Cut Flower Production

Lesson 4

This is just a cover sheet, turn to the next page to continue.

Flower Initiation and Development

Lesson Aim

Explain the physiological processes which affect flower development in plants.

AGING IN FLOWERS

When a flower is harvested, it begins to deteriorate. The rate of deterioration can vary greatly, according to the type of flower, its condition upon harvest, the way it is treated, and the environmental conditions under which it is stored.

The relative importance of these different factors will vary from one variety of plant to another:

Type of Flower
Orchids, for example, may last for 6 weeks or more as a cut flower, proteas can also last a number of weeks, but many herbaceous plants such as chrysanthemums, dahlias or stock may not last a week.

Condition at Harvest
If the flower, stem or foliage is damaged the flower can deteriorate faster.

Treatment
Certain treatments may prolong the life of the flower (e.g. adding sugar or certain chemicals to water which flowers stand in), protecting from exposure to wind, heat or other adverse environmental conditions.

Environment
Physiological processes continue to function after a flower is cut (e.g. the plant continues respiration).

These processes can be slowed (e.g. by lowering temperature or changing composition of gases in the air). By slowing physiological processes, the rate of deterioration can often be slowed. However, the natural processes of senescence will still occur eventually. Some flowers die faster than others due to their chemical and internal physiological makeup.

Genetics
The longevity of flowers is genetically influenced and varies greatly amongst different cultivars of the same species. These differences in longevity correlate with stem diameter and rigidity. Thicker stems are less likely to bend or break and contain more respiratory substrates for the flowers hence prolonging their vase life.

Anatomy and Physiology
This also exerts an effect. For example, a cultivar that produces more ethylene will age faster than one that doesn't. A plant's anatomy and physiology are influenced in turn by a number of environmental and technical factors as illustrated in the table below.

Light
Light intensity directly influences the efficiency of photosynthesis and hence the carbohydrate content of plants. Flowers with high carbohydrate (especially mobile sugars) content will last longer when cut.

Cooler temperatures, low light intensity and shorter periods of light reduce the life of cut flowers.

Temperature
Excessively high temperature during cultivation will reduce cut flower life. High temperatures increase rate of use of carbohydrates and rapid water loss from the plant.

Humidity

High humidity is required for optimal flower production in some species, e.g. roses, since it reduces transpiration (and hence stress) and the occurrence of pests such as red spider mite. However, high levels of humidity can increase the growth of bacterial diseases such as grey mould and downy mildew. Ventilation is necessary to reduce these effects and also to reduce ethylene in the atmosphere.

Stage of Flower Development

Generally speaking, flowers cut at a more advanced stage of development will not last as long as younger ones.

Factors Affecting the Longevity of Cut Flowers

During Cultivation	**During Post-Harvest Handling**
Light	Time of Harvest
Temperature	Mode of Harvesting
Fertilisation	Temperature
Watering	Humidity
Humidity	Light
Control of Pests and Diseases	Ethylene Production and Flower Sensitivity
Air Pollution and Sanitation	
Stage of Flower Development at Harvest	

Effects of Carbon Dioxide

Air normally contains approx. 300ppm of carbon dioxide. This is ample to support normal plant growth

In greenhouses, the proportion of carbon dioxide in air can be increased in some situations in order to increase the rate of plant growth, hence shortening the growing period from planting to flowering.

Given that photosynthesis occurs in the presence of light, the increase in carbon dioxide is only necessary during the day time. Carbon dioxide is, in some instances, supplied from gas cylinders to enrich the greenhouse environment.

Yield of Roses over 4 years with different CO_2 levels and differing solar energy levels over an 18 week production period (adapted from Goldsberry and Holley, 1962)

Year	**Total <u>Yield</u>**	**Stem length (inches)**	**CO2 added per cu.ft.**	**Total solar energy gm cal cm2**
1959	7017	15.3	none	50,884
1960	7891	15.7	561	49,833
1961	7611	17.5	1899	50,302
1962	8896	17.9	7678	54,302

The effect of carbon dioxide enrichment on the yield of greenhouse grown carnations: (adapted from Holley and Juengling, 1963).

