Selected Economic Aspects of Potato Protection in the Decision Support System for Integrated Plant Protection

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Abstract: An analysis of the costs of chemical protection of a potato field against late blight in view of the profitability of potato production is presented. The relationship between profitability and the number of sprays, potato price, pesticide dose reduction and field area has been considered. It was established that the cost of pesticide may make up from 40% (small fields) to 70% (large fields) of spraying costs; the dose reduction can play an important part in saving money. Profitability of successive sprays has, up to a limit, a growing tendency. Under the present price relation (between the potato and the production means) complete protection of the potato is more profitable than limited protection (reduced number of sprays). The model of protection profitability will make possible to take into account all important factors, and application of the decision support system against potato late blight should be advantageous.

Keywords: potato, integrated pest management, late blight, economy of plant protection, model of production technology

Introduction

The Institute of Soil Science and Plant Cultivation in Pulawy (IUNG) has a common project with the Danish Institute of Agricultural Sciences (DIAS) that started in September 2000 to build an Internet-based Decision Support System for Integrated Pest Management (IPM DSS) for Poland. In Denmark the research into DSS for Integrated Pest Management has been conducted for many years [1, 5]. PC versions of models give daily precise information on which timely spraying against diseases, pests and weeds can be conducted in a number of crops, winter wheat and potatoes among them. The savings in the cost of spraying are considerable and advisors and farmers use the models on the daily basis with success. An Internet version of the system is also being built. The IPM DSS's web-pages already show information about weather, diseases, pests, weeds, pesticides, varieties, timeliness of treatments etc.

The IPM DSS for Poland must take into account differences in climate, climatic variation, varieties, chemicals used, much lower average number of treatments, instability of prices etc. A cost factor has to be taken into account to optimise between the number of treatments and quality of produce (expected yields should be estimated as another important factor).
The authors of the present paper have developed a farm production-modelling tool called "Agroefekt" [2, 3, 7] which enables a researcher to model production activities on the farm and make economic analyses of crop production technologies used. The tool has been used for the purpose of the present analyses for modelling production of potato on the farm and calculating profitability of sprays against late blight.

Materials and methods

The Danish DSS for potato protection is based on the NegFry model [1]. The model takes into account humidity, temperature at 1.5 m as well as rainfall. The data come from Hardi Metpol automatic meteorological stations and are automatically transmitted by radio to a receiver and transferred to a computer to be used by the Negfry model. Additionally the model requires an input of emergence date and variety resistance. It calculates the accumulated risk value upon which the date of disease outbreak is determined and by use of blight units the dates of subsequent sprays can be determined. The main objective of the Negfry model is to reduce the total number of fungicides applied to the potato crop while at the same time achieving acceptable foliage and tuber blight control. From an analysis of literature sources it follows that the number of sprays against late blight may influence the yield to a great extent [4, 6].

Fig. 1: A preliminary concept of an analytical technological model of profitability of potato protection

It was assumed therefore that under conditions typical in Poland the system requires a module for precise cost analysis of sprays against late blight with reference to profitability of potato production. Thus an extended model of potato protection has been conceived (fig.1), which apart from the model of late blight would comprise:

- technology variants of production,
- field area,
- the relationship between reduced number of sprays and the yield,
- profitability of each successive spray (rate of increase of yield value to spray cost).

In order to test the concept of the extended model analytically three field areas were assumed (1.5, 5 and 10 ha). The highest number of sprays against late blight was determined on the basis of literature sources [6]. A range from 0 to 7 has been accepted.

With the aid of the Agroeefekt program [2] a technology model of a potato growing farm was built. The model consisted of operation sheets of potato for the three assumed field areas, variants of the cropping plan and the database with prices and exploitation data. The program computed direct costs of production, value of production and direct income.

Results

The results are presented in fig. 2-3. Fig. 2 shows the profitability of successive sprays. It has a growing tendency independent of the potato price (within the price range analysed 13.50-54.00 zł/dt - fig. 3).

![Fig. 2: Profitability of successive sprays (field area 10 hectare)](image)

![Fig. 3: Relationship between field area and the cost of spray](image)

The profitability of potato production grows along with application of number of sprays till full control is reached [4, 6]. The costs of materials are constant, however the exploitation costs of the spraying unit fall down along with growing field area (highest costs occur if the unit is used in the potato field only, lowest costs refer to the highest yearly use of...
the unit). Because of a rather high rate of costs of materials (about 70%) a reduction of the dose can lead to significant savings. The preliminary concept of an analytical technological model of profitability of potato protection assumes gathering data on the farm and development of "templates" of technologies of potato production. The accuracy of projection of the technology on the farm by a template will depend on completeness of the data set describing the technology of potato production on the one hand and on the completeness of technology coverage by the templates on the other. The concept of templates will make possible to automate the process of matching model of technology with the real farm on the basis of a limited set of data.

Conclusions

1. Costs of materials in the protection operation ranges from 40% (small fields) do 70% (large fields). It follows that a reduction of the dose has a potential of significant savings.
2. At present levels of prices of potato and production means full control of late blight is more profitable than reduced protection (reduced number of sprays). However, a model of profitability of protection must allow for the change of price relations.
3. Profitability of protection grows with the size of potato field.
4. At present levels of the price of potato application of a decision support system in integrated potato protection should be economically justified.

Bibliography


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