Integrated Production of Nursery Stock

Nico G.M. Dolmans
Research Station for Nursery Stock, P.O.Box 118, 2770 AC Boskoop, Netherlands

INTRODUCTION

The total area of nursery production in the Netherlands has grown rapidly during the last 10 years. More than 50% of the plants are exported. High standards of quality lead to the use of large amounts of fertilizers and pesticides, especially soil fumigants. These amounts are still way above the long-term targets associated with government environmental policy. The Multi Year Plan for Crop Protection aims to reduce the use of pesticides in nurseries by 25% by 1995, 39% by 2000, and 58% by 2010. In addition, the use of fertilizers is to be restrained to avoid polluting surface and ground water.

As growers will continue to face competition from imports they will have to maintain high standards of quality so economic and environmental aims have to be optimized. In 1990 the Research Station for Nursery Stock at Boskoop developed a programme to investigate alternative production methods (Dolmans, 1992). This has resulted in research projects at three different levels:

1) Analytical research, in which alternatives are investigated in "normal" scientific experiments.

2) Development of three prototype integrated nurseries, at which alternative growing methods are evaluated in relation to one another and to economical consequences at a semi-practical scale.

3) Implementation in practice, where alternative methods are introduced to nurseries.

Researchers are working at different levels. This guarantees a close interaction and constant evaluation of the results.

DEFINITION OF INTEGRATED PRODUCTION

The integrated nutrient management for field grown nursery stock implies maintaining soil fertility and nutrient balance, and preventing leaching. Chemical analysis of soil samples must be the basis of the nutrient management on the nursery. Organic manure is used as the basic fertilizer. Additional nitrogen (N) and potassium (K) fertilization can be given during the season, preferably in the rows. Special attention has to be given to the level of organic matter in the soil because the use of organic fertilizers is restricted. Organic content can be maintained using low nutrient manures such as compost and green manures.

The most common soil diseases and pests in open-ground nursery stock production are *Phytophthora cinnamomi*, *Verticillium dahliae*, *Meloidogyne hapla*, and *Pratylenchus* spp. A long-term crop rotation plan, based on host ranges of these diseases and pests must be used instead of chemical soil sterilization. *Tagetes* spp. can be used to suppress *Pratylenchus* spp.

The amount of pesticide applied can be reduced through better application techniques, good monitoring, and decision support systems. In integrated systems, selective compounds must be used. Mechanical weed control is preferred. All these

measures require better disease and weed management. This can only be achieved on a nursery when the number of crops is limited, allowing the grower to develop special techniques and to make specific investments.

Container growing raises additional problems because it is very intensive. The main environmental problem is leaching and run-off of irrigation water, which takes fertilizers and pesticides into the ground water or streams and lakes. This can be solved by water recirculation systems. Various alternatives are possible, depending on the size of the container and the irrigation system in use. The ultimate control, although rather drastic, is to grow the plants indoors—this also offers new opportunities for biological pest control measures.

ANALYTICAL RESEARCH

Biological and Integrated Control of Insects and Mites. Trials on the biological control of spider mite, aphid, and black vine weevil were undertaken. The predatory mite, *Phytoseiulus persimilis*, gave good control of spider mite in greenhouses and tunnels when air humidity was kept high enough and when the predator was introduced soon after the first spider mites were found. Biological control of aphids was tried with the parasitic wasp, *Aphidius colemani*, and the predatory midge *Aphidoletes aphidimyza*—the former to control new infections, the latter to eradicate established colonies. Most of the common aphid species could be controlled successfully.

Biological control on outdoor crops was not successful, although a research programme is still under way on the use of the lace-wing fly, *Chrysoperla carnea*, and the lady bug, *Hippodamia convergens*. Broad-spectrum insecticides currently used to control the black vine weevil, *Otiorhynchus sulcatus*, interfere with biological control measures. Pesticides with a more selective activity are being trialled against adult vine weevils. Parasitising nematodes (*Heterorhabditis* spp.) give good control of the larvae, but are not effective at low temperatures and are expensive. Trials are under way to find strains active at lower temperatures (van Tol, 1994).

Integrated Control of Fungi. A computerised decision-making aid is being developed to help growers control rose powdery mildew, *Sphaerotheca pannosa*. This program is fed meteorological data collected by an automated weather station. In trials the number of sprayings has been reduced by between 30% and 50%.

