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THE IMPACT OF DR GREEN FOLIAR FERTILIZATION ON PLANT HEALTH DURING THE GROWING PERIOD AS WELL AS ON THE POTATO YIELD AND QUALITY (JELLY VARIETY)

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ABSTRACT

The potato *(Solanum tuberosum L.)* is one of the four major crops in Poland. In 2013 the area used for potato cultivation in Poland reached 270 thousand hectares. Among the important factors influencing the potato yield and quality are: soil cultivation and protection of plants. One of the most essential factors affecting the potato yield and quality is fertilization. The aim of the field trials carried out in 2014 on experimental potato plots was to determine the effect of dr Green foliar feed nutrients on plant health and on potato quality and yield (Jelly variety). The results of the studies and observations revealed that the application of Dr Green Ziemniak, Dr Green Start and Dr Green Energy foliar feeds favourably affected the quality, yield and structure of Jelly potato tuber crop.

Introduction

The potato *(Solanum tuberosum L.)* remains one of the most important crops in Poland. Potatoes owe their large economic importance to the potato tubers' versatility. The potato is a staple food with high nutritional and dietetic value. Its consumption in Poland is large and exceeds 130 kg per capita (Chotkowski and Rembeza, 2006; Kołodziejczyk et al., 2013). The demand for edible potato varieties results from the increasing consumer requirements as to the quality of tubers. Potatoes intended for direct consumption or food-processing must meet certain quality requirements to ensure food safety standards (Gruczek, 2004).

Potato crop in Poland is relatively low and susceptible to large fluctuations resulting from adverse climate and soil conditions, improper agri-science and weak planting material (Starczewski and Trojanowska, 2001). The edible potato yield and its quality is also related to the number of factors such as: variety, planting time, the conditions during the process of growth, chemical protection, harvest and storing conditions as well as the environment (Zarzyńska, 2000b; Zarzecka and Gasiorowska, 2002; Rytel, 2004b). However, the most important factors that essentially affect potato yield and quality include both soil applied and foliar fertilizers. Foliar fertilization is an intervention procedure considered as the prevention against the decrease in the yield of arable crops, which means, among others, the

reduction in disease pressures of potato blight or Alternaria (Sawicka, 2003; Jarociński and Nowosielski, 2006; Sawicka and Skiba, 2009).

The aim of the single-factor experiment carried out in 2014 in West Pomerania province was to determine the impact of Dr Green foliar fertilization on the potato plant health during the growing period and on potato yield and quantity (Jelly variety).

Subject matter and methodology of research

A major experiment was carried out during the growing period in 2014 in the West Pomerania province. It involved experimental potato plots and was related to the impact of Dr Green foliar fertilization on Jelly potato yield and quality (a late variety). A single-factor experiment was carried out on randomly chosen plots in 4 iterations and in the light acidic sandy clay soil with 1.9% organic matter, low magnesium content and the average content of phosphorus and potassium. The size of an experimental plot was 22.5 m^2. All potato tubers were collected from each object experience to research. The examined variations of the experiment are presented in Table 1.

Table 1.
Variations of an experiment featuring Jelly potatoes and Dr Green fertilisers

Trial variation	Fertilizer *	Dose ($kg \cdot ha^{-1}$)	Date and phase of application	
			End of sprouting	End of row closure
A – mineral fertilization without chemical protection	-	-	-	-
B – mineral fertilization+ chemical protection	-	-	-	-
C – mineral fertilization +chemical protection+foliar fertilization	Dr Green Ziemniak Dr Green Start	2.0	12 June 2014	-
	Dr Green Ziemniak Dr Green Energy	2.0	-	1 July 2014
D – mineral fertilization without chemical protection+ foliar fertilization	Dr Green Ziemniak Dr Green Start	2.0	12 June 2014	-
	Dr Green Ziemniak Dr Green Energy	2.0	-	1 June 2014

* Due to a long-term drought and high temperature, the third application of Dr Green Ziemniak and Dr Green Quality was not implemented.

The scope of the study and the observation included:

- evaluation of the pace of the spread of potato blight (*Phytophthora infestans*) and potato Alternaria (*Alternaria* sp.) in 9-point scale based on the observation of plots in 7-10 day intervals;
- assessment of the impact of the applied fertilizer on the yield and structure of the produced crop:
- marketable yield (tubers with size greater than 35 mm).
- big tuber yield (size 55 mm).