	Ambient atmosphere	CO_2 enriched atmosphere
Total yield	4538	4932
Quality index	4.53	4.60

STANDARD NIGHT TEMPERATURES AT WHICH GREENHOUSE FLOWER CROPS ARE GROWN

Crop Species	Night Temperature °C	Remarks
Aster callistephus	10-13	Needs long days during early stages of growth
Calendula *(C. officinalis)*	4-8	
Calla Lily (*Zantedeschia sp.)*	13-16	Decrease to 13oC when flowering starts
Carnation (*D. caryophyllus*)	10-13 (winter); 13 (spring); 14-16 (summer)	Night temperatures adjusted seasonally in relation to radiant energy flux
Chrysanthemum (*C. morifolium*)	16 (cut flowers); 17-18 (containers)	Temperatures during flower initiation

GETTING PLANTS TO FLOWER OUT OF SEASON

Flowering occurs when there is a sudden change in the growing point, from vegetative organs (i.e. leaves, stems, leaf buds) to floral organs. When this happens, the apical dominance usually weakens.

The initial stimulus to cause this change in tissue type appears to normally (but not always) originate in the leaves.

Some target cells or tissues are stimulated by a fairly non-specific trigger, setting off a chain reaction (cascade) throughout the involved tissue. (Much work has been done trying to discover the chemistry of these changes, but the results tend to only show that there is a very great complexity involved).

As flowering tends to be related to particular times of the year, the initial stimulus is most obviously environmental. There are three possible types of environmental stimuli:

- Physical e.g. changes in pressure
- Electrical e.g. changes in pH
- Chemical (changes in levels of certain chemicals), e.g. more light increases photosynthesis, which increases levels of sugar

It appears there are two types of chemicals involved - both promoters and inhibitors.

- the inhibitors inhibit this inductive process
- the promoters stimulate the process of flower induction
- the promoters and inhibitors do not work together in a balancing interaction
- they affect each other through an interference process (e.g. with Kalanchoe, short days produce promoters, but if more than one third of the days are long, sufficient inhibitors are produced to stop the effect of the promoters).

Juvenility

Juvenility is a completely different thing to the affect of inhibitors.

A plant cannot respond to the affect of flowering promoters until tissue has gone through a phase change to reach maturity. It is possible for this phase change to be reversed and mature tissue become juvenile again.

Types of Flowering Response to Temperature

Temperature can affect time of flowering from sowing, three different ways:

- Vernalization where cold temperature hastens flowering.
- Rate of flowering process increases over a sequence of different temperatures. The final stage is an optimum temperature where flowering is most rapid.
- Supra Optimal Temperatures stressful temperatures which delay flowering as temperatures become warmer.

Ways to Cause Controlled Flowering

- If the plant suffers juvenility problem then you should propagate vegetatively (eg. boronia will only flower if the plant is a mature established one. A Boronia raised from seed will not flower for some time, but if a plant is grown from a cutting off an established plant it will flower sooner.)
- Photoperiod
- Temperature
- Type of light (e.g. red light on short day or long day plants)
- Gas – e.g. Carbon Dioxide enrichment on short day plants.
- Lack of carbon dioxide availability to leaves stops flowering production.

Principles Affecting Rates and Progress of Flowering

A. Rates and progress toward flowering, virtually always, bears a linear relationship to either photoperiod or temperature or both (e.g. as temperature increases, flowering increases or progresses towards development - the more temperature, the more flowering.

OR - as temperature decreases, flowering increases

OR – as light increases, flowering decreases etc).

B. The basic temperature response (not affected by photoperiod) is applicable to almost all annual crops.

C. A photoperiodtemperature response is common to all photoperiod sensitive plants. Photoperiod sensitivity varies among species and cultivars - greatest sensitivity being with tropical (short day) plants (here differences between day length are very small). Response is to mean temperature usually.

D. Environment insensitive plants generally have no response to either mean temperature or photoperiod.

E. Where temperatures are excessively above optimum levels there is a negative, lineal relationship, between mean temperature and flowering. Most generalizations refer to non stress temperatures.

F. Variable daily contributions by photoperiod and temperature conditions can be treated as additive increments towards flowering.

Applied Flowering Control

- There have been a few cases where treatment with auxin (hormone) or ethylene generating substances has induced flowering (eg. Bromeliaceae)
- There is more likelihood in the near future if finding chemical inhibitors to flowering rather than chemical stimulants (Inhibitors would be useful to stop pasture grasses from flowering etc).

NARCISSUS

Flower formation begins in the bulb during late spring and is completed by late summer or early autumn. The stage of flower development is important, as the bulbs give their best response to cool treatments once the trumpet has formed.

