Environmentally Sustainable Production Systems for Producing Ornamental Plants©

John Bunker
Redlands Nursery Pty. Ltd., 905-907 German Church Road, Redland Bay QLD 4165, Australia

INTRODUCTION

Since man has been producing crops on earth there has been constant evolution adapting to changes, including demand for increased production to service population increases and other changes. These changes include intensive monoculture of crops, mechanization, new improved cultivars as a result of breeding and selection, to increase yields and to develop resistance to pests and include the discovery and the use of agricultural chemicals.

In the 21st century as horticultural producers we face the same global issues: pressure on margins, increasing legislative changes (which we need to adapt to) with regulatory requirements on occupational health and safety and environment. In addition there are the ever-changing demands in the marketplace both at consumer and commercial levels. At no other point has there been so much change.

Currently in the State of Queensland there is a major focus on the consumption of energy, water, and waste output with current population growth and development projections in southeast Queensland indicating power network supply difficulties by 2010 and water infrastructure without further expansion lasting until 2026.

At no other point has there been so much change or challenge. However in every challenge there lies an opportunity.

THREAT OR OPPORTUNITIES

Each of these different areas can be viewed as a threat but importantly they are also opportunities that can shape our business into being leading-edge producers in the 21st century.

In the 1960s Dr. Ken Baker revolutionised the production of ornamental plants with his book, *The U.C. System for Producing Healthy Container Grown Plants*. This book described the benefits of using aerated steam for pasteurising growing media as well as the use of soilless potting mix. The Australian nursery industry embraced this document, which has become the basis of the production processes in a majority of nurseries. The nursery industry also commenced using waste products of the timber industry with the use of bark and sawdust.

In the Redlands Nursery case study, the last 20 years have been a constant evolution to today where the focus is on integrated crop management (ICM) using environmentally sustainable production systems focused on the triple bottom line.

A major focus of this approach is on hygiene so that we are preventing problems rather than trying to cure them chemically, this underlines the total system approach from weed management to water disinfestation. This also includes membership of the Nursery Industry Accreditation Scheme (NIASA).

In embracing the triple bottom line our investment strategies and production processes all revolve around this, which means the following:

- People — provision of career opportunities and training as well as ensuring that the work place processes take into consideration health and safety of the workforce.

- Profit — return on funds invested with the objective of improving profitability and being able to reinvest in the business and stay competitive.
- Environment — all processes are environmentally friendly and adhere to or exceed any environmental legislation, as an example all equipment upgrades take into consideration power and fuel consumption.

INTEGRATED CROP MANAGEMENT

Integrated crop management is a holistic approach to the production of crops. It encompasses the following major areas:

- Hygiene;
- Water;
- Nutrition;
- Planting material;
- Integrated pest management (insects, weeds, pathogens);
- Growing environment.

Plants are like people — both are living organisms and, to ensure peak performance, need to have all of these areas in balance.

HYGIENE

In any production system hygiene is the most critical factor in the prevention of problems occurring rather than trying to cure problems chemically after the event.

Hygiene includes effective quarantine and monitoring of new plant material to ensure that you aren't bringing any new pests onto the property.

An effective weed management plan as weeds harbour insect pests' plant pathogens. For example flowering weeds close to the crop can host thrips, aphids, whitefly, and two-spotted mites. The removal of dead or diseased plant material to prevent spread of plant pathogens and sterilising used growing containers with aerated steam at 72 °C to prevent the possible spread of soilborne pathogens are important points of hygiene.

Keeping the production and propagation facilities clean all the time rather than trying to clean occasionally is more effective housekeeping and an important hygiene step as well as promoting a professional image.

People are important and the cleanliness of the team and equipment which takes into consideration issues such as smokers who are capable of spreading TMV onto susceptible crops underpin hygiene and quarantine.

WATER MANAGEMENT

This is a continuing process of reviewing, recycling, and strategic application as it is a precious resource. Four years of below average rainfall created the opportunity to critically review the use of this important resource.

Our annual evaporation rate is 1.2 m with rainfall for the 2004 year being 1.32 m.