– assessment of crop health (tuber infestation with dry rot – *Fusarium ssp.,* wet rot – *Pectobacterium sp.,* and potato blight – *Phytophthora infestans);*
– evaluation of starch content in tubers on Raihmann-Parow scales;
– evaluation of the blackening of raw tubers in a 9-point scale.

Table 2.
Meteorological conditions during the growing period in 2014

Month	Decade	2014		1981-2010		2014	
		Temperature (degrees Celsius)	Precipitation (mm)	Temperature (degrees Celsius)	Precipitation (mm)	+ /-% long-term data	
						(degrees Celsius)	(mm)
APRIL	1	7.7	31.0	5.8	17.0	+32.8	+82.4
	2	8.4	8.6	6.7	13.8	+25.4	-37.7
	3	13.4	8.6	9.5	12.2	+41.1	-29.5
	The average/total	9.8	48.2	7.3	43.0	+34.2	+12.1
MAY	1	9.3	21.2	11.1	22.9	-16.2	-7.4
	2	12.1	15.2	12.3	25.2	-1.6	+ 39.7
	3	15.6	4.8	13.6	22.5	+14.7	-78.7
	The average/total	12.3	41.2	12.3	70.7	0.0	-41.7
JUNE	1	16.2	22.4	15.1	29.4	+7.3	-23.8
	2	15.0	8.8	14.4	32.6	+4.2	-73.0
	3	14.2	38.0	15.7	34.6	-9.6	+9.8
	The average/total	15.1	69.2	15.1	96.6	0.0	-28.4
JULY	1	20.3	28.6	17.5	29.5	+16.0	-3.1
	2	19.1	2.4	17.7	27.8	+7.9	-91.4
	3	22.6	3.2	17.9	27.3	+26.3	-88.3
	The average/total	20.7	34.2	17.7	84.5	+16.9	-59.5
AUGUST	1	20.8	12.9	18.3	23.5	+13.7	-45.1
	2	16.2	39.7	17.4	26.5	-6.9	+49.8
	3	14.0	20.9	16.3	38.0	-14.1	-45.0
	The average/total	17.0	73.5	17.4	88.0	-2.3	-16.5
SEPTEMTEMBER	1	15.9	13.8	14.4	40.0	+10.4	-65.5
	2	16.7	20.6	12.8	23.1	+30.5	-10.8
	The average/total	16.3	34.4	13.6	63.1	+19.9	-45.4
The average/total in April - September		*15.2*	*300.7*	*13.9*	*445.9*	*+9.4*	*-32.0*
The average/total in June - August		*17.6*	*176.9*	*16.7*	*269.1*	*+5.4*	*-34.3*

The meteorological conditions in 2014 in the first half of the growing period significantly diverged from the average long-term forecasts. From the second decade of April to the second decade of June there was a significant deficit in precipitation. However, no delay in

plant sprouting was observed (sprouting started in the second decade of May and ended at the beginning of June). However, a prolonged deficit in precipitation negatively affected further growth and development of plants (complete closure of rows and formation of flower buds took place only at the turn of June and July). In the second half of the growing period the weather conditions were not conducive to the growth and development of potato plants as well as collecting daughter tubers. Table 2 presents the meteorological conditions with a significant impact on the efficiency of Dr Green fertilization.

During the growing period the potato plants of the tested variety were subject to two chemical procedures aiming at combating weeds, one protective treatment against potato beetles and seven treatments against the potato blight.

Results of the tests

Assessment of the effectiveness in reducing the development of Alternaria and potato blight

The observations revealed that the 2014 growing period was free from high infestation pressure with *Phytophthora infestans*. The first symptoms of blight infestation in Jelly potato were traceable in the second decade of July. These observations suggest that foliar fertilization has beneficial effects on the effectiveness of reduction of the spread of potato blight. The application of Dr Green foliar fertilization in potato cultivation without chemical protection extended the time preceding the destruction of 50% of vines from 72 to 75 days. The level of damage in the assimilation layer of potato plants after the application of foliar fertilizers was much lower than in case of the plants without foliar fertilization and (14.5%) amounted to 5.5%. Table 3 illustrates the pace of the spread of potato blight, the date marking the destruction of 50% of vines, and the level of destruction of the assimilation layer.

