A NEW BACKGROUND IN THE PROTECTION OF PLANTS FROM BIOTIC PATHOGENS

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Plant protection from biotic agents is part of a complicated system that constantly evolves under the influence of many factors, availability and technical features of control means, their toxicological and environmental concerns and legislative background being the most important. Control programs based on scheduled treatments, established since the beginning of modern crop protection owing to the introduction of many synthetic pesticides in the middle of the last century, moved towards flexibility in the early seventies, especially in Italy, at first through “guided control”, then “integrated control”, followed by “integrated production”. In the early nineties, Council Directive 91/414 ECC started changing the European rules for placing plant protection products on the market, with the aim of strengthening health and environmental safety. New changes in legislative background were recently introduced by European authorities, concerning both the authorization and utilization of agrochemicals, through many measures such as Regulation (EC) No. 396/2005 on pesticide residues in food, new Regulation CE 1107/2009 on the marketing of plant protection products, and Directive 2009/128/EC on the sustainable use of pesticides. Regulation (EC) No. 396/2005 (which became effective on 1 September 2008) has completed the harmonisation and simplification of pesticide maximum residue levels (MRLs), with the aim of protecting consumers from exposure to unacceptable levels in food and feed. Regulation CE 1107/2009 (that will come into force as of 14 June 2011) revises Directive 91/414, modifying the criteria for approval of plant protection products to ensure a high level of safety for humans, animals and the environment and establishes a mechanism for the substitution of the most toxic pesticides. Directive 2009/128/EC (that must be acknowledged by Member States by 14 December 2011 and will come into force between 2012 and 2016) has the objective of achieving the sustainable use of pesticides by reducing their use and risks, improving the quality and efficacy of their application, ensuring better training and education of users, and promoting Integrated Pest Management (IPM) and the use of non chemical control means. In particular, among the many measures, this Directive makes IPM compulsory as of 1 January 2014 (it is now implemented on a voluntary basis). The control of diseases, especially of fungal pathogens, is strongly involved in the new approach to plant protection, because the main principle of IPM concerns the correct choice of intervention timing, which is often more complicated for pathogens than for other biotic agents. This new legislative and political background implies the need to implement a general system for taking, managing and sharing decisions, and, specifically for plant pathology, makes it even more necessary not to overlook, among research topics, biological and epidemiological aspects which can provide useful information in rationalizing intervention timing.
The development of crop varieties resistant to different pathogens is one of the most attracting perspective in breeding projects aimed at increasing host plant resistance. Since most microbial pathogens need to surmount the plant cell wall to penetrate the host tissue, the reinforcement of this compartment should increase the capacity of the host to resist pathogen attacks. One way to pursue this strategy is the enhancement of the host plant ability to inhibit or reduce the activity of cell wall degrading enzymes (CWDEs) secreted by the pathogens during the penetration and colonization of the host tissue. Polygalacturonases (PGs) are among the first CWDEs secreted by fungal pathogens during infection and in some pathosystems they are virulence factors. PGs are inhibited by the host inhibitors polygalacturonase inhibiting protein (PGIP). Moreover, PGs exhibit a reduced activity towards methylated pectin. Pectin is secreted into the cell wall in a highly methyl-esterified form and subsequently de-esterified in muro by pectin methylesterases (PMEs). Since PME activity is controlled by the pectin methylesterase inhibitor (PMEI), this inhibitor might indirectly play a role in plant defence by limiting the action of PGs secreted by microbial pathogens. By using a transgenic approach we have shown that PGIP or PMEI can endows wheat with new capacities to control the activity of fungal PGs, possibly through a direct interaction or indirectly by modifying the level and pattern of methyl esterification of cell wall pectin. Both modifications have been proven to be effective in limiting fungal disease symptom development.
