

THE INFLUENCE OF SELECTED ELEMENTS OF METEOROLOGICAL CONDITIONS ON POTATO TUBERS WITH COMMON SCAB

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A b s t r a c t. An attempt to define quantitative relationships between the attack of common scab on 21 varieties of potatoes and selected elements of weather conditions was undertaken. The analysis was based on a field experiment carried out on podzolic soil of loamy sand in Jabłoń, Biała Podlaska voivodeship, Eastern Poland, in the years 1983-1987. It was revealed that the percentage of tubers with common scab more than the degree of the infection was determined by meteorological conditions.

K e y w o r d s: potato, varieties, scab infection, temperature, precipitation

INTRODUCTION

The common scab of potato (*Streptomyces scabies*) is a disease peel and provokes the debasement of seminal quality of seed-potatoes: deterioration of their taste and increase of flesh darkening [4,6,8]. According to Rudkiewicz *et al.* [9,10], scab retards and thins out sprouting, diminishes plant density, and weakens the initial growth. At storage tubers with scab loose water, their consumable quality being reduced; they are attacked derivatively by fungi and putrefactive bacteria [5,6]. Crop loss provoked by scab infection can be defined approximately as 6%. Common scab constitutes a widespread disease; it attacks all potato varieties, however, the degree of scabs seizure of tubers is determined not only genetically, but also by such factors as weather and soil conditions, forecrop type, fertilization [1-5,9-11].

The objective of the present study was to analyse the influence of selected elements of

the field's climate, reproduction sequence of seed-potato material and varieties resistance to *Streptomyces scabies* infection.

MATERIALS AND METHODS

The analysis was carried out on basis of the results of a degenerative experiment in PTR-S Jabłoń in 1983-1987. The experiment was laid out by means of the method of randomized blocks in three replications. Twenty one potato varieties of all earliness and of varied resistance to common scab were examined (Table 1). First-year seed-potato material was superelite. The seed-potato in the second-fifth years of the experiment were received from successive reproduction of the material prepared in the first year. Unsprouted, the tubers were bedded out in early May, spaced 62.5 x 40 cm. Whereas rye constituted the forecrop of potato, organic and mineral fertilization was at a constant level: 25 t of manure, 90 kg N, 90 kg P₂O₅, 135 kg K₂O ha⁻¹.

The reaction of potato varieties to common scab was defined by means of: (a) the percentage of infected tubers; (b) the average degree of scab infection of tubers.

The evaluation of scab infection on tubers was carried out immediately after harvest, on freshly washed tubers. The percentage of infected tubers was defined in respect of weight in a 10 kg test; the degree of their infection by

Table 1. The reaction of potato varieties to common scab

Earliness group	Variety	% of infected tubers		Degree of tuber infection in 9° scale		Resistance to scab in 9° scale **
		Average	V *	Average	V	
Early	Dalia	52	95	7.8	4	6
	Elipsa	40	123	7.9	14	6
	Jaśmin	48	101	7.7	15	6
Medium early	Beryl	60	60	7.5	15	6
	Dukat	68	66	6.6	29	5
	Elida	56	89	7.8	21	7
	Mila	58	92	7.7	13	6
	Pola	59	81	7.4	20	6
Medium late	Atol	57	84	7.6	15	6
	Certa	56	87	7.6	14	5
	Cisa	43	108	7.7	13	5
	Poprad	61	78	7.9	27	7
	Sokół	53	90	7.5	17	6
	Wilga	55	88	7.9	13	5
Late	Bronka	62	76	7.5	13	4
	Janka	75	37	7.3	10	5
	Liwia	65	77	6.7	48	6
	Narew	56	89	7.7	17	5
	Pilica	57	87	7.5	24	5
	Reda	67	68	7.5	28	6
	San	78	64	7.0	19	1

* V - variation coefficient in %; ** - degrees in 9° scale: 9 - the best evaluation, 1 - the worst evaluation.

means of a 9 scale (1 stands for healthy tubers, 9 for 60 % of tuber area with scab symptoms).

On account of significant scatter of results of infected tubers percentage, our statistical analysis was based on values transformed, employing: $y = \arcsin \sqrt{x}$ formula, where x - percentage of tubers with scab. Other working up was realized on actual values. The results were processed statistically by means of multiple and linear correlation and regression. Where as function parameters were defined, using least square method, significance verification by means of t Student test. Initial dependences between *Streptomyces scabies* infection on tubers and reproduction sequence, varieties' resistance to scab, total precipitation and soil temperature (depth 5 cm) in the following periods: 1/5-20/5; 20/5-20/6; 20/5-30/6; 1/6-30/6; 1/6-10/7; 10/6-10/7 as independent variables were estimated by means of simple correlation coefficients. After

their analysis it became evident that the dependences were significant not in all cases; hence, in regression equations it was decided to select only varieties' resistance to scab, soil temperature and precipitations in the following periods: (1) 20th May-30th June, (2) 1st-30th June, (3) 1st June - 10 July.

