Preventing invasive pathogens: deficiencies in the system

Import controls are meant to protect our gardens and environment from devastating plant diseases, but CLIVE BRASIER believes that the global system is fundamentally flawed because it ignores scientific realities: he recommends some solutions


Heather Angel

WE LIVE IN a time of increasing international trade in plants and plant products. This inevitably carries the risk of importing new diseases and pests. Most gardeners will be familiar with the impact of potato late blight and the consequent Irish potato famine in 1845. In modern times we have endured Dutch elm disease and the more recent box blight (*Cylindrocladium buxicola*) and ramorum dieback (*Phytophthora ramorum*, also known as sudden oak death) which infects rhododendrons and viburnums. Last year pathologists discovered another new invasive *Phytophthora*, *P. kernoviae* which infects *Fagus sylvatica* (common beech). These invasive fungal pathogens threaten our natural ecosystems, forests and gardens. While individually significant, collectively they are no more than symptoms of a historical, and now rapidly growing, problem.

There is a global system for preventing import of plant diseases that is systematic, international, well-regulated and well-policed. However, in my opinion, because it is not fully science-based it cannot cover the range of threats. Here I present possible solutions representing my views, based on more than 35 years investigating the evolutionary behaviour of forest pathogens. Compared to other issues of relevance to gardeners, such as climate change, genetic modification, peat products and pesticide reduction, there is virtually no debate on the issue. This article intends to stimulate and encourage debate in a field where debate is not only seriously lacking but may also be suppressed through non-recognition or even avoidance of the issues.

Biological weaknesses

The international plant health regulatory system is supervised by the 1951 International Plant Protection Convention (IPPC) and the World Trade Organisation (WTO). WTO and IPPC rules govern the plant health regulations for the European Union (EU) under which the UK now falls. A major objective is to prevent plant health issues being used as an unjustifiable barrier to trade. The regulations cover areas such as statutory recognition of high risk pests and disease, customs inspection, quarantine and phytosanitary certificates.
In its current form, the system has a number of biological weaknesses:

- **List-dependency.** The present system is essentially list-based, derived from a 'Noah's Ark' perspective. By this I mean that it is usually based on traditional classifications of disease organisms and a species concept that says if a pathogen 'looks like' X, it is X; rather than upon modern, population-based and molecular variation-based species and genotype concepts. Consequently, there are legal and identification loopholes.
- **Non-Darwinian.** The present protocols take surprisingly little note of basic evolutionary science of 1850. Evolutionary theory warns us that the greatest threat is from organisms that have evolved in other biogeographical zones but have not yet escaped and could potentially cause serious damage on new hosts. These threats need to be anticipated. It is apparent, from recent events, that many (probably the majority) of the pathogens that seriously threaten European or US forests are not on the schedules of listed quarantine organisms, because they do not cause any notable damage in their natural habitat.
- **Reactive not proactive.** Instead, existing schedules tend to cover mainly those pathogens that have already escaped from their original

Dutch elm disease devastated the British countryside in the 1970s. New exotic diseases, often imported on garden plants, pose an increasing threat to our native plants

evolutionary zone and are causing noticeable damage on new (that is, not co-evolved) hosts. Some recent examples are Dutch elm disease, North American oak wilt, ramorum dieback, chestnut blight and jarrah (eucalyptus) dieback pathogens and pinewood nematode.

■ **PRA over-dependency.** Present protocols, encapsulated by the WTO/IPPC rules, are based strongly on pest risk analysis (PRA). The PRA is an in-depth procedure that assesses the likelihood of introduction and damage of known diseases. It is an excellent tool for summarising current risk information of well-characterised threat organisms that have already escaped their natural habitats. However, PRAs do not cover the majority of unknown or unescaped threat organisms.

Structural rigidity

The present system is essentially list-driven, not process-driven. It tends to lack the flexibility to embrace major new risks related to, or even arising directly from, the system including:

■ **Stable door syndrome.** Newly identified organisms that may be internationally dangerous, but are without a PRA, are often not on plant health schedules. Recognition and awareness of these organisms, under current protocols, is often too slow, which can promote spread. Part of this problem is that the organism may be perceived as benign in the country of first discovery. *Phytophthora alni*, the new hybrid pathogen now killing alders across the UK and Europe, and a new oak wilt fungus discovered in Japan are examples of potentially dangerous organisms that should probably be on many national quarantine schedules.

