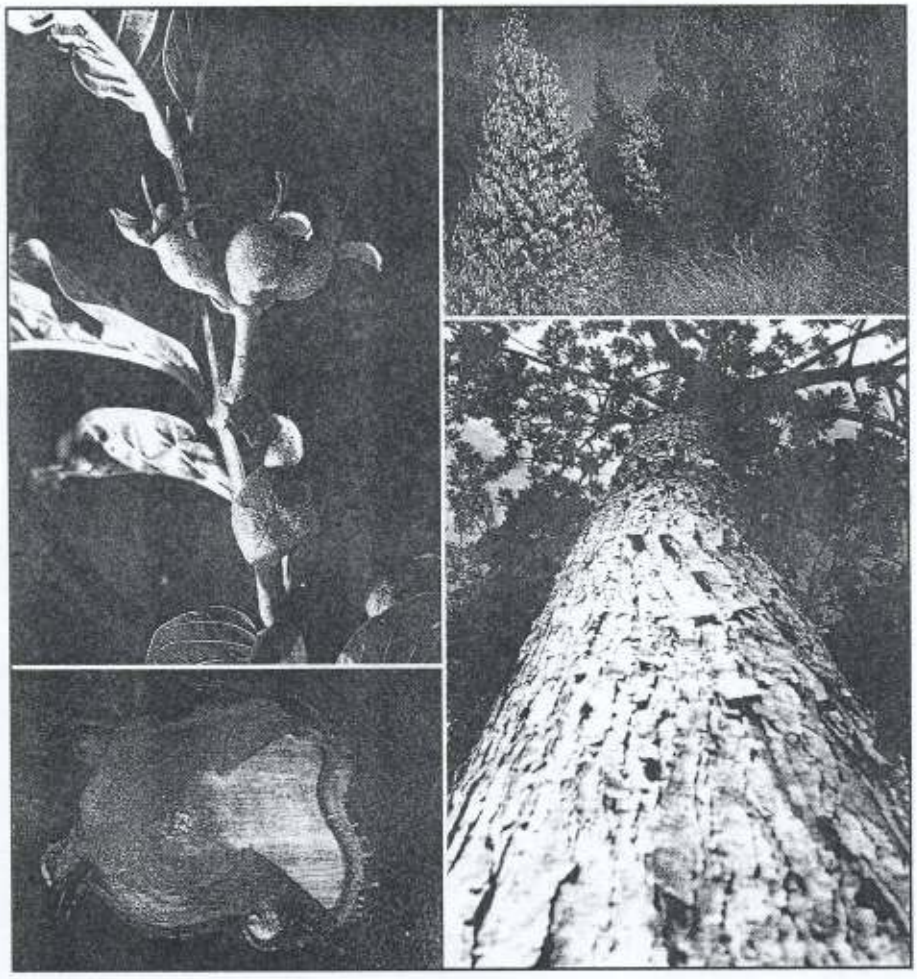
A Positive Prognosis for Plantation Species



The report here discusses how a good tree improvement programme starting with species can usually result in considerable gain in wood yields. The report on page 19, on the other hand, says that the selection of a hitherto unused tree species for cultivation in forest plantations can help reduce the global wood deficit and reduce the need to cut down natural forests

By Michael J. Wingfield and Brenda D. Wingfield

THERE has been a dramatic increase in plantation forestry, particularly in the tropics and the Southern Hemisphere, in the past 30 years. These plantations contribute significantly to the world pulp and solid wood product markets. They have also begun to alleviate pressures on native tropical forests where indiscriminate logging has come to threaten delicate ecosystems.

The preferred and most successful route to establishing profitable plantations has been through the planting of exotic species. The most widely planted trees are species of *Pinus*, *Eucalyptus* and *Populus*, of which many millions of hectares have been established outside their native ranges. The success of these species as exotics has largely been due to the fact that they were separated from their natural enemies – the pests and pathogens that live in a delicate ecological balance with the trees where they are native.

Where native tree species are established in plantations that are adjacent to natural stands of these species or other species of the same genera, they are typically subjected to considerable damage due to pests and diseases. Here, pests and pathogens move from the natural stands and apparently capitalise on the fact that plantations of trees tend to have a high degree of genetic uniformity. There is generally a substantial genetic diversity in the pest and pathogen populations and, thus, individuals that are able to overcome genetic barriers to infection/infestation are likely to arise relatively easily.