In their natural habitat Southern Europe and the Mediterranean, their growth cycle is as follows:

- *Hot dry summer* early summer old leaves and flowers die, new leaves and flowers are initiated; mid to late summer, leaf and flower formation completed
- *Warm autumn* new root growth begins, and shoots starts but does not emerge
- *Cool wet winter* leaves emerge through soil, flower elongates within leaves
- *Warm spring* rapid growth of leaves and flowering

Forcing Schedule

- Harvest bulbs in summer
- Store at 17 degrees centigrade until flower bud development complete. This is normally for 24 weeks. Temperatures should not go over 20 degrees - that will delay flowering.
- Cooling treatment before and after boxing. If you want late flowering hold at 17 degrees; low temperature treatment is not given if you want late flowering; 9 degrees C treatment for 6 weeks if you want early flowering.
- Plant bulbs in boxes of peat or straw. The earlier the plants are boxed the earlier they flower.
- Place boxes in forcing house. This is done when flower bud is at the neck of the bulb (later for later flowering, earlier for earlier flowering).
- Grow on in house, until flowering. A temperature of 15 degrees centigrade is used when forcing.

Forcing with Lights

Place boxes under clear or pearl tungsten lights (60 or 100W) 1.0 to 1.5 metres above the crop on a 1.1 metre grid spacing. Give seven hours lighting every 24 hrs.

High Temperature

For early flowering bulbs - treat with 35 degrees centigrade immediately after lifting in late spring, for 5 days. This treatment will not work once the warm weather of summer commences.

AZALEAS

Cool temperatures provide some vernalization so plants force flower buds more rapidly and evenly.

Plants with well-developed flower buds (in USA) are stored at 10 degrees centigrade or less. Keep at 2 degrees (no lower) for extended storage, or 910 for short storage.

There has been some evidence that short photoperiods promote flowering, however the photoperiod aspect has been controversial - low temperatures are known to be critical.

Growing plants are pinched to bush up. Then place at 18 degrees centigrade for 6 weeks on long photoperiods, followed by 18 degrees with short photoperiods; then placing in cold storage storing at 7 degrees centigrade for 6 weeks. Then remove and grow at 1618 degrees for 36 weeks.

HYDROPONICS: AN INTRODUCTION

Worldwide, the interest in commercial hydroponics has steadily increased over the past few decades. Hydroponic growing is certainly significant in market gardening, but more so in some countries than others.

There would certainly be more than 5,000 hectares of commercial hydroponic production worldwide. This compares with around 100 hectares in 1960.

Total production area in some countries, particularly many eastern bloc countries, is not known.

Unsuccessful attempts at hydroponics in the U.S.A., Australia and some other countries during the early years contributed towards a bad reputation for this type of production. This impeded development of commercial installations in those countries. Other countries, such as the U.K. and the Netherlands, which were more successful with their early attempts found it easier to develop a viable hydroponic industry.

The Netherlands accounts for more than 50% of the known area under production. The U.K. accounts for more than 10%. No other country accounts for much more than 5%.

Australia's hydroponic industry is estimated at just under 100 hectares, but growing steadily.

On an international basis, rockwool is the most commonly used system by far, with NFT or aggregate culture being particularly significant in some countries.

Hydroponics is the technique of growing plants without soil.

The roots grow:

- in air which is kept very humid
- in water, which is well aerated
- or in some solid, nonsoil 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 in.
- *Rockwool culture* - A fibrous spongelike 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 "soil-less culture", "nutriculture" and "chemiculture".

Hydroponic Systems

There are two main groups of systems:

WATER CULTURE	AGGREGATE CULTURE
Nutrients are dissolved in water which is brought in contact with the roots.	Nutrients are dissolved in water which is moved into the root area.
Water is either aerated or roots are allowed to contact air as well as nutrient solution.	The roots are grown in solid material (inertfree of nutrient) which is chosen to hold sufficient moisture but drain off excess allowing adequate aeration.
Trellis, wire mesh or other support is provided above the nutrient solution.	The solid material which the roots grow in contributes towards (if not fully supplying) anchorage.
EXAMPLES: Nutrient tank, Standard Jar, Nutrient film (NFT), Mist systems	EXAMPLES: Beds; tier systems etc.