■ **Trojan horse syndrome.** Fungistatic compounds that suppress, but do not cure, plant disease are widely used in the nursery trade. These temporarily mask disease symptoms on exported plants and thereby promote spread of exotic pathogens such as *Phytophthora*.

■ **Typhoid Mary syndrome.** Organisms that threaten forests and ecosystems are imported on apparently innocuous 'carriers'. A recent example of this is the international transport of ramorum dieback on *Rhododendron* and *Viburnum*.

■ **Hybridisation syndrome.** Rapid evolution of new hybrid pathogens is promoted by present trade practice. For example, at intensive nurseries in Europe, numerous species of exotic pathogens are brought into physical contact with each other. They may often be treated with unusual chemicals, and this is suspected to increase the chances of hybridisation. Such emerging hybrid pathogens are neither detected nor adequately covered by the current list system. *Phytophthora alni* probably arose from a cross between two other species which had previously been inadvertently introduced to Europe.

Escalating threats

In summary, our present system of prevention tends to respond to the ripples after a splash and not prevent the splash. The result is that probably only a minority of the exotic pathogens threatening our forests and natural ecosystems are covered in current quarantine schedules. Basic evolutionary principles are insufficiently encapsulated into the current approach to plant health, whereas they should underpin the entire scientific rationale. On evolutionary grounds, rapid commercial movement of large numbers of rooted nursery plants and soil between continents and countries probably cannot be carried out with a high degree of long-term safety. Once an unknown organism has escaped, it may build up such an explosive disease momentum that its further spread to other continents is difficult to prevent. Many such organisms may be waiting in their centres of origin.

Market forces and policy weaknesses

In addition to the biological weaknesses, there are a number of economic and social weaknesses in the plant health protection system:

■ **Weakest link.** Within multi-state economic political units, such as the EU, the plant health protection system may tend to operate at the level of the weakest states: those states with poor protocol, or those that flout the rules. This promotes risk and is the very antithesis of how living organisms evolved to restrict the spread of diseases by developing multiple body compartments.

■ **Economic incentives.** The present global system, as operated, is not properly science-based in market economics. It usually lacks the central, social responsibility or environmental principle that the polluter pays.

Although this is enshrined in the 1992 Rio declaration, in practice neither the trade, the regulator nor the government usually pay for the consequences arising from invasives. Therefore, there is no incentive for the economic system, or the regulatory system, to encourage effective bioprotection.

- **Institutionalisation.** A lack of market pressure in favour of progressive and sustainable bioprotection policy can allow governments, trade and regulators to become entrenched and conservative. Therefore, the system itself becomes part of the problem rather than the solution.
- **Nelsonian approach.** The consequences of defensiveness from regulators over unspoken weaknesses of a system can be (i) resistance to strategic thinking, (ii) resistance to funding research that exposes or addresses the weaknesses and (iii) resistance to any policy change. If the regulator claims 'I see no risks!' then the tendency will be inaction.

In summary, there is insufficient linkage between market forces and governments, regulators or commerce to ensure support for more proactive or effective bioprotection measures. The consequences of not recognising or anticipating threats are clear: Dutch elm disease or the current alder mortality are good examples.

Horticultural implications

Since 1993, imports of plants through the UK horticultural trade have more than doubled from £370 million to £860 million. This includes such diverse items as large landscaping trees and ancient olives from Europe, exotic palms from further afield and tree ferns from Australia. All have the potential to carry diseases and pests, even if quarantined or visually inspected. The public have yet to start regularly asking nurseries where

Beatrice Henricot

Box blight is most likely to have been imported on garden plants. It now threatens rare native stands of box such as here on Box Hill, Surrey

their plants have come from. But they may reasonably begin to do so.

Additionally, our borders have to contend with small-scale imports of rare plants from specialist producers or unscrupulous collection of wild material. Also, we have to consider the potential for scientific plant collections, such as those for study and herbaria, to introduce pathogens.

