in 1929 began to develop what had previously been a laboratory technique into a commercial means of growing plants. Throughout the 19th Century a number of scientists undertook significant research into the nature of plant nutrition. Classical experiments conducted by German

plant scientists, Sachs in 1860 and Knop between 1861 and 1865, led to our first understanding of what were essential plant nutrients. Chemical formulae developed by Sachs and Knop, and several other researchers who followed them, provided Dr Gericke with the knowledge to make an effective nutrient solution, thus overcoming the major restriction to the development of hydroponic culture.

Plants had been grown hydroponically before Dr Gericke, but only as laboratory experiments or (in the case of some earlier civilisations) without a proper understanding of the methods being used. Dr Gericke is credited with having recognised the commercial potential of what he had seen as a laboratory technique, and having conducted trials which inspired the development of a commercial industry in the following decades.

Scientists in North America, Europe and Japan, inspired by Dr Gericke's experiences, worked throughout the 1930s and 40s to refine our knowledge of hydroponic growing. The United States army used hydroponic culture to grow fresh food for troops stationed on infertile Pacific Islands during World War II. By the 1950s there were viable commercial hydroponic farms operating in America, Britain, Europe, Africa and Asia.

Interest in hydroponics developed in Australia throughout the 1960s, and in the 1970s many vegetable growers, inspired by tales of increased production, attempted to convert their operations to hydroponics. Unfortunately many of these people failed to do their 'homework', and embarked upon schemes without having a real understanding of the differences between soil and hydroponic culture.

The result was many failures, and the development of an attitude in Australia that hydroponics doesn't really work.

In 1981 CSR Ltd established an Australian plant to produce horticultural grade rockwool for hydroponic production. CSR did their homework, promoted their product well and supported it with excellent technical information. As a result, Growool (as it is known) became widely accepted, and today is used extensively in the Australian cut flower industry.

At the beginning of the 21st century commercial crops of vegetables, berry fruit, and cut flowers are grown extensively by hydroponic culture in many countries. The most popular technique worldwide is rockwool culture, though NFT (Nutrient Film Technique), perlite and gravel bed culture are all very significant techniques in use in commercial hydroponics.

HOW PLANTS GROW

To understand and practice hydroponics successfully requires the grower to have an understanding of how plants grow.

Almost all plants grown in hydroponics are flowering plants. These plants have four main parts:

Roots – the parts which grow below the soil

Stems – the framework

Leaves – required for respiration, transpiration and photosynthesis

Reproductive parts – flowers and fruits.

ROOTS

Soil provides the plant with the following:

- Nutrients
- Water
- Air
- Support

Roots absorb nutrients, water and gasses, transmitting these 'chemicals' to feed other parts of the plant. Roots hold the plant in position and stop it from falling over or blowing away.

When we grow a plant in hydroponics, we must make sure that nutrients, water and air are still supplied and that the plant is supported, as would occur if it was growing in soil.

Nutrient supply in soil is a more complex matter than in hydroponics. Plant nutrients can be supplied, broadly speaking, in three different forms:

Water soluble simple chemical compounds

Nutrients in these compounds are readily available to plants (i.e. the plant can absorb them quickly and easily).

Less soluble simple chemical compounds

The nutrients in these compounds can be used by plants without needing to undergo any chemical change, but because they don't dissolve so easily in water they aren't as readily usable as the more soluble compounds. The diminished solubility may be because of the nature of the compound (e.g. superphosphate) or may be due to something else (e.g. slow-release fertilisers such as Osmocote, which is made by incorporating the simple chemicals inside a semi-permeable bubble – thus nutrients move slowly out of the bubble).

This second group of nutrients, when placed in soil, will last longer than the first group of water soluble nutrients.

Complex chemical compounds

These require chemical changes to occur before the nutrients can be absorbed by plants. They include organic manures and fertilisers which need to be broken down by the soil microorganisms into a form which they can use. They also include other complex fertilisers which need to be affected by natural acids in the soil, or heat from the sun, to become simple compounds which the plant roots can use.

Complex chemicals release their nutrients gradually over a long period of time, depending on the range of chemical changes needed to take place before the plant can use them.

Plants grown in a soil derive their nutrients from all three types of compounds. The availability of these compounds varies not only according to the group they come from but also with factors such as heat, water, soil acids and microorganisms present. Consequently it is impossible to control the availability of nutrients in soil.

This is one intrinsic advantage of hydroponics over soil growing. In hydroponics you can choose to use only simple, soluble compounds, and so you can determine the exact amount of each essential nutrient available to a plant at

any point in time.

STEMS

The main stem and its branches are the framework that support the leaves, flowers and fruits. The leaves, and also green stems, manufacture food by the process known as photosynthesis, and this is transported to the flowers, fruits and roots. The vascular system within the stem consists of canals, or vessels, which transfer nutrients and water upwards and downwards through the plant. This is equivalent to the blood system in animals.

LEAVES

The primary function of leaves is photosynthesis, a process in which light energy is caught from the sun and stored via a chemical reaction in the form of carbohydrates such as sugars. The energy can then be retrieved and used at a later date if required in a process known as respiration. Leaves are also the principle plant part involved in the process known as transpiration whereby water evaporating, mainly through leaf pores (or stomata), sometimes through the leaf surface (or cuticle) as well, passes out of the leaf into a drier external environment. This evaporating water helps regulate the temperature of the plant. This process may also operate in the reverse direction whereby water vapour from a humid external environment will pass into the drier leaf.

The process of water evaporating from the leaves is very important in that it creates a water gradient or potential between the upper and lower parts of the plant. As the water evaporates from the plant cells in the leaves then more water is drawn from neighbouring cells to replace the lost water. Water is then drawn into those neighbouring cells from their neighbours and from conducting vessels in the stems. This process continues, eventually drawing water into the roots from the ground until the water gradient has been sufficiently reduced. As the water moves throughout the plant it carries nutrients, hormones, enzymes, etc. In effect this passage of water through the plant has a similar effect to a water pump, in this case causing water to be drawn from the ground, through the plant, and eventually out into the atmosphere.

REPRODUCTIVE PARTS

Almost all plants grown in hydroponics are flowering plants. These reproduce by pollen (i.e. male parts) fertilising an egg (i.e. female part found in the ovary of a flower). The ovary then grows to produce a fruit and the fertilised egg(s) will grow to produce seed.

There can sometimes be difficulty in obtaining a good crop because insufficient pollen reaches the female parts, resulting in insufficient fruit forming. (This is discussed in chapter 11.)

blueberries