The influence of selected weather conditions on tubers infection with common scab was examined at the interval of standard deviations from arithmetic mean (Table 2). The regressions defined in Tables 3 and 4 were calculated, employing $y = a + b_j x_j$ formula, where y - an independent variable, a - a free term, b - a regression coefficient value, x - an independent variable. Regression equations were determined separately for each of the following groups of potato earliness: early, medium-early, medium-late, and late in order to define quantitative dependences between intensification of scab occurrence as expressed by the percentage and degree of tubers' infection, and independent variables.

Table 2. Statistical characterization of independent variables (average in the years 1983-1987)

Independent variables			
x ₁	x ₂	x ₃	x ₄
Arithmetic means			
77	17.2	17.8	5.4
Standard deviations			
53	2.0	2.3	3.0

x₁ - total precipitation from 20/5 to 30/6 in mm; x₂ - average soil temperature at the depth of 5 cm from 1/6 to 30/6

RESULTS

In the group of early varieties it was temperature of 1/6 - 30/6 period that determined both the percentage and degree of scab infection. Then, the elevations of soil temperature by a unit in the range of 15.2 to 19.2 °C provoked on the one hand the reduction of the ratio of tubers with *Streptomyces scabies*, on the other hand the increase of infection degree

(values presented in Tables 3 and 4), assuming that other factors in the function model remain at an average level. The resistance of varieties to scab reduced only the weight of tubers with scab. The determination coefficients for both equations amounted to more than 65 % which testifies to their high significance (Tables 3 and 4).

Among the medium-early varieties, the ratio tubers infected with common scab was determined by total precipitation of 20/5 - 30/6 which influenced the reduction of their weight approximately 0.7 % to every 1 mm increase of precipitation in the range of standard deviation from arithmetic mean. The rise of soil temperature at the depth of 5 cm in the period of 1/6 - 30/6 from 15.2 to 19.2 °C contributed to the increase of ratio and degree of tubers infection; values presented in Tables 3 and 4. It is noteworthy that both precipitation and soil temperature at the depth of 5 cm do not

Table 3. Influence of meteorological factors on the incidence of common scab of the potato tubers

Terms of regression equation	Value of regression coefficient			
	Varieties			
	early	medium-early	medium-late	late
Constant regression	82.821	-3.125	-72.035	-698.33
Independent variables in regression equation				
Total precipitation from 20/5 to 30/6 in mm	-	-0.683	-	7.825
Average soil temperature at the depth of 5 cm from 1/6 to 30/6 in °C	-1.028	1.305	-1.526	-5.516
Average soil temperature at the depth of 5 cm from 1/6 to 10/7 in °C	-	-	-	4.001
Resistance of varieties to scab infection in 9° scale	-0.172	-3.362	3.08	-2.035
Determination coefficient in %	67.4	70.1	83.3	71.8

*The lack of data stands for the insignificance of regression coefficient at the level $\alpha = 0.05$.

Table 4. Influence of meteorological factors on the degree of infection of common scab of the potato tubers

Terms of regression equation	Value of regression coefficient			
	Varieties			
	early	medium-early	medium-late	late
Constant regression	-0.028	9.396	-4.989	20.529
Independent variables in regression equation				
Total precipitation from 20/5 to 30/6 in mm	-	-	-	-
Average soil temperature at the depth of 5 cm from 1/6 to 30/6 in °C	0.416	-0.234	0.043	-0.185
Average soil temperature at the depth of 5 cm from 1/6 to 10/7 in °C	-	-	-	0.019
Resistance of varieties to scab infection in 9° scale	0.094	0.295	0.036	0.099
				0.029
Determination coefficient in %	65.4	48.0	83.7	66.0

*The lack of data stands for the insignificance of regression coefficient at the level $\alpha = 0.05$.

constitute the direct cause of the phenomenon in question. In particular with low precipitation, they form favourable conditions for the development of scab on potato tubers. Varietal resistance to scab proved to constitute the factor which reduced most scab occurrence on tubers. The determination coefficients of the ratio of tubers with scab was high and amounted to 70.1 % whereas its value in infection degree was only 48 %, which testifies to the fact that other factors (not included in the function model) also determine the quantity of this feature.

The quantity of scab infection in medium-late varieties proved to be determined by average soil temperature at the depth of 5 cm from 1/6 to 30/6 and by varieties' resistance to the disease. A one-unit rise of soil temperature in the period under consideration (in the range of standard deviation from the arithmetic mean) reduced the ratio of infected tubers, but the degree of scab intensity increased in tubers. The resistance of varieties to scab contributed to the reduction of the occurrence of the pathogen in question. The determination coefficients for both regression equations were very high and amounted to >83 %.