While horticulturists and traders could resent imposition of further restrictions, they may wish to consider the impact that new diseases will have on their gardens and commercial operations. Disease levels on nursery stock and garden plants appear to be increasing. Already with ramorum dieback and *Phytophthora kernoviae* some garden owners are having to contend with the ugly destruction of long-established garden plants.

Nursery owners are also suffering significant financial losses from destruction of stock and the hardship fund recently announced by the UK government is necessarily limited. The true picture of *Phytophthora* disease levels on nursery stock remains unclear. This is partly because of suppression of symptoms by chemical controls and partly because we are in the early phase of reacting after recognition of this new threat.

Diagnosis and treatment

My scientific health check indicates the present global plant health system has fundamental shortcomings. Most notably, too high an emphasis on known, already escaped organisms with a track record of damage. Evolutionary biology argues that the present system needs to be better balanced and, in parts, reversed.

The system needs to be based on more environmentally realistic bioscience, with strong linkage to market-based economics. We need more rapid and comprehensive reporting and assessment of newly identified potential pathogens between the country of discovery and countries at risk.

A Rio-style agreement among nations could provide for scientific testing of risks posed by newly identified potential pathogens before they escape. Modern technology could permit the conduct of these tests, either under international co-operation in the centre of origin or discovery, or under quarantine conditions in a country at risk. It is already known that the large-scale commercial movements of rooted nursery stock between continents and vegetation zones (and subsequent rapid dispersal to other countries) is very high risk. The risk from plant imports can be reduced by:

- Regulating plant introductions far more stringently, as we regulate animal introductions, taking strong account of the high risk from non-listed organisms.
- Importing, under licence, only meristem cultures or seed for propagation, or, more rarely, importing small, licensed quantities of rooted material for quarantine testing before release).
- Encouraging local commercial propagation of exotic forest trees, shrubs and ornamentals.

Tim Sandall

Large containerised plants with the potential to transport exotic diseases are increasingly traded across national borders

- Applying risk protocols that routinely cover different pathogen genotypes, varieties and unnamed taxa as well as classical species defined by their physical appearance.
- Having regular and periodic reviews of plant health policies and protocols. In this way we can ensure that the protocols are based on current scientific knowledge, are led by an understanding of the dynamics of biological processes rather than by lists of organisms, are responsive to informed criticism, and are open to public debate.

Effective intelligence

Protecting forests and natural ecosystems from invasive pathogens will always be a protracted war. If present invasion trends continue, future losses in terms of species elimination, loss of biodiversity or ecosystem degradation will be large. Currently, we may be in danger of losing this particular war. Indeed, the increasing damage and threat to forests and natural ecosystems, even though movement of plants is covered by IPPC/WTO plant health protocols, indicates the latter are inadequate to serve current policies of sustainable forestry and ecosystem protection.

We need to accept that the majority of potential invasive pathogen threats are likely to be currently unknown, or organisms that have not yet escaped from their natural habitats. Effective scientific intelligence and scientific insight should be our first line of defence to keep us at least two steps ahead of the enemy. More globally and locally correct prevention protocols, based on these scientific insights, need to be the second line of defence.

Provision of scientific intelligence in this area is presently patchy. Much of the research taking place alongside the formal channels of plant health regulation tends to be too reactive to identify the numerous risk organisms and processes, many of which are very dangerous but not very obvious. Greater support and encouragement is needed from research funding agencies for intuitive, insightful and strategic research.

Trade role

The nursery trade has a key role to play. Knowing their products are primary pathways for pathogen movement, the trade needs to consider how practical or acceptable it would be to limit imports, especially where high volume or desirable large plants are involved. It also needs to assess the impact of importing only meristem cultures or seed, as licensed introductions for propagation. Moving to a system of local propagation of ornamentals and forest trees would also have significant economic and social impacts.

Fundamental choice

As I see it we have a choice. We can take steps now to protect more effectively our present natural environment and its constituent species. Alternatively, we must resign ourselves to it becoming a global melting pot of imported diseases, resulting in further ecological destabilisation and extinctions. Science can play an important role in presenting the issues. Ultimately, however, our management of the problem resides in social and political choices. ■

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