It would be wholly incorrect to suggest that diseases and insect pests have not imparted serious losses in exotic plantation forestry. Indeed, one could list many examples of such problems that have plagued exotic plantation forestry worldwide. The impact of *Dothistroma septospora* (red band needle blight) on *P. radiata* plantations in virtually every country where this tree has been grown extensively as an exotic represents one example. Likewise, the impact of *Mycosphaerella* leaf blight (associated with a number of *Mycosphaerella* spp.) on *Eucalyptus globulus* and *E. nitens* in many parts of the world serves to illustrate this point.

It is generally accepted, at least by pathologists and entomologists, that new pests and diseases will appear with time. The

origin of these impediments to forest production will come through two major routes. These are:

- Accidental introduction of pests and pathogens from areas where host trees are native. For example, any one of a large number of pests and pathogens of *Eucalyptus* spp. in their native range threaten more than eight million hectares of these trees planted outside the native range of *Eucalyptus*.
- Adaptation of native pests and diseases to the exotic species. A worrying example is Eucalyptus rust caused by *Puccinia psidii* that is native to Myrtaceae in South and Central America and that has moved to *Eucalyptus* in this area. The disease causes significant damage to *Eucalyptus* where the rust is native, but now also threatens species of the tree elsewhere in the world, including areas where *Eucalyptus* is native.

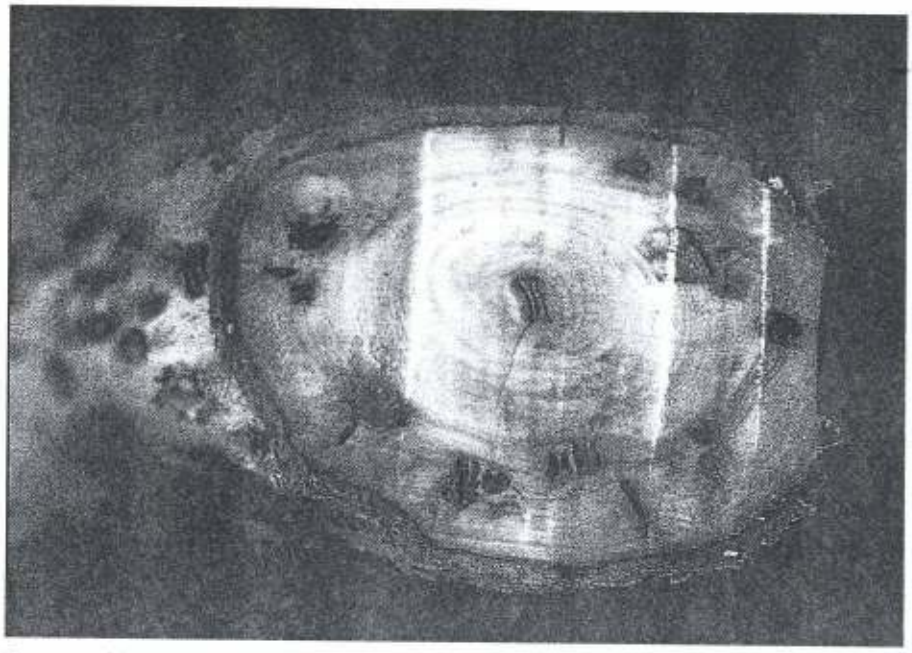
Pathogen and pest exclusion, achieved through quarantine, is the major barricade that most countries use to avoid the appearance of new and damaging diseases. In this respect, success is variable.

Countries such as Australia and New Zealand boast outstanding quarantine programmes and a high degree of success at minimising new introductions. These countries have the advantage of a sophisticated infrastructure to promote quarantine and to manage single national boundaries. They are also island countries that benefit from having oceans that provide a large physical buffer zone from pests and pathogens. The situation is much more complex and threatening where countries have poor infrastructure, fragile economies and boundaries with other countries with poor or even non-existent quarantine programmes.

On the surface, the threat of insect pests and diseases to exotic plantation forestry seems to be a daunting one. Indeed, some pathologists and entomologists view the future of exotic plantation forestry with varying degrees of pessimism. We believe that such attitudes are due to a simplistic view and that they do not take into consideration recent and dynamic developments in plantation forestry. In this report, we hope to illustrate some of the many exciting developments that will ensure long term product security. We also add a number of caveats that will need to be considered by winning forestry companies.