As a result, recycling of water became a necessity on the home property, as the site did not have any underground water supply only a dammed creek. Using the creek water resulted in losses caused by water borne *Phytophthora* or *Pythium*. In addition to chemical treatment of the crops sodium hypochlorite was recommended to disinfest the water supply. This eliminated the problem and was prevention rather than trying to cure the problem after the event chemically.

Water quality is also improved by using sand filtration and inline filters to remove organic matter and ensure that the disinfestation process is most effective.

Regular monitoring of all water sources to manage pH, EC, and nitrates is vitally important. We aim for a pH of 6.5 down line solution as sodium hypochlorite solution reduces in effectiveness after pH 7.2.

The nursery runoff water is channelled back to separate collection dams where it is blended with other water sources to create our irrigation water.

Other water management strategies include the location of stockpiles of mulch, potting mix, and animal manures so that the leachate from these sources is adequately filtered before entering the recycled water supply.

Application of Water. Sprinkler technology matched to the requirements and growing facilities is a vital step in ensuring efficient use of water.

New technology has seen advances in different application techniques as well as upgrades of previous overhead sprinklers, which can increase water efficiencies. The Nelson rotator R 2000 has been used to replace conventional brass sprinklers and the following was achieved:

- Water saving 20%.
- Improved crop quality due to more even application when the sprinklers were fitted with pressure regulators.
- Sprinklers fitted with pressure regulators gained water saving at the beginning and end of the irrigation cycle with no drain down or the resultant crop damage under these sprinklers.
- More efficient water application results in savings in electricity, water treatment costs, and nutrition due to reduced leaching, crop health, which all ultimately affect the bottom line.

The use of variable speed drive pumps improves management of operating pressure for the sprinklers as well as flexibility when beds are partially shut down. The pump only pumps enough water for the sprinklers, which stops over pressurising causing broken or leaking water mains.

Variable speed drive pumps are also more energy efficient and this lowers running costs as well as water main maintenance.

The next stage in water management will be the use of aerators and biological bacteria in the recycling system to manage pH and algae bloom in the recycling ponds.

NUTRITION AND POTTING MIX

Composting of the potting mix is a critical step in the nutrition process.

Over the last 20 years when initially we commenced using aging of sawdust as opposed to a dedicated composting process which included added nutrition and regular turning we have seen crop growth and quality improve with the reduced nitrogen drawdown.

Controlled-release fertiliser was used as a dibble that ensured each plant received the same amount of fertiliser in the root zone and where it received constant moisture and temperature.

Now we are applying irrigation water more effectively (reduction of up to 20% in water application rates) it has reduced leaching and some crops created excess nutrients that caused root burn, poor growth, and secondary disease infections. The initial reaction was to reduce the irrigation cycles further, which made the problem worse. Further testing showed the EC to be excessive so irrigation was increased to flush out the excess nutrients.

This season all controlled-release fertiliser is now incorporated in the mix; this has resulted in further reduction in water use, reduced crop losses, and better crop performance particularly of the woody ornamentals such as camellias, azaleas, and magnolias.

All potting mix is batch tested for air-filled porosity, water-holding capacity, pH, EC, and germination before use with pH being stabilised at 6.5. Regular full lab nutritional testing is also carried out by a professional consulting company.

Sand has been eliminated from the potting media as it was washed river sand, which intermittently tested positive for phythium.

Now the focus is use of the totally renewable products pine bark and coir peat.

Fertigation to fine tune the plant nutrition is managed using media testing and sap testing of the target crops to provide accurate real time crop data, ensuring optimum crop growth.

PLANTING MATERIAL

Without quality planting material it is not possible to produce a quality-finished product.

A major step forward in ornamental production in the last 5 years has been the availability of virus-indexed plant material as mother plants.

European and North American cuttings are produced in specialised quarantined clean houses and are then shipped to rooting stations to create plugs, which can be shipped to the producers for finishing. This has resulted in a major change in production techniques and improved crop growth and health.

High quality well maintained healthy stress-free mother plants whether in conventional propagation systems or the new high health systems are still the critical first step in a successful production cycle.

