

glasshouse and field only after permission from (GMAC) Genetic Manipulation Advisory Committee. There may be patent obligations involving up front payments and/or royalties before these plants can be grown commercially. If PRSV resistance can be transferred from wild species there are no patent obligations or restrictions on field testing.

Both approaches should provide PRSV-P resistant papaya lines in the future although the first plants in the field are likely to result from the gene-transfer project.

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Getting the Most Out of Growing Media and Nutrition

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INTRODUCTION

Plants need carbon dioxide, water, mineral nutrients, oxygen in their root zone, and energy. In their natural state they acquire these for themselves. It ought not to be too difficult to help them along in a nursery, but somehow it often is. The typical Australian nursery is placed at various levels, somewhere between the maligned backyarder who recognises the simplicity of it all and the idealism of a Dutch grower nurturing a single variety with almost total environment control.

We can abridge the requirements of plant survival in nurseries into the following parts: the plant, the growing media, nutrition, the environment, pest, disease and weed control, and management.

THE PLANT

Universally, plants obey the same principle rules for survival but because they have to cope with different environments they modify their responses. In short, each plant is distinct and requires a different level of management. Most have wide tolerances of growing conditions. If this were not so then the nursery industry could

not survive in its present form. However, there are exceptions where growing conditions and nutrition, in particular, have to be precise (Fig. 1).

THE MEDIA

At one time the potting mixture was considered the most important part of container plant production and was often the means by which a grower gained an edge over competitors. Media knowledge has developed in stages to a level where we now understand the require-

ments to be a set of properties rather than a catalogue of different formulas (Australian Standard, 1993).