Over a half century of molecular genetics has transformed our view of how genomes operate in the cells of living organisms. Instead of the DNA-centric view in which the genome determines the properties of cells and organisms, we understand today that cells use their genomes as read-write (RW) data-storage systems. The ability of cells to restructure their genomes is critical to episodes of evolutionary change, where new genomic structures become necessary to survive and proliferate in a modified ecology. Contrary to conventional evolutionary views, the genome record teaches us that many of these changes involve intercellular and intracellular horizontal DNA transfer, cell fusions, novel symbiotic associations and unusual fertilization events. Illustrations of critical genome sequencing data come from all kingdoms of life (bacteria, archaea and eukarya) and from both microbes and larger organisms. Cell sensory and regulatory networks as well as the molecular toolkit for genome restructuring are central to a modern 21st Century view of the evolutionary process. The ability of cells to regulate genome restructuring at the epigenetic and other levels plays a key role in the timing of evolutionary events. It is likely that the complementary ability of cells to target change within the genome has played a significant part in the origination of evolutionary novelties, ranging from new protein domains to entire morphogenetic circuits. These ideas serve as the basis for a new way of thinking about the evolutionary process that both integrates ecological disruptions and suggests an innovative research agenda for the new century.
EMERGING CRYPTIC DISEASES OF FOREST TREES

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DNA based molecular tools have revolutionized the identification of fungi causing diseases of forest trees. This process started almost two decades ago and is still gaining momentum, especially in recent years with advances in next generation sequencing. In many cases, the causal agents of tree diseases have turned out to be a number of morphologically cryptic species, which are sometimes sister taxa, other times not. As a result, the control and management of a number of well-known diseases of trees have had to be re-evaluated. For example, *Botryosphaeria dothidea* and *B. ribis* have long been thought to be the main cause of Botryosphaeria canker on *Eucalyptus* trees around the world. Today it is known that these species are rarely the primary causes of the disease, but that at least 21 other species in the *Botryosphaeriaceae* are also involved, with different species dominating in different regions. Similar examples exist for *Cryphonectria* and *Chrysoporthe*, *Mycosphaerella* and *Teratosphaeria*, *Fusarium* and many other pathogen groups. This information changes approaches to breed for resistance to these pathogens dramatically. Quarantine programs also need to be re-evaluated to reduce the chances of introducing further diversity in disease causing agents of a particular disease. Another significant challenge lies in understanding and managing the movement of these pathogens between native and non-native trees in a particular region. In this paper we will explore the recent advances in understanding of these cryptic species causing of diseases of forest trees, their origin and potential management.
Forest ecosystems face unprecedented challenges from the rising rate of influx of alien invasive pests and pathogens resulting from increased global trade. Moreover, climate change predictions suggest that many additional alien pests and pathogens may become problems in forests as temperatures increase and rainfall patterns change. Recent indications of the potential for pathogens to transfer between hosts and the inter-specific hybridisation possible between related pathogens increase concerns over the possibility of escalations in damage in the future. Why are these organisms such a threat? Using examples drawn from wide-scale environmental damage caused to tree populations and forest ecosystems in Europe and elsewhere in the world, in this talk, we will illustrate the potential of alien pathogens to reduce biodiversity, alter ecosystems beyond recognition and impact on human requirements of forests. Classic examples of devastation by alien invasive pathogens affecting trees include Dutch elm disease, caused by Ophiostoma novo-ulmi, Jarrah dieback caused by Phytophthora cinnamomi, canker stain disease of Platanus caused by Ceratocystis platani, and white pine blister rust arising from accidental trans-Atlantic transfer of Cronartium ribicola. Many other examples exist in Europe and elsewhere in the world. Each of these pathogens still causes severe ecosystem damage in areas of introduction. Recent findings obtained from the application of state-of-the-art tools in molecular biology are reshaping our knowledge of alien invasive pathogens. The advent of these molecular biological techniques has greatly enhanced our ability to analyse aspects related to the biology, taxonomy, hidden biodiversity and temporal and spatial structuring of genetic diversity in organisms. Molecular diagnostic assays have resulted in improved detection methods for pests and pathogens based on molecular profiles, that are essential for accurate and rapid detection and enhanced understanding of the pathways of dispersal locally and internationally. This information greatly increases the reliability of pest risk assessment procedures and the development of phytosanitary measures aimed at eradicating, containing or managing these pests. The possibility of regulating the ‘plants for planting’ pathway, one of the major routes through which alien invasive problems are now entering and being dispersed in Europe, will be discussed.