Table 3.
The pace of the spread of potato blight, the date marking the destruction of 50 percent of vines and the level of damage in the assimilation layer

Trial variation	The pace of the disease's progression	The destruction of 50 percent of vines	Damage of assimilation layer (%)
A – mineral fertilization without chemical protection	0.081	after 72 days	14.5
B – mineral fertilization + chemical protection	0.045	after 140 days	1.0
C – mineral fertilization + chemical protection+foliar fertilization	0.045	after 140 days	1.0
D – mineral fertilization without chemical protection+ foliar fertilization	0.084	after 75 days	5.5

Table 4.
The pace of the development of Alternaria, the time marking the destruction of 50 percent of vines and the level of damage of the assimilation layer

Trial variation	The pace of the disease	The destruction of 50 percent of vines	Damage of assimilation layer (%)
A – mineral fertilizers without chemical protection	0.094	after 67 days	5.5
B – mineral fertilization + chemical protection	0.084	after 75 days	4.5
C – mineral fertilization +chemical protection+ foliar fertilization	0.065	after 98 days	2.1
D – mineral fertilizers without chemical protection + foliar fertilization	0.065	after 98 days	2.5

The first symptoms of Alternaria in the 2014 growing period manifested themselves in the first decade of August. The smallest pace of Alternaria development was visible in variations involving foliar fertilization (C and D variation – the pace of the development of disease was 0.065). However, the largest rate of Alternaria development was reported for variation A and it amounted to 0.094. Also variations C and D presented the longest time of resistance (98 days) before the destruction of 50% of vines as compared to other variations A (67 days) and B (75 days). Table 4 presents the level of infestation and the date marking the destruction of 50% of vines.

The evaluation of the yield and structure of the crop

The conducted studies suggest a beneficial effect of Dr Green foliar fertilization (Dr Green Ziemniak, Dr Green Start and Dr Green Energy) on the general yield, marketable yield and the yield of large Jelly potato tubers. The increase in the general yield in plants treated with foliar fertilizers in comparison to plants from A variation (mineral fertilization without chemical protection) and B (mineral fertilization with chemical protection) ranged from 7.0 to 9.0 $t \cdot ha^{-1}$ for C variation (mineral fertilization with chemical protection and foliar fertilization) and 5.8 to 6.4 $t \cdot ha^{-1}$ for D variation (mineral fertilization without chemical protection with foliar fertilization).

After the application of Dr Green foliar fertilizer an increase in marketable yield was observed by (tubers with a diameter exceeding 35 mm) 7.6 to 8.9 $t \cdot ha^{-1}$ (13.7-16.5%) for variation C and by 3.6 to 4.9 $t \cdot ha^{-1}$ (6.5-9.1%) for variation D as compared to A and B variations.

Foliar fertilization with Dr Green technology also improved the yield of large tubers (tubers with a diameter exceeding 55 mm) of Jelly potato. The general yield, marketable yield and the crop of large potato tubers is shown in Figure 1.