The elements of field's climate expressed the intensity of scab symptoms in late varieties with more determination than the resistance of varieties to the pathogen. The rise of precipitation at the time of the most intensive growth and tuber setting (in the range of 24 to 130 mm) contributed on the one hand to the increase of infected tubers ratio, on the other hand they reduced the degree of infection. From 1/6 to 10/7 the rise of soil temperature (in the range of standard deviation from the arithmetic mean) provoked the reduction of the amount of tubers with scab, but simultaneously it contributed to the degree of the infection of tubers.

DISCUSSION

On the basis of research results conclusions can be drawn about the occurrence and intensity of common scab in potato tubers exclusively in the range of standard deviation

from the arithmetic mean (Table 1). The data presented in our study confirm the findings of Rudkiewicz and Zakrzewska [10] about the slight influence of varieties on scab infection and about the significant influence of environment. From 1/6 to 30/6 the rise of soil temperature at the depth of 5 cm reduced the amount of tubers infected with *Streptomyces scabies*, but simultaneously the pace of disease development (expressed by the degree of tubers infection) increased. While analyzing the correlative dependencies between scab infection in tubers and selected weather elements, Rudkiewicz and Zakrzewska [10] revealed the existence of such a dependence only in the third decade of May and June. The influence of soil temperature on scab development is signalled by numerous authors [3,6,8-10].

The influence of precipitation from 20/5 to 30/6 became evident exclusively in medium-early varieties, contributing to the reduction of scab invasion in potato tubers as well as in late varieties where, on the one hand, it increased the ratio of tubers with the disease, on the other, diminished the pace of scab development. It can be supposed that the rise of precipitation at a time when tuberization develops and the first stage of tuber growth provokes soil saturation with water and stops the pace of disease development, which would correspond to the views of numerous authors [6,7,9]. The dependence in question did not appear in early varieties as they set tubers when plants still use reserves of water after winter, Davis [1] and Lapwood [5] argue that it is possible to diminish completely or significantly common scab infection in tubers by means of soil saturation with water up to the full field capacity or by means of drenching 10 cm soil layer at the time of tuber setting. Kućmierz [3] states that whereas scab develops best in soil of 14 % moisture, it develops less significantly in that of >22 %.

The resistance of potato varieties to common scab constitutes an essential element in controlling the disease, in particular on light soils with a tendency to dry. The resistance of the examined varieties amounted from 1 to 7,

the mean for the group of 21 examined varieties was 5.4 in 9° scale, which indicates their average resistance. Numerous authors [6,7,9] remarked the differences in varietal resistance to the pathogen. While investigating the reaction of 44 Polish potato varieties to selected diseases of tubers' peel, Pietkiewicz and Choroszewski [7] conclude that the dominant varietal group includes averagely susceptible to averagely resistant varieties.

The percentage of infected tubers does not constitute any ideal indicator of tuber infection since it signals only the incidence of infection places; it does not indicate the individual susceptibility of tubers [8], hence it is necessary to use as a criterion the percentage of infected tubers and the degree of the infection to characterize the susceptibility of a variety to scab.

CONCLUSIONS

1. In June the rise of soil temperature at the depth of 5 cm resulted in the increase of common scab infection degree in potato tubers of all varieties and of percentage of infected tubers in medium-early varieties. The rise of temperature from 1/6 to 10/7 diminished the percentage of infected tubers and accelerated the pace of *Streptomyces scabies* infection in late varieties.

2. The increase of precipitation from 20/5 to 30/6 contributed to the reduction of infection degree in late varieties and of the percentage of tubers with scab in medium-early varieties.

3. Whereas the resistance of varieties to *Streptomyces scabies* influenced the decrease of the percentage of infected tubers, it did not limit the degree of the infection.

4. The percentage of tubers with scab symptoms (more than the degree of their intensity) was determined by meteorological conditions.

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WPLYW NIEKTÓRYCH ELEMENTÓW WARUNKÓW METEOROLOGICZNYCH NA PORĄŻENIE BULW ZIEMNIAKA *STREPTOMYCES SCABIES*

Podjęto próbę określenia zależności ilościowych pomiędzy porażeniem bulw 21 odmian ziemniaka parchem zwykłym (*Streptomyces scabies*), a wybranymi elementami warunków meteorologicznych. Analizę wyników oparto na doświadczeniu polowym przeprowadzonym w miejscowości Jabłoń w woj. białkopodlaskim na glebie bielicowej o składzie mechanicznym piasku gliniastego lekkiego w latach 1983-1987. Stwierdzono, że procentowy udział bulw zainfekowanych *Streptomyces scabies* zależał bardziej niż stopień ich porażenia od warunków meteorologicznych.

S ł o w a k l u c z o w e: ziemniak, odmiany, porażenie *Streptomyces scabies*, temperatura, opady.