Increased Diversity of Planting Stock

The threat of pests and pathogens is directly linked to susceptibility of the host trees. Where a single species is planted to large areas, risks are substantially greater than they are where more than one species is grown. Likewise, where plantation forestry depends on clones, there is a direct relationship between risk and the number and relatedness of clones that are commercially deployed. Thus, in plantation forestry, efforts to diversify the crop will result in reduction of risk and should be encouraged.



Symptoms of *Coniothyrium canker* on eucalypts caused by *Coniothyrium zuluense*, resulting in serious losses in plantations of *Eucalyptus* in South Africa

Countries that sustain exotic plantations of a number of species have a reduced risk of substantial losses to an entire crop. For example, forestry in South Africa benefits from the fact that numerous species of both *Eucalyptus* and *Pinus* are planted. The disadvantage of this situation is that a wide diversity of planting stock also implies that research and development costs must be widely spread.

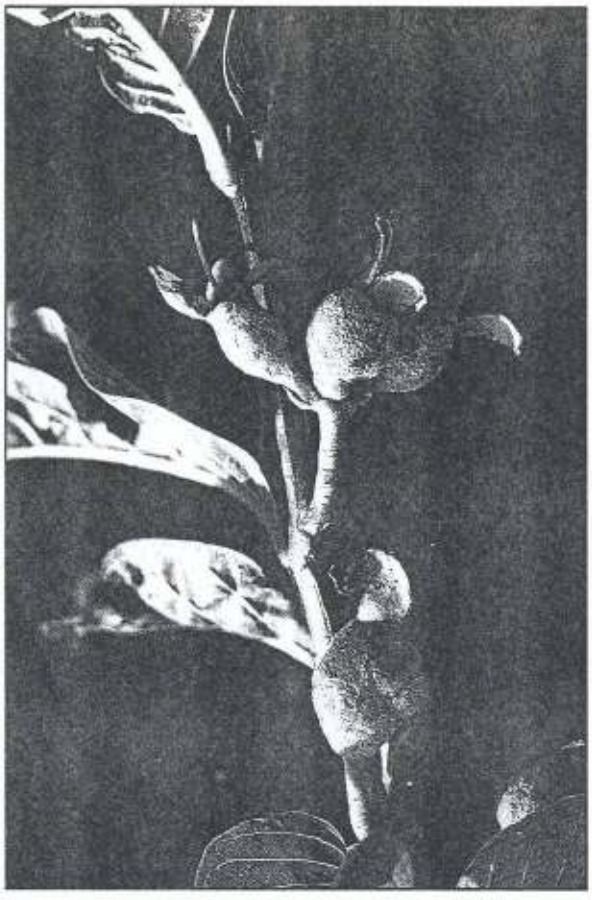
The New Zealand forestry situation that largely focuses its research vote on one species, brings to exotic plantation forestry advantages, not available in areas where a greater number of species are planted. Thus, improvement through breeding and selection has advanced more rapidly in companies where fewer species are utilised.

During the early part of this century, exotic plantation forestry was typified by relatively slow growing plantations. Where a disease or insect problem emerged, this could lead to the loss of many years of tree growth. More recently, there has been a dramatic shortening of rotation periods with pulpwood rotations of *Eucalyptus* and *Populus* being as low as five years. *Pinus* and *Eucalyptus* solid timber rotation lengths are longer, but have nevertheless been shortened dramatically. This is a trend that is likely to continue.

Shorter growing periods have logically led to a significant reduction in risks due to pests and diseases. Certainly a change from one planting stock to another is currently much more feasible now than it was in the past. The capacity of tree farmers to avoid diseases through deployment of pest and disease tolerant planting stock has and will continue to improve in the future.

Hybrids and Clones

One of the most exciting developments in contemporary plantation forestry is the emergence of interspecific hybrids as planting stock. These plants have the advantage of heterosis (hybrid vigour) and they also display distinct phenotypes, including disease and pest tolerance. Thus, losses due to *Cryphonectria* canker of *Eucalyptus* caused by *Cryphonectria cubensis*, have been overcome through the deployment of selected disease tolerant hybrids of *Eucalyptus grandis* and *Eucalyptus urophylla*. This has specifically been possible through improved methods to propagate desirable hybrids vegetatively. Techniques for vegetative propagation are continuously being improved and these will have a positive



Symptoms of the rust pathogen *Puccinia psidii* on guava. This pathogen is considered to be one of the major threats to plantation eucalypts and to native *Myrtaceae* on other continents and particularly in Australia

impact on insect and disease risk abatement in the future.