The variables of a system:
The types of hydroponic systems that can be used vary for a variety of reasons. The most common variables are:

- Solution dispensation
  - Closed or open (i.e. is the solution recycled or drained through and lost?)
  - Drip, slop, capillary feed, wicks, misting, dry fertilizing etc.
- Automatic or manual operation
- Type of medium - Gravel, vermiculite, perlite, sand, scoria, peat, expanded clay, a mixture etc.
- Construction materials - Concrete, fibreglass, plastic, glass, wood, masonry, metal, PVC, ceramic, polystyrene etc. What will your container be?
- Rate and frequency of irrigation and feeding
- Air Injection? (In water culture)
- Plant support - Trellis, wire, nets etc.
- Environmental controls - Temperature, ventilation etc.

Why Practice Hydroponics?

Hydroponics has been practiced by market gardeners and other growers since the 1940s. The advantages of hydroponics are many however the disadvantages should not be overlooked when you are deciding whether or not to set up a hydroponics system.

Advantages

- *You can grow anywhere.* Crops can be grown where no suitable soil exists or where the soil is contaminated with disease.
- *Culture is intensive.* A lot can be grown in a small space, over a short period of time. It is also possible to grow on multilevels. Where transportation costs to the market are significant (e.g. in the centre of large cities), hydroponic farms may be viable irrespective of land values. EXAMPLE: In Japan, vegetables are grown in supermarkets in the centre of large cities. The savings on transport costs and the benefit of having fresh produce offsets the increased cost of space in these cities.
- *Heavy work is reduced.* Labour for tilling the soil, cultivation, fumigation, watering and other traditional practices can be reduced and sometimes eliminated.

- *Water is conserved.* A well designed, properly run hydroponic system uses less water than soil gardening.
- *Pest and disease problems are reduced.* The need to fumigate is lessened. Soilborne plant diseases are more easily eradicated in many nutriculture systems. This is particularly true in "closed systems" which can be totally flooded with an eradicant. The chance of soil borne human disease is also reduced. Though rare in developed countries, it is possible for diseases to transmit from animal manures or soil microorganisms onto food plants grown in soil, leading to illness.
- *Weed problems are almost eliminated.*
- *Yields can be maximized.* Maximum yields are possible, making the system economically feasible in high density and expensive land areas.
- *Nutrients are conserved.* This can lead to a reduction in pollution of land and streams because valuable chemicals needn't be lost.
- The environment is more easily controlled. For example, in greenhouse type operations the light, temperature, humidity and composition of the atmosphere can be manipulated, while in the root zone the timing and frequency of nutrient feeding and irrigation can be readily controlled.
- *Root zone chemistry is easier to control.*
  - Salt toxicities can be leached out.
  - pH can be adjusted.
- *New plants are easier to establish.* Transplant shock is reduced.
- *Crop rotation/fallowing is not necessary.* All areas can be used at all times you don't need to leave a paddock for a year to fallow every so often. The amateur horticulturist can use hydroponic systems in the home, even in high rise buildings. A nutriculture system can be clean, light weight and mechanized.

Disadvantages

- *Initial cost is high.* The original construction cost per acre is great. This may limit you to growing crops which either turnover fast or give a high return.
- *Skill and knowledge is needed for efficient operation.* Trained plants-men must direct the growing operation. Knowledge of how plants grow and the principles of nutrition are important.
- *Disease and pests can spread quickly through a system.* Introduced diseases and nematodes may be quickly spread to all beds using the same nutrient tank in a closed system.
- *Beneficial soil life is normally absent.*
- *Plants react quickly to both good and bad conditions.* The plants in hydroponics react more quickly to changes in growing conditions. This means that the hydroponic gardener needs to more closely watch his plants for changes.
- *Available plant varieties are not always ideal.* Most available plant varieties have been developed for growth in soil and in the open. Development of varieties which are specifically adapted to more controlled conditions is something which will be slower to come.

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
- leavesrequired for respiration, transpiration and photosynthesis
- reproductive Parts Flowers and fruits

Roots

Soil provides the plant with the following things:

- 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 useable as the more soluble compounds. The diminished solubility may be because of the nature of the compound (eg. superphosphate) or may be due to something else (eg: Slow release fertilizers such as osmocote, which is made by incorporating the simple chemicals inside a semipermeable 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 fertilizers which need to be broken down by soil microorganisms into a form which the plant can use. They also include other complex fertilizers 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 according to not only the group they come from but also according to factors such as heat, water, soil acids and micro-organisms present. As such, it is impossible to control the availability of nutrients in soil.

