Plague, pestilence and plantations

Integrated pest management should be used more widely in tropical forestry

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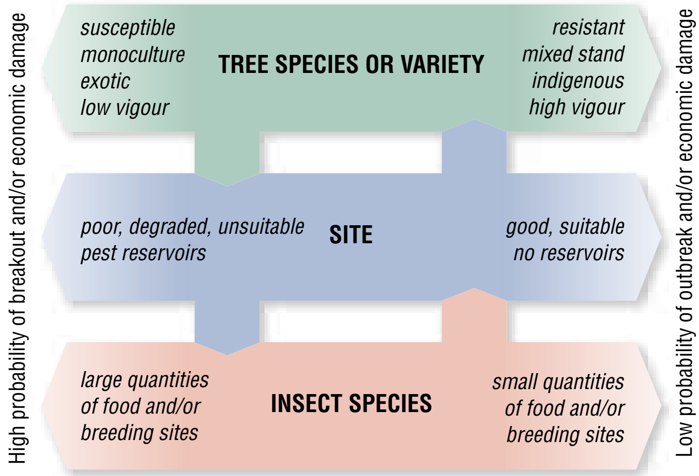
PEST OUTBREAKS in tropical forest plantations are almost inevitable at some time during the rotation and can cause major economic losses. In the past, the main response to pests has been to hit them with poisons, but such an approach not only becomes less effective over time as pests build resistance, it also pours large quantities of toxic chemicals into the environment.

Pest control can be achieved more effectively through integrated pest management (IPM). This can be defined as the use of a combination of control measures—preventative and/or remedial—to contain a pest within operationally acceptable levels of damage with minimal environmental side-effects. The basic philosophy behind it is that control will be more effective, and resistance will be less likely to build up, when a range of measures are deployed against a pest. Crucially, it requires planning and a good understanding of the ecology and biology of both the pests and the plantation crop.

Pesky

Figure 1: Summary of factors which may interact to create insect pest outbreaks in tropical forestry, and strategies for reducing risk *(from Speight 1997)*



Appropriate strategies

Figure 1 presents the basic factors in insect pest outbreaks in tropical forestry and how these might be addressed in plantation design; *Table 1* summarises the options for pest management. Both clearly show that smart plantation managers will begin implementing their pest management strategies well before they start putting seedlings in the ground. Choosing species and provenances that suit the site (and will therefore grow vigorously) and demonstrate resistance to potential pests is clearly important. However, resistance can be overcome if selection pressure is high enough and planting a mixture of resistant varieties—if more than one is available—is probably the best strategy. Multi-species plantations or even single-species plantations with a 'mosaic' of tree ages are also less likely than even-aged monocultures to experience catastrophic pest infestations.

Stage-managed

Table 1: Components of a generalised IPM system. Stages A and B are entirely preventative, Stage C involves monitoring and prediction, and Stage D covers control strategies should prevention fail or monitoring reveal high risk *(from Speight et al. 1999)*

Stage	Options			
A	Site choice: avoid low tree vigour; consider history and previous cultivation	Tree species or genotype choice: consider end-use and economics	Location choice: consider proximity to older stands and natural vegetation	Silvicultural choice: consider mixed vs monoculture, shade resistance, enrichment
B	Inventory major pests and diseases in locality; consider history of problems	Research biology and ecology of major pest and disease species, especially host plant relationships	Inventory pests' major natural enemies in locality	
C	Determine potential impact of major pests on crops; set economic thresholds	Monitor pest levels during vulnerable growth period; relate to economic thresholds		
D	Ecological control: sanitation thinning; nursery treatment; establishment	Biological control: parasitoids; predators; pathogens	Chemical control: insecticides; growth regulators; pheromones	

The merit of planting exotic as opposed to indigenous tree species is still the subject of debate; it depends on a range of factors, not just indigenous or exotic status. Exotics sometimes experience an initial period after introduction where there are few pest problems, but indigenous pest organisms may gradually adapt to these new hosts (Wylie 1992). Indigenous plantations also experience damaging pest outbreaks despite the presence of natural enemies. Intelligence on possible pest threats is essential.

Individual IPM programs won't necessarily include all the options shown in *Table 1*; plantation managers need to tailor their programs depending on circumstances.

Challenges in implementing IPM in forestry

Defining economic damage

In their IPM programs, managers must establish what is called the 'economic threshold': this takes into account the revenue losses resulting from pest damage and the costs of treatment to prevent unacceptable damage. Below the economic threshold, the presence of the pest is tolerated. Only when damage rises (or is predicted to rise) above the threshold is action taken *(Figure 2)*.

Determining the threshold value is made particularly difficult in a long-lived perennial crop like a tree plantation, because economic and biological forecasts sometimes must be made over decades. For example, an Indonesia-based pulp and paper company constructed a mill in the 1980s and simultaneously established plantations of eucalypts, the first of which was scheduled for harvest eight years later when the existing natural resource would be exhausted. The plantations suffered a severe attack from sap-sucking mosquito bugs (*Helopeltis* spp.), causing sufficient damage to threaten harvesting schedules and thus pulp supply to the mill. In this situation, the insect damage assumed greater economic importance than could be attributed directly to growth losses because the mill might have closed if sufficient fibre could not have been supplied. The economic threshold was therefore set lower than would have been appropriate on growth losses alone.