Molecular Genetics

Molecular genetics is being used increasingly to improve forest plantation trees. For a number of species (including those of *Pinus*, *Eucalyptus* and *Populus*), significant advances have been made in identifying areas in the genome that are linked to desirable traits. These advances are already contributing to breeding programmes and this trend is likely to increase significantly in the future. Thus, where pests and diseases appear, the tools to rapidly identify desirable genes in breeding programmes will be increasingly available.

Significant progress has been made in the identification of genes liked to disease and insect tolerance in plants. The discovery and study of additional genes is a field that is growing rapidly. New genes including those linked to disease and insect tolerance are currently being incorporated into crop plants and these are already being tested at an experimental level in forestry situations. It is not the aim of this paper to review the field of forest biotechnology but the fact that the scope and nature of exotic plantation forestry has changed dramatically in recent years must be recognised when considering risks of damage due to pests and diseases. Where diseases might have led to the abandonment of species or even whole forestry programmes in the past, new opportunities to overcome such problems are emerging rapidly and will become commonplace in the future.

There is little question that molecular genetics will bring significant advantages to exotic plantation forestry. These will clearly also include our capacity to avoid the ravages of diseases and insect pests. It is, however, also important not to expect unrealistic developments in this particular field. There remain many hurdles to be faced in the process of exploiting molecular genetics in forestry. Issues such as transgene escape and a negative public perception of the exploitation of transgenic plants must be faced and dealt with in a responsible fashion. Some groups such as the Forestry Stewardship Council (FSC) currently reject the deployment of genetically modified trees and their concerns will need to be addressed before transgenic trees are commercially planted.

Genetics of Pests and Pathogens

A significantly neglected field of study in forestry relates to the genetics of pests and pathogens. Very little is known regarding the population diversity of major pests and pathogens of even the most widely planted exotic plantation trees. Thus, while a considerable effort is made to identify disease tolerant species, clones and clonal hybrids, almost nothing is known of the capacity of pests and pathogens to adapt and feed on these selected trees.

Durability of disease tolerance is directly related to genetic diversity of pathogens. The presence or absence of sexual recombination in the pathogen will also have a significant impact on durability of disease tolerance. Where a pathogen has become established based on a single or limited introduction, disease tolerant planting stock is likely to retain this desirable trait for an extended period of time.

Risks are thus also closely linked to the genetic nature of the pest or pathogen and there is a great need for an increased focus on this important and neglected field of study. Modern molecular biology has also provided powerful tools that can be used to measure the population diversity of pests and pathogens. These tools will also become increasingly powerful in the future.

Biological Control of Forest Pests and Pathogens

Biological control of forest insect pests is a well-established field. Successes date back many years and as early as the beginning of this century. In the future, it can be anticipated that refined techniques for breeding and selection of insect predators and parasites will lead to more impressive advances. Molecular genetics tools will also be increasingly used to promote this field. This is likely to be particularly evident where microbes such as bacteria (e.g. *Bacillus thuringensis*) are used for insect control.

In contrast to the case with insect pests, biological control of forest tree pathogens is a field that is only beginning to emerge. Indeed, virus mediated hypovirulence (reduction of virulence) is a relatively new concept in plant pathology that emerged when chestnut blight cankers caused by *Cryphonectria parasitica* in Europe began to heal. The subsequent discovery of double stranded RNA viruses and associated hypovirulence in a number of tree pathogens is now beginning to yield promising results.

The spread of double stranded RNA viruses of forest pathogens is limited by somatic incompatibility amongst genetically distinct isolates of a pathogen. Thus, where a pathogen population is genetically diverse, spread of viruses is limited. There have, however, been exciting recent advances in research that will allow viruses to move across vegetative compatibility barriers. At an experimental level, viruses imparting hypovirulence are also being moved to new fungal hosts and many opportunities for biological control are likely to emerge from this field of research.