INTEGRATED PEST MANAGEMENT

Integrated pest management (IPM**)** was first practiced at the Redlands in the 1980s as a result of difficulty in managing two-spotted mite (TSM) populations built up on neighbouring tomato growing properties with the only sustainable way to produce, *Chamaedorea elegans* in particular was to look at alternative methods rather than the traditional use of pesticides as we were not achieving satisfactory control. The predator used was *Phytoseiulus persimilis*. The challenge was to research the pest and the predator to understand the lifecycles of both friend and foe, also understanding the environment required by the predator. This resulted in the introduction of a humidity cycle in the middle of the day, to enhance the predator's reproductive cycle at the expense of the TSM, which prefers hot dry conditions.

Other successful uses of biocontrols have included the use of nematodes applied as a drench for the management of fungus gnats and the use of *Cryptolemus* beetle for managing mealy bug.

With ICM the application of pesticides is only one management tool and part of the whole crop production strategy.

Weekly crop monitoring by dedicated professionally qualified personnel combined with feedback from the production team gives real time information of what is happening.

Traditionally all pesticides were applied on a calendar basis, now pesticides are applied on a needs-only basis which reflects pest populations as well as stages in pest life cycles.

Some fungicides are still applied on a calendar basis to foliage crops in periods of high rainfall and humidity or flowering crops such as azaleas during their peak flowering stage.

For effective pest management strategies to be implemented timing is critical as well as understanding the pests cycles.

For the management of *Heliothis*, monitoring egg lay we have been able to achieve total control of the 1st instar stage with the use of Bt plus mobait an attractant within 12 h of recording egg lays.

Waiting until the larvae are 2nd or 3rd instar requires the use of more potent pesticides as well as more applications often with mixed results.

The understanding of the insect pest life cycle or the best conditions for plant pathogen development means that the environment can be modified further preventing possible outbreaks of disease. For example keeping the crop dry into the evening helps prevent the spread of a lot of fungal leaf diseases as well as botrytis on flowering crops particularly in cooler conditions.

The successful use of the new oil-based pesticides is totally dependent on timing of the applications to the correct life stage of the pest's life cycle for effective prevention of problems.

Application Techniques. Traditional use of high volume application technology of 2000 $L \cdot ha^{-1}$ and applying the spray to run off was accepted as the norm. This resulted in mixed results as well as excessive time particularly if being applied by hand.

Currently application rates have been reduced to 250 $L \cdot ha^{-1}$ and treating 2 $ha \cdot h^{-1}$ using airshear sprayers.

We now have more effective control of the application as the small droplets produced by the airshear sprayer and carried by the turbulence created by the machine are deposited on both the upper and lower sides of the target leaves and stems throughout the crop.

Of particular interest since using this technology is the increase in populations of eastern water dragons as well as the insect eating blue fairy wrens, which actually nest successfully in the crop. This wildlife is playing an effective bio control role of certain insect populations.

This demonstrates that we are able to work with nature and also how the approach of change to low-volume application coupled with spot spraying and use of (softer) pesticides is having a positive effect on the natural ecosystem.

Alternative Pest Management Techniques. We will continually support research or experiment with the use of alternative chemicals, and biocontrols, as well as other pest management strategies. The total approach to pest management is science based and not muck and mystery.

Use of Insect Traps. For example, insect traps killing the adults effectively stop them laying eggs, which then turn into larvae, which can ultimately damage the crop. Insect traps can be an important tool in monitoring what insect populations are present, acting as an early warning system. The majority of the caterpillar pest problem is related to moths, which are all night flying and are able to be caught using attractant lights and insect traps.

GROWING ENVIRONMENT

The correct growing environment for the crop is not only critical in producing a healthy product but also important in reducing pest problems. Researching where the crop grows in its natural environment provides important facts for matching water requirements, nutrition, and temperature and light levels required for optimum crop performance.

It is also important to research the environmental factors that favour pests as this can also influence selection of the growing environment. For example TSM thrive in hot dry conditions, roses produced under drip irrigation can be more susceptible to TSM and it maybe difficult to establish predator mites compared to situations where roses are produced under overhead sprinkler irrigation.