This is one of essential advantage of hydroponics over soil culture. In hydroponics, you can choose to use only simple, soluble compounds, and as such you can determine the exact amount of each essential nutrient which is available to the plant at any point of time.

Stems

The main stem and its branches are the framework that supports the leaves flowers and fruits. The leaves, and also green stems, manufacture food via the process known as photosynthesis, which 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 (i.e. this is equivalent to the blood system in animals).

Leaves

The primary function of leaves is photosynthesis, which is 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 the leaf pores (or stomata), sometimes through the leaf cuticle (or surface) 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) fertilizing an egg (i.e. female part found in the ovary of a flower). The ovary then grows to produce a fruit and the fertilized egg(s) 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.

Growing Carnations in hydroponics

Growing Conditions

- Good aeration and drainage is critical for optimum cropping.
- Optimum temperature for disbuds (or Sims) is 15 to 18 degrees Celsius, and preferably not over 22 degrees Celsius.
- Optimum temperature for spray (bunching) carnations is up to 6 degrees higher than sprays in summer and 3 degrees higher in winter.
- Will tolerate almost freezing temperatures
- Flowering is initiated by both mild to warm temperatures and medium to long days. You need both a good day length and adequate temperatures.
- Water requirement can be up to eight times as much in summer as mid winter.
- Avoid high humidity.

Nutrient Requirements

- E.C. should never exceed 3.5mS/cm; ideally keep at 2.0mS/cm
- pH should be around 6.0
- Excessive sulphates can sometimes cause a problem.
- While establishing nitrogen and calcium requirement are high but during flowering calcium requirement decreases (Up to 30kg/litre of additional
- Calcium nitrate may be added to the standard nutrient solution over the first few months gradually being reduced as the plants establish.
- Established plants would be fed with the standard solution).

Suitable Systems

- Rockwool used commercially in the Netherlands since 1978 - used commercially in Australia since 1981

- Rockwool slabs between 10 and 12cm deep are more successful than shallower slabs. Six to eight drippers supplied per sq.m of rockwool slab.
- Set slabs on plastic sheet base with a slight slope for sub drainage.
- Plastic sheet can lead to reduced humidity in a greenhouse in some instances this needs to be countered with routine overhead misting.
- Perlite: 810cm deep gives excellent results
- Scoria has given good results.

Planting

- Use virus tested cuttings from approved carnation growers. These may be supplied in growool blocks or perlite tubes (If in soil based media, the media must be washed off before planting).
- Disbudded carnations (e.g. Sims) are planted at 3036 plants per sq.m.
- Spray Carnations are commonly planted at 3648 plants per sq.m. A wider spacing improves ventilation and reduces likelihood of disease.
- Cropping starts around three months after planting.

Special Cultural Techniques

- Open horizontal mesh supported 1520 cm above the media provides a support system.
- Pruning is necessary to stop spindly undesirable growth habits. (Pinch out the growing tip on young plants when they reach about 15cm tall.
- Artificial lighting is sometimes used to concentrate flowering period (i.e. you get more flowers over a shorter period, but after that flowering is delayed for the next crop). This is done by lighting at 110 lux from dusk till dawn for 4 weeks, usually in mid winter.

Problems

- Hygiene is very important to disease control and in turn crop quality.
- Fusarium Wilt (Fusarium oxysporum) spreads rapidly through irrigation.
- Botrytis is sometimes a problem
- Alternaria leaf spot occurs as small purple spots which grow to larger black areas bearing spores.
- Virus diseases, mainly transmitted by aphids are a particularly serious problem reducing cropping in many parts of the world. It is critical to only plant virus free plants, and to control aphis to prevent healthy plants from becoming infected.
- Don't get flower buds or petals wet. It can cause markings.
- Flowers which develop at lower temperatures have a tendency to split.
- Flowers developing at higher temperatures develop faster and tend to have weaker stems.
- Aphis and Mites can be very serious pests. Aphids spread virus and cause distorted growth. Mites cause mottling of the leaves and eventually drying of the foliage.
- Thrip and caterpillars can also become a problem.

Harvest and Post Harvest

- For single flowering varieties, the flowers are harvested when the bud has opened fully so that the outer petals are at right angles to the stem and the inner petals are still tightly bunched.
- For spray types harvesting occurs when the top three flowers begin expanding and the lower buds are showing colour.
- One part of Boric acid in ten parts water will improve the keeping quality of the flowers by up to one week.
- Dipping treatments, based on sodium thiosulphate, that extend the keeping quality of the flowers are also available.
- Harvested flowers can be damaged by ethylene. An ethylene inhibiting chemical is used on flowers which are not sold as soon as they are picked.

