Twelfth EuroBlight workshop
Arras (France), 3-6 May 2010

Rating of fungicides used for the potato late blight control

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SUMMARY
A method for the evaluation of the consumer qualities of fungicides, applied for the potato late blight control, has been proposed. The rating of fungicides, basing on their functional properties and cost, was calculated for three stages of a potato plant development.

KEY WORDS
potato, late blight, protection efficacy, rain resistance, cost

In 2010 the Russian market of fungicides, used to protect potato against the late blight, included 15 preparations.
The most frequent questions, asked by Russian potato growers, are related to the optimal choice of fungicides. In our study we tried to make a quantitative characteristic of the consumer qualities of the offered preparations.
In this paper we considered only functional and economical indices of the consumer qualities of compared fungicides, which are directly connected with the profit of a potato-growing company. We did not take into account any anthropological indices, such as the comfortability of application, safety, and ecological compatibility.
Functional properties of a fungicide are characterized mainly by its ability to protect leaves, new growing leaves (during a rapid growth of tops), tubers, and also by its rain resistance. The economical characteristic represents the cost of a fungicide dose, required for the protection of 1 hectare of a potato field.
To compare the efficiency of different fungicides, we used the assessment of these parameters made by the group of independent international experts of the Euroblight association (N.J. Bradshaw, 2007; see Table 1) and also the results of our own studies (M.A. Kuznetsova *et al.*, 2010). We transferred the efficiency indices, expressed in pluses, into numbers:

+ + +	3
+ + (+)	2,5
+ +	2
+ (+)	1,5
+	1
(+)	0,5

The data on the cost of preparations were obtained from the on-line price lists of manufacturers.

PPO-Special Report no. 14 (2010), 255 - 258

Table 1. *Characteristics of the efficiency of compared fungicides (Euroblight PPO-Special Report 12, 2007)*

Preparation	Efficiency			Resistance to rain
	Leaves	New growing leaves	Tuber	
Copper preparations: **Abiga Pik**	+	0	+	+
Dithiocarbamates: **Dithan M45, Mancoceb, Penncoceb, Polyram**	+ +	0	0	+ (+)
Chlorothalonyl: **Bravo**	+ +	0	0	+ + (+)
Fluazinam: **Shirlan**	+ + +	0	+ + (+)	+ + (+)
Dimethomorph + mancoceb: **Acrobat MZ**	+ + (+)	0	+ +	+ + (+)
Cymoxanyl + copper: **Ordan, Kurzat**	+ + (+)	0	0	+ +
Phamoxadon+ cymoxanyl: **Tanos**	+ +	0	n/r	+ + (+)
Phenamydon + mancoceb: **Sectin Fenomen**	+ + (+)	0	+ +	+ +
Methalaxyl + Mancoceb: **Ridomil Gold MZ, Metaxyl**	+ + +	+ +	n/r	+ + +
Propamocarb-HCl + fluopicolid: **Infinito**	+ + +	+ +	+ + +	+ + (+)

+ + + excellent; + + good; + satisfactory; 0, zero effect (or no any data about the effect); n/r, not recommended for the tuber protection

According to our concept of chemical protection of potato, the assortment of used fungicides depends on the potato development stage. Therefore, we calculated the rating of fungicides separately for three stages: **I**, from the shoot emergence to the time of row closing; **II**, from the time of a row closing to the flowering; and **III**, from the flowering to the natural destruction of haulm.

In the case of the stage I, the most important parameters are the leaf protection efficiency, rain resistance, and the cost of a fungicide. In the case of the stage II, these parameters are the efficiency of protection of new growing leaves, rain resistance, and the cost of a fungicide. In the case of the stage III, the important parameters are the tuber protection efficiency, rain resistance, and the cost of a fungicide.

