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DECISION SUPPORT SYSTEMS FOR INTEGRATED CONTROL OF LATE BLIGHT

ABSTRACT

All definitions for integrated control agree that maximum emphasis should be put on prevention by using resistant cultivars and cultural measures. Moreover, the use of plant protection products should be limited to the essential minimum using Decision Support Systems (DSSs) that integrate and organise all relevant information. Computer–based DSSs that require weather information and regular late blight scouting inputs have been developed and validated in a number of European countries. In the frame of the EU concerted action "European network for development of an integrated control strategy of potato late blight (EU.NET.ICP)" several DSSs were validated in 1999–2001. The overall conclusion was that in most cases the use of DSSs combined a good disease control with a reduction of fungicide input. The DSSs can be used as a PC–version but more and more, parts of information are delivered to users by phone, fax, e–mail, SMS and websites on the Internet. An important task for the near future is to update the DSSs with information on the epidemiology of the new aggressive population of *Phytophthora infestans.* Issues such as (1) the influence of temperature and relative humidity on the infection process, (2) the role of primary inoculum sources (seed, oospores, volunteers, dumps), (3) the role of secondary inoculum sources (distance, severity), (4) control of early blight and (5) resistance ratings for foliar and tuber blight have to be addressed in order to be able to formulate a robust control strategy that effectively controls late (and early) blight with a minimum input of fungicides.

Key words: Decision Support Systems, integrated control, late blight, *Phytophthora infestans*, potato

INTRODUCTION

In integrated control prevention by using resistant cultivars and cultural measures play an important role (Wijnands 1997). Decision Support Systems (DSSs) that integrate and organise all relevant information can help growers and advisors to target the use fungicides in such a way that optimal efficacy is coupled with a minimum input. In this paper some examples are presented of elements that can be part of such an integrated control strategy of potato late blight. The campaign in the Netherlands to reduce the role of primary and secondary

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inoculum sources is described as well as the possibilities to reduce fungicide input in resistant cultivars. The targeted use of fungicides by combining the characteristics of the fungicides with infection pressure and crop growth is also presented. The role of DSSs in the integrated control of late blight in Europe will be presented as well as possibilities to improve them.

PRIMARY AND SECONDARY SOURCES OF INOCULUM

The first step in integrated control is reducing the primary sources of inoculum. In the Netherlands it has been shown that in most years blight epidemics start from infected plants on dumps (Zwankhuizen *et al.* 2000). Therefore, farmers were intensively informed about a nation–wide regulation to cover dumps before April 15. This campaign organised by the Masterplan Phytophthora, launched by the Agricultural and Horticultural Organisation LTO–Nederland in 1999, resulted in a significant reduction of the number of uncovered dumps (Schepers *et al.* 2000). The better "control" of dumps led to an increased importance of (latently) infected seed tubers as a source of primary inoculum (Turkensteen *et al.* 2002). The use of (healthy) certified seed is therefore very important to delay the onset of the epidemic as long as possible. Early crops covered with perforated polythene, volunteer plants and organic crops can also act as (primary) inoculum sources. To further reduce disease pressure the regulation has been extended to control of volunteers and excessive late blight foci. Volunteers have to be controlled after July 1 when more than 2 plants are present per m^2 on a part of the field of 300 m^2. A field is considered to contain an excessive amount of blight when more than 1000 infected leaflets on 20 m^2 or 2000 infected leaflets on 100 m^2 are observed. The regulation forces growers to take measures to control this disease either by spraying eradicant fungicides or by desiccation of the crop with propane burners (organic growers).

CULTIVAR RESISTANCE

Both partial resistance (lower susceptibility) and fungicides can slow down the development of late blight. Several reports show that partial resistance in the foliage may be used to complement fungicide applications to allow savings of fungicide by reduced applications rates or extended intervals between applications. Nærstad (2002) showed that exploiting high foliage resistance to reduce fungicide input was risky when field resistance to tuber blight was low. When field resistance to tuber blight was high, a medium–high resistance in the foliage could be exploited to reduce the fungicide input. In a number of European countries trials are carried out in which the possibilities of a reduced input in resistant varieties are investigated. In Western Europe resistant cultivars are not grown on a large scale because commercially important characteristics such as quality, yield and earliness are usually not combined in the same cultivar with late blight resistance. In the grower's perspective, the savings in fungicide input that can be achieved in resistant cultivars are not in balance with the higher (perceived) risk for blight. In countries where fungicides are not available or very expensive, the use of resistant cultivars is one of the most important ways to prevent too much damage from blight. In future certification schemes, requested by governments or supermarkets, with strict rules for input of fungicides might provide additional motives for growers to reduce fungicide input. The recommendations to reduce fungicide input in resistant cultivars should be validated and demonstrated in a range of practical situations (with low and high disease pressure) to convince growers of their robustness.