START NETWORKING – DEVELOP CONTACTS WITH SUPPLIERS

By interacting with industry, studying lists of plants and seeds from suppliers; or even visiting suppliers; your knowledge of different plants will expand.

Irrespective of the courses you study, or the qualifications you gain; this is a journey that cannot be fast tracked, nor can it be avoided, if you wish to develop a level of knowledge that will serve your needs and optimise your opportunities for success in the flower industry.

Following is a list of Seed Merchants (Note: this list will give you an impression of the nature and scope of seed suppliers, even if it is not all relevant to sourcing seed in your own country. Additional seed merchants can be found by searching web sites).

INTERNATIONAL SEED MERCHANTS

Colegrave Seeds Ltd:
West Adderbury, Banbury, Oxon OX173EY, UK.

Ph: Banbury (0295) 810632; Fax: (0295) 811833.

Flower seed specialists.

Silverhill Seeds:
18 Silverhill Crescent, Kenilworth, 7700, South Africa.

Ph: (21) 762 4245; Fax: (21) 797 6609.

Specialist in South African natives. Proteaceae, Ericaceae, Geraniaceae, bulbs, succulents, annuals, perennials, trees and shrubs. Catalogue available.

Kings Herb Seeds (New Zealand):
PO Box 19-084, Avondale, Auckland, New Zealand.

Ph: (09) 887 588; Fax: (09) 828 7588.

Wide variety of herb, vegetable and flower seeds.

A.L. Tozers Seeds:
Pyports, Cobham, Surrey, KT11 3EH, UK.

Ph: (0932) 62059; Fax: (0932) 68973.

Vegetable and flower seeds.

Hamer Flower Seeds:
Sheraton House, Office 29, Castle Park, Cambridge, CB3 0AX, UK

Ph: (0223) 327520; Fax: (0223) 462542.

Breeders Seeds:
17 Summerwood Lane, Halsall, Ormskirk, Lancs, L39 8RQ, UK

Ph: (0704) 840775; Fax: (0704) 841099.

Flower and Vegetable seed.

E.W. King and Co:
Monks Farm, Kelvedon, Essex, C05 9PG, UK.

Ph: (0376) 570000

Vegetable seeds.

Elsoms Seeds:
Ph: Spalding (0775) 711911; Fax: (0775) 723209.

Distributor for several European seed merchants.

Pinetree Vandenberg:
Lower Rd, Effingham. Leatherhead, Surrey KT24 5JP, UK.

Ph: (0372) 456688; Fax: (0372) 452857.

Vegetables (lettuce).

Clause UK Ltd:
Ph: (061) 4866872; Fax: (061) 4866874.

Iceberg lettuces.

Enza Zaden UK Ltd:
Plantation House, Milber Trading Estate, Newton Abbot, Devon TQ12 4SG, UK

Ph: (0626) 333616; Fax: (0626) 331457.

Vegetables (ie: lettuce).

Booker Seeds:
Boston Rd, Sleaford, Lincolnshire NG34 7HA, UK

Ph: (0529) 304511; Fax: (0529) 303908.

Vegetable seeds.

Chiltern Seeds
Bortree Stile, Ulverston, Cumbria LA12 7PB, England.

Abundant Life Seed Foundation
P.O. Box 772, Port Townsend, WA, 98368, USA.

Applewood Seed Company
5380 Vivian St, Arvada, CO, 81067, USA.

W. Atlee Burpee Company
Warminster, PA, 18974, USA.

D.V. Burrell Seed Growers Company
P.O. Box 150, 405 N. Main, Rocky Ford, CO 81067, USA.

Clyde Robin Seed Company
P.O. Box 2366, Castro Valley, CA 94546, USA.

The Country Garden
Route 2, Box 455A, Crivitz, WI 54114, USA.

Far North Gardens and International Growers Exchange
PO. Box 52248, Livonia, MI 48152, USA.

Gurney Seed and Nursery Company
Yankton, Sd 57079, USA.

Harris Seeds
3670 Buffalo Rd, Rochester, NY 14624, USA.

J.L. Hudson, Seedsman
Box 1058, Redwood City, CA 94064, USA.