Good air movement and crop spacing are important cultural factors in the prevention of the spread of disease; it also helps to keep the crops foliage dry.

The Nursery Industry Accreditation Scheme of Australia (NIASA) focuses on best practise production techniques with a strong focus on the growing environment, including light and humidity, the maintenance and management of the facility, air movement, and ventilation. Management of wind, cultural controls, and hygiene are also important facets of the growing environment considered for the NIASA Accreditation Scheme.

Producing on benches or gravel beds to provide good drainage away from the container or rain splash onto the crop are also critical steps in prevention of disease spread.

MULCHING

This is an effective use of green waste produced on the property and then processed through aging or composting.

Mulching of field-grown stock and garden beds not only improves soil health and encourages surface feeder roots but also is an effective weed management strategy as well as insulating the soil keeping it cooler in summer and warmer in winter.

Mulching is also important in water management locking in soil surface moisture after rainfall or irrigation which other wise would be lost through evaporation.

For field production the use of green manure crops for fallowing the soil reduces the risk of soil erosion in a high rainfall area and is important in building up the organic matter and organic carbon content of the soil and feeding the soil microflora. Forage sorghum is used in the summer months coupled with oats in the cooler months as effective green manure crops.

WASTE GENERATION

In some countries the manufacturer who creates the packaging has to have in place a waste disposal system. This has resulted in packaging, which is recyclable from manufacturing of luxury cars to household consumables.

Ultimately the goal is the reduction of the amount of waste that is going into landfill.

The catch cry of reduce, reuse, and recycle is driving Australia in areas from water to energy to waste management.

In southeast Queensland current population projections indicate we will run short of power in 2010 and water in 2026.

Better use of these resources is seen as critical in the environmentally sustainable future for our communities.

Waste Disposal and Recycling. At Redlands the old potting mix is aged then incorporated with topsoil, which is then enriched with green manure crops and has its nutrition balanced. This value added product is then marketed through our local landscape yard as a value added garden soil.

Prunings or green waste, which had been traditionally burnt can be aged or composted and used as mulch for garden beds or field production.

Recycling of cardboard, paper, some plastics, and steel have well established programs available in most communities which saves them going into landfill and being remade into other usable products.

Packaging. Using packaging, which is recyclable or returnable is an important step in reducing material going into landfill. This may be in the form of returnable plastic trays, crates, bins, or trolleys.

The nursery industry has traditionally used waxed trays, which are not recyclable and go to land fill which is a cost to the community.

FUTURE

The world around us is changing rapidly with concern about global warming, changing of weather patterns, and consumption patterns of resources such as water, fuel, and energy as populations continue to grow.

The Kyoto protocol, which comes into effect on 16 Feb. 2005 is an initial step in setting carbon emission targets and opens up the opportunity for carbon trading.

As we growers of plants produce clean air machines will we be able to take advantage of carbon trading and linking with companies who have emission issues. It certainly is an opportunity for the future.

As environmentally sustainable producers the triple bottom line will be the focus of our business in managing costs and key resources especially energy, water, and waste. In producing crops we will have to carefully consider the energy and water consumption of crops along with their profitability.

Environmentally sustainable developments in commercial and residential developments will in the selection of landscaping not only look at landscapes that use water efficiently but are also energy efficient. For instance the selection of trees to shade buildings in summer and let light in the winter reducing energy cost of heating and cooling respectively.

People will remain the key in both having qualified trained people to use and understand the new technologies and techniques, which will be adapted to crop production. Managing the systems and the information that they deliver will be the difference between success and failure.

CONCLUSION

We have found our new approach of scientifically based, ecologically compatible production to be stimulating, sustainable, and profitable. The opportunities for our industry and as members of IPPS are exciting as we move into this new era of the 21st century. We have unique opportunities, the products we produce are not only important for man's survival in the production of food and future shelter (in timber production) but also they enhance the environment removing CO_2 and produce vital supplies of oxygen.

Ultimately we must all contribute to enhancing the environment and making the world a more beautiful and better place to live.

We wish you well in your quest for a better future for your community and mankind in general.