Monitoring, training and cost

IPM relies heavily on monitoring to identify areas where pest populations are high and when economic thresholds are likely to be exceeded (Clarke 1995). In contrast to intensive agriculture, however, such monitoring may be impractical or at least inaccurate in large and inaccessible forest areas. Advice from trained forest protection specialists is essential at all stages of the program, but this may not be available in all developing tropical countries and will be a particular problem for small-scale forest operations. IPM is more complex than just spraying with a chemical pesticide, and it can be expensive when detailed monitoring is required. This is obviously a constraint in many tropical forestry operations where profit margins may be low.

IPM in practice

Table 2 provides examples of pest infestations and the IPM tactics that have been deployed successfully in response.

Case study: sirex wood wasp

The sirex wasp, *Sirex noctilio*, was accidentally introduced to Australia from southern Europe almost 50 years ago and is a serious pest of *Pinus* plantations. The most destructive outbreak occurred between 1987 and 1989 in the states of South Australia and Victoria; more than 5 million *P. radiata* trees with a royalty value of A$10–12 million were killed (Haugen et al. 1990).

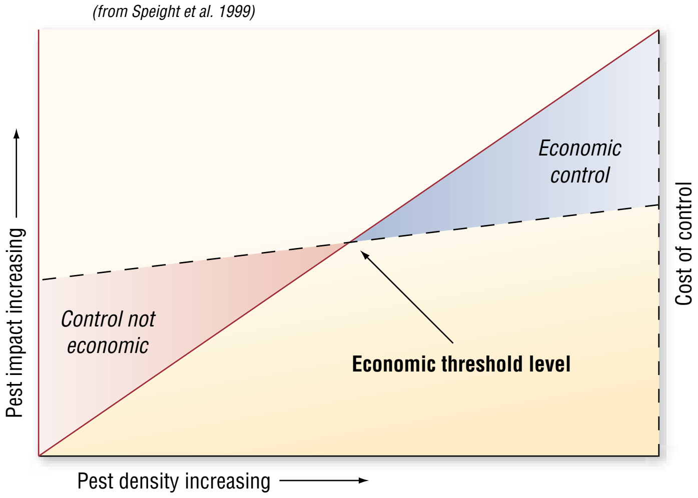
As described by Elliott et al. (1998), the IPM strategy employed against sirex combines detailed monitoring and detection methods, silvicultural treatments and biological control. Detection relies on forest surveillance by aerial and ground inspections and a trap tree plot system that uses herbicide-injected trees, arranged in plots on a fixed grid depending on infestation level, to attract and concentrate *Sirex* populations. The objective is to detect the wasp in a given locality before annual *Sirex*-induced tree mortality reaches infestation levels of 0.1 percent (1–2 trees per hectare in an unthinned stand).

Silvicultural treatment of *P. radiata* plantations by thinning to maintain or improve tree vigour is a key factor in preventing *Sirex* establishment or keeping damage within acceptable levels. Control of *Sirex* populations established in a plantation is achieved by biological means using the parasitic nematode *Beddingia siricidicola* (by artificially inoculating nematode cultures into *Sirex*-attacked trees whence they sterilise, and are carried by, the emerging *Sirex* adults), and parasitoid wasps. Regular evaluation of the dispersal and effectiveness of these biocontrol agents is an essential component of the strategy.

In South America, *S. noctilio* was first detected in Uruguay in 1980, in Argentina in 1985 and in Brazil in 1988. Current annual losses in Brazil are estimated at US$5 million (Iede et al. 1998). Brazil has implemented most of the components of the Australian IPM strategy described above and the other countries are working towards this.

Drawing the line

Figure 2: The concept of economic threshold in insect pest management
(from Speight et al. 1999)



Fighting back

Table 2: Examples of pest management problems and the IPM tactics employed to combat them

Example	IPM tactics
Sirex noctilio wood wasp in Australia and South America (see case study)	Detailed monitoring and detection (aerial and ground survey, trap trees), thinning to improve stand vigour, biological control
Fivespined bark beetle *Ips grandicollis* in Queensland, Australia	Quarantine and pheromone monitoring of zone border, salvage of damaged trees, destruction of logging slash, biological control
Root disease caused by *Rhizina undulata* in South Africa	Chemical insecticides, delayed planting, sanitation felling and removal
Dieback induced by *Sphaeropsis sapinea* in South Africa	Use of resistant/tolerant tree species, sanitation felling and removal
Sal heartwood borer *Hoplocerambyx spinicornis* in India	Regulating timing of felling, removal of logging debris, monitoring to detect infested trees, sanitation felling and removal, trap trees

Concluding comment

IPM offers an effective and environmentally acceptable means of pest management. For forestry, the key IPM tactic is that of prevention. This requires planning, expertise and information-gathering on the pest 'enemy', but such efforts may make the difference between an economically viable plantation enterprise and one plagued by pest problems.

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