Jackson and Perkins
83-A Rose Lane, Medford, OR 97501, USA.

Johnny's Selected Seeds
Albion, ME 04910, USA.

J.W. Jung Seed Company
Randolph, WI 53956, USA.

Earl May Seed and Nursery Company
Shenandoah, IA 516032, USA.

Nichol's Herbs and Rare Seeds
1190 N. Pacific Highway, Albany, OR 97321, USA.

Park Seed Company
Highway 254N, Greenwood, SC 29647, USA.

Plants of The Southwest
1812 Second St, Sante Fe, NM 87501, USA.

Stokes Seeds Inc.
Box 548 Buffalo, NY 14240, USA.

Otis S. Twilley Seed Company, Inc.
P.O. Box 65, Trevose, PA 19047, USA.

SELECTED AUSTRALIAN SEED MERCHANTS

Alliance Seeds Pty Ltd
101 Basin Olinda Road, The Basin, Vic.

Ph: (03) 9761 0906

Anco Seed and Turf
Lawn seed suppliers.

Dandenong-Hastings Road, Lyndhurst, Vic. 3975.

Ph: (03) 9799 1370

Arthur Yates and Co
Wide range of varieties, including flowers, perennials and cut flowers.

PO Box 6672 Silverwater BC, NSW, 181

Ph: (02) 9763 9200; Fax: (02) 9763 9300

Atlantic Seeds
PO Box 205, Seaford, Vic, 3198.

Ph: (03) 9786 0337.

Giant pumpkin, watermelon and squash seeds.

Australian Seed Company:
P.O. Box 67, Hazelwood, NSW, 2779

Ph: (02) 4758 6132; Fax: (02) 4758 7022

Native tree and shrub seeds for landcare, revegetation.

CIC Suppliers
14-16 Ballieu Court, Mitchell ACT, 2911

Phone: (02) 6241 7477

Email: sales@cicsuppliers.com.au

Colgrave Seeds
P.O. Box 303, Cranbourne, Vic. 3977

Phone (03) 5998 1777

Email: seeds@colegraveseeds.com.au

D. Oriell
45 Frape Ave, Mt Yokine, Perth, WA, 6060

Phone: (08) 9344 2290

Email: dorriell@iinet.net.au

Diggers Seeds (Clive Blazey)
105 Latrobe Parade, Dromana, Vic, 3936.

Ph: (059) 87 1519.

Wide range of vegetable, flower and perennial seeds. Many rare and heritage seeds.

Ellinson Horticultural
P.O. Box 365, Nowra, NSW, 2541

Phone: (02) 4421 4255

Email: seeds@ellinsonhort.com.au

Fairbank's Selected Seed Company
542 Footscray Road, Footscray, Vic, 3011

Ph: (03) 9689 4500, Fax; (03) 9687 7089

Germinox:
404 Upper Heidelberg Road, Heidelberg, Vic. 3084

Ph: (03) 9457 6782

Henderson Seed Group:
165 Templestowe Road, Lower Templestowe, Vic. 3107

Ph: (03) 9850 2266

Heritage Seeds:
7 McDonalds Lane, Mulgrave, Vic. 3170

Ph: (03) 9561 9222

Heritage Seed Curators Assoc.
PO Box 1450, Bairnsdale, Vic, 3875

Ph: (03) 5153 1034.

HG Kershaw Seeds
325 Mc Carrs Creek Rd, Terrey Hills, NSW, 2084.

Ph: (02) 9450 2444.

Wide range of native and exotic trees, shrubs and flowers.

Kings Herb Seeds (N.Z. Company):
PO Box 975, Penrith, NSW, 2751.

Ph. (047) 761 493.

Wide variety of herb, vegetable and flower varieties.

H.G. Kershaw Australian Native Seeds:
Flower, tree, shrub and palm trees.

The Pde, Dee Why, N.S.W. 2099

Ph: (02) 9984 7226

Kings Herb Seeds (N.Z. Company):
PO Box 975, Penrith, NSW, 2751.

Ph. (047) 761 493.

Wide variety of herb, vegetable and flower varieties.

Kimseed Environmental:
Native seed suppliers.