FUNGICIDE CHARACTERISTICS

Fungicides still play a crucial role in the integrated control of late blight. In order to use fungicides in the most optimal way it is important to know the effectiveness and action mode of the active ingredients used in fungicides to control blight. What is their effectiveness on leaf blight, stem blight and tuber blight and do they protect the new growing point? Are the fungicides protectant, curative or eradicant? What is their rainfastness and mobility? During the yearly workshops on integrated control of potato late blight, the fungicide characteristics of the most important fungicide active ingredients used for control of late blight in Europe, are discussed and ratings are given. The ratings are based on the consensus of experience of scientists in countries present during the workshop (Bradshaw 2003). The characteristics of the fungicides can be used to optimise their efficacy by combining their strong points with specific situations in the growing season concerning infection pressure and plant growth.

DECISION SUPPORT SYSTEMS

DSSs integrate and organise all available information on the life cycle of *Phytophthora infestans*, the weather (historical & forecast), plant growth, fungicides, cultivar resistance and disease pressure, required for decisions to control late blight. Computer–based DSSs that require weather information and regular late blight scouting inputs have been developed and validated in a number of European countries (Hansen *et al.* 2002). Six different DSSs were tested in validation trials in 2001: Simphyt (D), Plant–Plus (NL), NegFry (DK), ProPhy (NL), Guntz–Divoux/Milsol (F) and PhytoPre+2000 (CH). The use of DSSs reduced fungicide input by 8–62% compared to routine treatments. The level of disease at the end of the season was the same or lower using a

DSS compared to a routine treatment in 26 of 29 validations. DSS can deliver general or very site–specific information to the users by extension officers, telephone, fax, e–mail, SMS, PC and websites on the Internet. Web–blight, an international collaboration on information and DSS for potato late blight, provides online warning and prognosis systems for blight in the Nordic and Baltic countries and Germany (http://www.web–blight.net). In the U.K., three websites are available to assist in the control of potato blight. They all use weather data from a network of local weather stations and provide area–based information on the risk of blight infection (http://www.ruralni.gov.uk/crops/potatoes/blight & http://www.potato.org.uk & http://www.syngenta–potato.co.uk). In Germany also a number of websites is available that provide information on monitoring for blight and disease pressure. Recommendations are based on the DSS Simphyt (http://www.phytophthora.de & http://www.LBP.bayern.de & http://www.syngenta.de). In Switzerland an Internet based DSS is available that informs on infected fields. Warnings are sent to growers based on weather information, cultivar resistance and history of fungicide applications (http://www.phytopre.ch). Companies like Dacom (http://www.plant–net.com), Opticrop (http://www.opticrop.nl) and Pro–Plant (http://proplant–expert.com) have developed DSS for control of late blight and offer these services – after registration and payment – also on the Internet. In France, Belgium and Italy DSSs are used but not available on the Internet.

Taking into account all available information to control blight is of course more complicated than applying fungicides in a regime with fixed intervals. Moreover, factors that can obstruct the implementation of IPM strategies can be the higher costs, the higher perceived risk and the availability during the growing season of fungicides with different action modes and unpredictable weather conditions. The presence of the new, aggressive population of late blight will force growers to take all information into account because the risk of regimes with fixed spray intervals will often be too high (Turkensteen *et al*. 2002). An important task for the near future is to update the DSSs with information on the epidemiology of the new aggressive population of *P. infestans*. Issues such as the influence of temperature and relative humidity on the infection process, the role of primary and secondary inoculum sources and the resistance ratings for foliar and tuber blight will have to be addressed. Also the control of early blight caused by *Alternaria* will have to be integrated in control strategies for late blight.

DSSs will play an increasingly important role in the more technologically based agriculture with greater requirements by governments and processors for regulating and reporting the use of plant protection products. The site–specific weather data and scouting reports may (in the future) serve as criteria for justifying (to regulatory authorities, whole–

salers or processors) the application of fungicides to control late blight (Magarey *et al.* 2002).

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