Crop Rotation. The nematode, *Pratylenchus penetrans*, has a very broad host range, which makes it difficult to find a good rotation scheme. However, there are possibilities when more is known about the host suitability and the damage threshold of the main crops. This is being investigated for a range of different crops.

Fertilization. To help us understand leaching of nitrogen in field-grown crops, different aspects of the nitrogen balance are being studied. Several trials are under way to determine the optimal level for soil nitrogen. It appears that this level in May and June is between 50 and 100 kg ha^{-1}—depending on the crop. Application of fertilizers by fertigation and slow-release formulations are being tested.

PROTOTYPE NURSERIES

Three prototype nurseries are in use to help develop integrated production systems for growers to use. At each prototype nursery one person, acting as nursery manager, is supported by a counselling group of nurserymen and extension officers.

Field-Grown Seedlings for Forests and Hedges and Rose Rootstocks. This nursery is located on 1.5 ha of reclaimed peatland. For crop rotation, plant species are divided into four main groups plus *Tagetes erecta* for nematode control. In principle, for each group a crop rotation system of 1 : 6 (or 2 : 6 for the biennial crops) is planned. So far, nematode populations have been kept low by the use of *Tagetes*, although there are infestations of *Pratylenchus penetrans*. As the soil is phosphate saturated, animal manure cannot be used for fertilization. Use of composted waste materials and *Tagetes* can just compensate the loss of organic matter by mineralization. The level of nitrogen in the soil can easily be lowered to 50 kg ha^{-1} for first-year seedlings and 75 kg ha^{-1} for transplanted plants without loss of growth or quality. Weeds are controlled mechanically between the rows by hoeing, ridging, and brushing. In the rows it is still necessary to use a soil herbicide, as hand-weeding is very expensive. On seed beds, weeds are killed by infra-red burning. There is a list of acceptable pesticides that can be applied with technically advanced spraying equipment. By good monitoring, the use of pesticides can be reduced without noticeable pest damage to the crops. Integrated control of beech woolly aphid (*Phyllaphis fagi*) and oak midge (*Arnoldiola quercus*) appears to be very difficult and both need more research.

Field-Grown Ornamental Shrubs and Conifers. This nursery is located on 0.8 ha of sandy soil. Plants are grown from planting stock to saleable plants in 2 years. The crops are divided into six rotation groups plus *Tagetes*. The crops are grouped according to susceptibility to nematodes and *P. cinnamomi*, and general cultural practices. After 4 years (two crops) *T. patula* is grown for 1 year. In principle for the groups, a crop rotation system of 2 : 15 is planned. The nursery has quite high infestations of *Pratylenchus* and the rotation scheme had to be adjusted, but so far no pest damage has occurred. Fertilization and plant protection are generally the same as described above for seedlings, except that more organic material has to be applied because some plants are sold with a root ball. The mineralization rate at this site is high so nitrogen additions can be very low. The use of pesticides in this nursery is very low, as only selective chemicals are used and natural enemies are abundant.

Container Grown Ornamental Shrubs and Conifers. A nursery composed of an outside container bed of 0.2 ha plus a greenhouse of 0.2 ha with a removable polythene roof (convertible greenhouse) protecting the system from excess rain. The roof can be opened to obtain a mild climate for growing and hardening-off. The water in the system is recirculated. Shrubs and conifers are grown from rooted cuttings to saleable plant. Plants are grown in 1- to 3-litre containers in lots of 100 or 200 m^2 on a concrete floor to facilitate mechanization. An automated system for potting, transporting, placing, and spacing the containers avoids undesirable working conditions and reduces labour costs. Plants are fertilized with every irrigation, the leachate is collected and reused. So far, no undesirable effects of recirculation have been found. Biological control of aphids, spider mites, caterpillars,

and black vine weevil works very well, although pesticides are sometimes used for correction or to control other diseases and pests.

IMPLEMENTATION IN PRACTICE

Although the results of the research on integrated production are promising, Dutch nurserymen have been slow to introduce the techniques on their own nurseries. To overcome this, the Research Station, the Advisory Service, and other organisations made a plan for the introduction of integrated control of general nursery pests and diseases, integrated nitrogen-management, and integrated control of powdery mildew in rose. In 1994 approximately 25 nurseries were involved with one or more of these areas. Practically all nurserymen are positive about the results and see the advantages of better monitoring and using less pesticides and fertilizers.

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