Osborne Park, W.A. 6916

Ph: (08) 9446 4377

Mr Fothergills
15B Walker St, South Windsor, NSW, 2756

Phone: (02) 4577 5457

Email: fothergills@comcen.com.au

New Gippsland Seed Farm
P.O. Box 1, Silvan, Vic, 3795

Phone: (03) 9737 9560

Email: newgipps@bigpond.com

Web: www.possumpages.com.au/newgipps.index.htm

Rijk ZwaanAustralia P/L

P.O. Box 284, Daylesford, Vic, 3460

Phone: (03) 5348 5528

Web: www.rijkzwaan.com

Royston Petrie Seeds P/L

P.O. Box 77, Kenthurst, NSW, 2156

Phone: (02) 9654 1186

Email: roseed@bigpond.com

Stephen Pasture Seeds

Pasture and lawn seed.

27 Wiltshire Lane, Ballarat, Vic, 3350

Ph: (03) 5335 8055

South Pacific Seeds

PO Box 934, Griffith, NSW, 2680.

Ph: (069) 62 7333; Fax: (069) 64 1311

Melbourne:- Ph: (03) 9562 8908; Fax: (03) 9543 4270.

Brisbane: Ph: (07) 3393 3766; Fax (07) 3893 1522.

Vaughans Wildflower Seeds

C/- PO Gingin, WA, 6503.

Ph: (095) 75 7551.

Wide range of Australian native species, in particular West Australian. Catalogue available on request.

W and G Plants and Palm Seeds

216 Outlook Drive, Dandenong North, Vic.

Ph: (03) 9795 7505

Wrightson Seeds (Aust) P\L

PO Box 357, Seven Hills, NSW, 2147.

Ph: (02) 9674 6666; Fax: (02) 9674 6257.

Wright Stevenson

117 Silverwater Rd, Silverwater, NSW, 2141.

Ph: (02) 64 8744.

438 Torrens Rd, Kilkenny, SA.

Ph: (08) 268 9855.

OTHER SOURCES OF SEED AND INFORMATION

- The Australian Correspondence School's garden ezine is one of your best resources. It can be found at http://www.acsgarden.com Click on "Organisations" then search for seeds. If you find a company not listed here, help other students out by "clicking on add a listing". You can then add that seed company to our list for free.
- Do a search on the Internet elsewhere for "Seeds" or a particular type of seed (eg. Vegetable Seeds). If you also type in your country name, you can narrow the list to suppliers in your country.
- Most Australian state Departments of Conservation, Land Management, or Forestry will supply large orders of some native seeds, in particular timber species. Their phone numbers can be obtained from the Government listings near the front of your white pages phone book. (A few of these can be found on the accompanying photocopied list of tree seed suppliers).
- In addition these departments generally have a range of books, reports, and information leaflets available on a range of topics to do with revegetation and land rehabilitation, timber crops, and seed collection and germination.
- Greening Australia is a nation-wide organisation with the aim of regreening Australia. It has a wealth of information available on various tree planting groups, tree planting and rehabilitation techniques, and seed collection and germination. The various state branches are listed in the white pages of the telephone directories for the state capital cities. They have two publications, in particular, that are worth obtaining. These are:

  (1) How To Collect Native Tree Seed Easily, and
  (2) How To Germinate Native Tree and Shrub Seed Enjoyably.
- The Royal Horticultural Society in the U.K. operates a Seed Distribution Scheme for members. This is a great way to get different seeds. Joining the RHS is a really worthwhile thing to do; both in respect to this and other benefits (no matter where you live in the world). For details on joining, or making contact with, the RHS, contact the school.
- There are a large number of landcare and tree planting groups in both rural and metropolitan areas. These will often have seed available of plants indigenous to their area. Their addresses or phone numbers can usually be obtained through such organisations as the state or national Farmers Federation, State Departments of Agriculture or Conservation, and Greening Australia.
- The Society For Growing Australian Plants is an Australia-wide organisation that aims to promote the preservation and cultivation of Australian native plants. Each state branch maintains an extensive seed bank that includes many rare or uncommon native species. Seed is readily available to SGAP members. In addition, there are a large number of study groups within the SGAP that specialise or concentrate their study and interest onto specific groups of plants. These study groups are often the best source of rare or uncommon species. Examples include the Banksia, Rainforest, Daisy, Eucalypt, Native Ferns and Grevillea study groups. For information either search for the Society on the Internet; or ask the school and we can supply up to date contact details.

SET TASK

Buy some bulbs, flower seed and/or flower seedlings. Plant them into several different containers.

Place the containers in different places and treat them differently in an attempt to manipulate some to flower earlier and others to flower later. Report on the results later in the course when they have flowered.