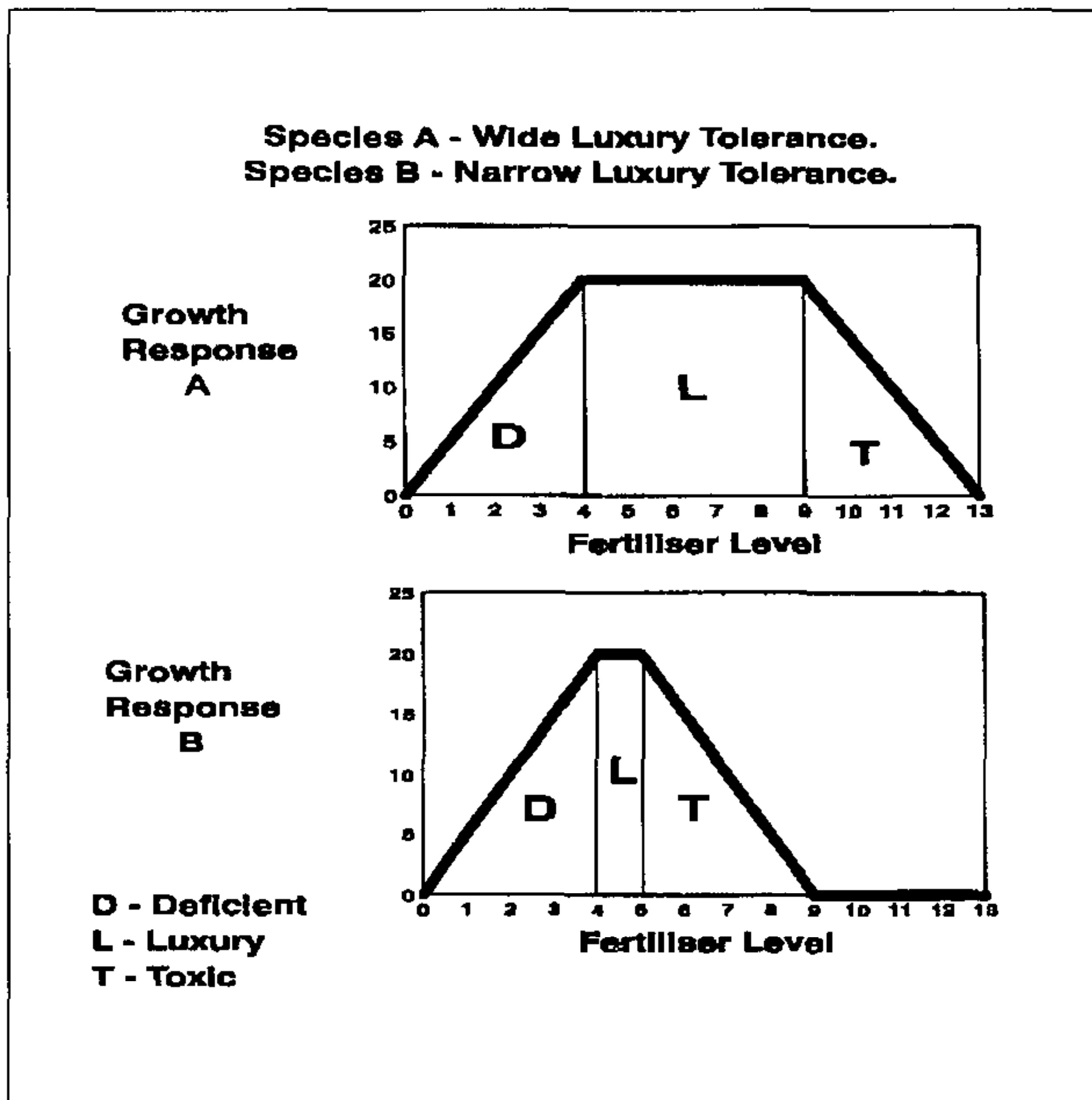


Figure 1. Schematic response of plants to increasing fertiliser. Species A - wide luxury tolerance; species B - narrow luxury tolerance.

NUTRITION

Nutrition is a subsidiary function of the media. Plants can take nutrients through their leaves but they do so much better through their roots and the roots are situated in the media. The supply of oxygen and water are important parts of this function. Plants also differ remarkably in their requirements for various nutrients. In nurseries today, nutrients are applied predominantly as polymer-coated controlled-release fertilisers (CRFs) or in liquid form.

ENVIRONMENT

Environmental factors impact heavily on the media, particularly in relation to nutrition.

Temperature and light have a dominant effect with each plant subject to optimum ranges for growth. With temperate species, plant metabolism slows down at levels above and below the optimum whilst tropical species, having few problems when grown in the tropics, suffer at the extremes experienced in cooler climates.

Controlled-release fertilisers can present a problem in this regard. Release is regulated by temperature, which is not a problem so long as the plants metabolic activity is also increasing at the same rate. However plants have limits to their ability to tolerate extremes in environmental temperature, beyond its optimum range their metabolism slows down, while the fertiliser continues to accumulate. In regard to CRFs, growers should be conscious of hot heaps of potting mixture, heat

sterilisation, heatwaves with temperatures above 35C, and heated greenhouses under conditions of low light.

PEST, DISEASE, AND WEED CONTROL

Plant pests and diseases represent an enormous threat to nurseries and have contributed to the loss of thousands of dollars worth of sales. Modern soilless composts are usually weed free and may actually contain disease-suppressing organisms. The relationship between disease and nutrition is obscure and often conflicting (Gladstone et al., 1990; Chase, 1988). Irrigation management is important because root diseases proliferate in an aqueous environment. There is ample scope for improvement in regard to nutrition and disease relationships because disease organisms are often discovered simply as secondary outcomes of nutritional failure.

However, because insects and disease spores are everywhere, it is simply not possible to prevent everything from going wrong. The answer to this is inherent in the principles of integrated pest management, wherein an approach can be taken involving such disciplines as strict quarantine, nursery hygiene, crop rotation, environment control (e.g. fans in glasshouses to dry leaves before spores can germinate), proper nutrition, irrigation timing, and biological control. It is at this juncture that the simplicity of the backyarder philosophy begins to collapse.

MANAGEMENT

Management is the key to the solution, growers need to make the most of the scientific advice on offer and their own accumulated experience to stay in business. One of the most critical areas is water management. Everyone appears to recognise that "too little" can be disastrous, but the converse of "too much" has sometimes subtle, sometimes glaring, effects on the final product. Whichever watering system is used, the best approach is to water when needed. This minimises nutrient and water wastage, while capitalising on media airspace. Media management requires a good balance between water-holding capacity and air-filled porosity, and rainfall being considered if necessary. Irrigation will always be difficult in situations where, as is often the case in Australian nurseries, the grower is dealing with a broad range of plants of differing watering requirements and in different stages of growth.

Being aware that the plant is responding to the interaction of environmental stimuli, and the raw materials and growing conditions we provide, adds another dimension to the art of nursery management. Good horticulturists are acutely conscious not only of seasonal change but more importantly of unexpected conditions such as heat waves, excessive cloud cover, frosts, prolonged winds, and subtle changes in temperatures. They will modify their practices to irrigate and fertilise accordingly.

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