The ratings of fungicides concerning their consumer qualities were assessed using a 5-score scale (Tables 2-4). To do this, we compared all preparations and chose the best and the worst value of each parameter, setting them as 5 and 1 score, respectively. All other compared preparations obtained intermediate scores, corresponding to their position between the leader and the outsider. For example, if for the stage I the leader and the outsider showed 3 and 1 pluses in the leaf protection efficiency, respectively, then the preparation, which had 2.5 pluses, obtained 4 scores. In the case of a cost evaluation, 5 scores were assigned to the cheapest preparation, and 1 score – to the most expensive one.

To evaluate the preparations according to their functional properties, we used the equation 1; to evaluate preparations by only their cost, we used the equation 2.

$$R_x = 4\frac{y_x - \min(y)}{\max(y) - \min(y)} + 1. \qquad (1)$$

$$R_x = 4\frac{\max(y) - y_x}{\max(y) - \min(y)} + 1. \qquad (2)$$

In both formulas FR_x is the quantitative value of the studied characteristics of the fungicide X (in scores), y_x is a quantitative value of the studied parameter of the fungicide X, expressed in the number of pluses (Euroblight assessment) for the formula (1) or the cost of treatment, rubles/hectare, for the formula (2).

For each stage of potato development, the total scores of the compared fungicides were determined as the average values of intermediate scores.

Table 2. *Consumer qualities of fungicides, applied at the stage I (from the shoot emergence to the time of a row closing)*

Fungicide	Leaf protection		Resistance to rain		Cost of fungicide		Total score
	1*	2**	1*	2**	Cost, rub./hectare	Intermediate score	
Shirlan	3,0	5	2,5	5	1168	2,4	4,13
Acrobat MZ	2,5	4	2,5	5	1338	1,6	3,53
Mancozeb	2,0	3	1,5	2,3	553	5	3,43
Ordan	2,5	4	2,0	3,6	1120	2,6	3,40
Kurzat R	2,5	4	2,0	3,6	1150	2,4	3,33
Penncozeb	2,0	3	1,5	2,3	632	4,7	3,33
Dithane M45	2,0	3	2,0	2,3	699	4,4	3,23
Polyram	2,0	3	1,5	2,3	680	4,4	3,23
Tanos	2,0	3	2,5	5	1366	1,5	3,16
Bravo	2,0	3	2,5	5	1491	1,0	3,00
Sectin Fenomen	2,5	4	2,0	3,6	1475	1,1	2,90
Abiga Pik	1,0	1	1,0	1	570	4,9	2,30

1 Efficiency, number of pluses;*

*2** Intermediate score.*

Table 3. *Consumer qualities of fungicides, applied at the stage II (from the time of a row closing to the flowering)*

Fungicide	Protection of new growth		Resistance to rain		Cost of fungicide		Total score
	1*	2**	1*	2**	rub./hectare	Intermediate score	
Methaxyl	2,0	5	3,0	5	1445	2,1	4,02
Infinito	2,0	5	2,5	1	1297	5	3,66
Ridomil Gold MZ	2,0	5	3,0	5	1500	1	3,66

1 Efficiency, number of pluses;*

*2** Intermediate score.*

Table 4. *Consumer qualities of fungicides, applied at the stage III (from the flowering phase to the time of natural haulm destruction)*

Fungicide	Tuber protection		Resistance to rain		Cost of fungicide		Total score
	1*	2**	1*	2**	rub./hectare	Intermediate score	
Infinito	3,0	5	2,5	5	1297	1,78	3,92
Shirlan	2,5	4	2,5	5	1168	2,35	3,78
Acrobat MZ	2,0	3	2,5	5	1338	1,60	3,20
Abiga Pik	1,0	1	1,0	1	570	5	2,33
Sectin Fenomen	2,0	3	2,0	2,7	1475	1	2,23

1 Efficiency, number of pluses;*
*2** Intermediate score.*

The tables show that, according to the consumer qualities for fungicide preparations, the best fungicides are Shirlan, Acrobat MZ, and Mancoceb (for stage I); Metaxyl, Ridomil Gold MZ, and Infinito (for stage II); and Infinito, Shirlan, and Acrobat MZ (for stage III).

ACKNOWLEDGMENTS
This study was supported by the International Science and Technology Center (ISTC), project #3440.

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