Possible Impediments to Progress

There is every reason to believe that

plantation forestry based on exotic species has an exciting and profitable future. The importance of pests and diseases is likely to increase but the techniques with which to cope with these problems are becoming increasingly more powerful.

In the past, it has been possible to make relatively modest investments to produce outstanding crops of exotic plantation trees. The future of forestry is likely to be technologically sophisticated with a very strong focus on niche markets. Competition will be based on the ability to produce specialised products, some of which are hardly dreamed of at present.

Avoidance of losses due to insect pests and diseases will necessitate increased levels of investment in technologies, some of which are currently considered to be unrealistic. Planting stock to capture narrow niche markets will in all likelihood be protected by intellectual property rights. Disease and insect tolerance characters are equally set to be placed relatively high on the list of desirable traits that will add value to protected planting stock.

Successful forestry companies that focus on planting exotic species in plantations will be those that have invested wisely in new and emerging forest technologies. Lack of foresight and investment is certain to separate winning companies from those that are dependent on others for their success. It might also be expected that some of the leading forestry companies today could fall back to a position as "followers" in the future, due to a lack of appreciation and investment in novel approaches to forestry. It is also reasonable to expect that small landholders will become increasingly dependent on larger investors for desirable planting stock, the nature of which is also likely to be specified by market forces. ■

This paper was presented at the Woodfor Africa meeting held in Pietermaritzburg, South Africa last month. Michael J. Wingfield is Mondi Professor of Forest Pathology and Brenda D. Wingfield is professor at the Department of Genetics at the Forestry and Agricultural Biotechnology Institute located in the University of Pretoria in South Africa.

Sentang – Malaysia's Fast Growing Source of Quality Timber

THE nineties have seen broader and greater political and public awareness of the role trees play in human welfare, environmental quality, conservation of biodiversity and as a source of forest products obtained in a sustainable manner. At the same time, forest plantations or man-made forests as they are known, are being recognised as engines of economic development and also of environmental enhancement through many ways, one of which results from the reduced need to cut down natural forests. One important function of plantation forests is to help reduce the global wood deficit.

FAO projections for global wood consumption show that the demand of 3 billion m^3 in 1990 is liable to reach a demand factor of 5.1 billion m^3 in 2010. Such growth and demand projections have fuelled many countries such as New Zealand, Australia, Chile, Indonesia and Vietnam to establish forest plantations.

In this part of the world, the Forest Research Institute of Malaysia (FRIM) has been actively promoting the planting of species such as *sentang* (*Azadirachta excelsa*) in forest plantations to augment the supply of raw materials for the wood processing industries.

Considerable feedback obtained from previous seminars and road shows conducted by FRIM indicate that more information was needed on the feasibility of *sentang* for forest plantation development as well as on its utility for various applications.

Besides timber, other parts of the *Sentang* tree can be used in the manufacture of medicine and insecticide

Responding to the needs of industry, a seminar titled "Utilisation of Plantation Timber: *Sentang*" was organised by the FRIM on 20 April 1999 in Kepong, Kuala Lumpur, as part of its Conference on Forestry and Forest Products (CFFPR) 1999 series.

More than 120 participants from both the private and government sector attended the conference. 11 papers were presented at the seminar and in addition to speakers from FRIM, there were speakers from Universiti Putra Malaysia (UPM) and Universiti Sains Malaysia (USM). The topics covered included the characteristics and economic suitability of *sentang* and the financial feasibility and incentives for setting up *sentang* plantations.

Speaking at the opening of the seminar, the Secretary-General of the Ministry of Primary Industries, Datuk Haron Siraj, urged the private sector to venture into forest plantation development using species such as *sentang* which have been identified as suitable for such purposes.

He said wood processing industries such as furniture manufacturers should not be overly dependant on rubberwood for export manufacturing and must pay more attention to using other species available locally such as *nyatoh, sepetir, merbau, mengkulang, red meranti, geronggang, kembang semangkok, bayur, dedali, delek, meransi*, and *surian*, which have properties that make them suitable for use in furniture manufacturing.

Apart from the demand for solid wood, there is also growing demand for panel products such as particle board, Medium Density Fibre (MDF) and Oriental Strength Board (OSB) for the manufacture of furniture and joinery and the establishment of forest plantations should also take into account the growing need for raw materials for such panel products. It has been estimated that the demand for