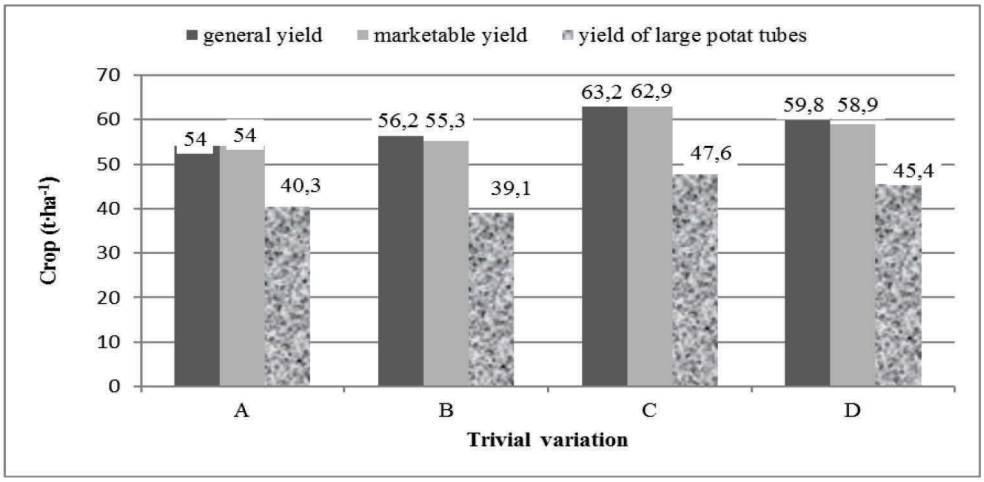

Figure. 1. The potato yield and structure for Jelly potato variety

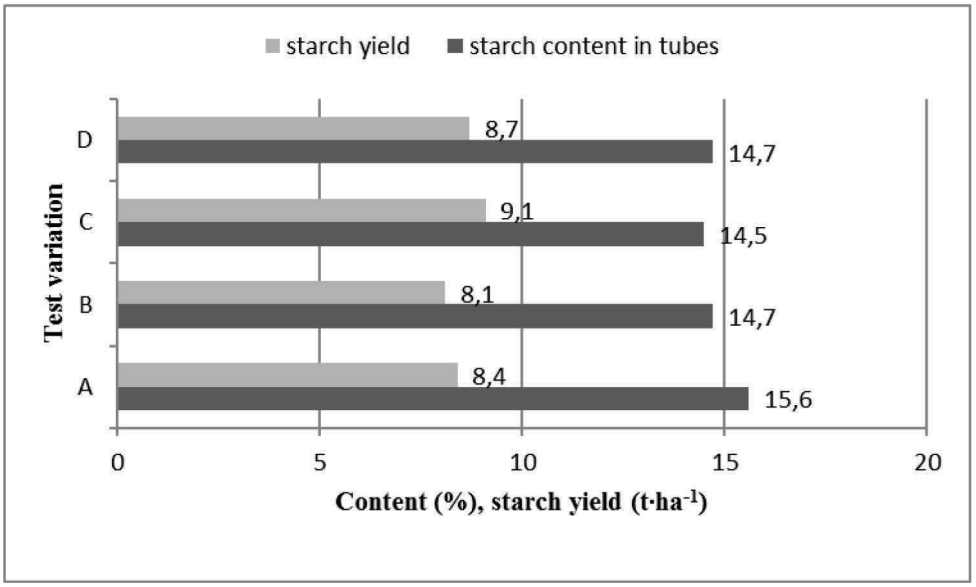

Figure. 2. Yield (t·ha^{-1}) and the content (percent) of starch in Jelly potato tubers

The assessment of the crop's health

After a 1.5 month of storage no symptoms of dry or wet rot was found on Jelly potato tubers. No sign of potato blight was observed in variations C and D. The rot infestation rate in A and B variations was 1.4 percent for wet rot, potato blight and 4.1 percent for dry rot and 1.4% for wet rot and 1.1% for potato blight and 1.9% for dry rot, respectively.

The content of starch in tubers and starch yield

According to COBORU, the average starch content in the Jelly potato variety is 14.3%. In the 2014 growing period due to the weather conditions the starch content in the tubers of the trial variations was significantly higher and ranged from 14.5% for C variation to 15.6% for A variation. The average starch yield per 1 hectare ranged from 8.1 $t \cdot ha^{-1}$ for variation B and 9.1 $t \cdot ha^{-1}$ for variation C. The average starch yield ($t \cdot ha^{-1}$) and starch content (%) in Jelly potato variety is shown in Figure 2.

Conclusions

1. The study carried out in the 2014 growing period revealed that the application of Dr Green Ziemniak, Dr Green Start and Dr Green Energy foliar fertilizers favourably affected the yield and structure of tubers of the Jelly potato variety.
2. A beneficial effect of foliar fertilization with Dr Green Potato, Dr Green Start and Dr Green Energy fertilizers was observed in the context of the yield quantity as was compared with A and B variations.
3. After 6 weeks of storage no symptoms of the following were observed in potato tubers of the Jelly variety: no wet, dry rot nor potato blight in variations C and D. The rot infestation rate in A and B variations amounted to 1.4% for wet rot, potato blight and 4.1% for dry rot (A variation) and 1.4% for wet rot, 1.9% for dry rot and 1.1% for potato blight (B variation).
4. In the 2014 growing period due to the weather conditions the starch content in tubers was insignificantly higher and in all test variations amounted 14.5-15.6%.

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WPŁYW NAWOŻENIA DOLISTNEGO TECHNOLOGIĄ DR GREEN NA ZDROWOTNOŚĆ ROŚLIN W CZASIE WEGETACJI ORAZ WIELKOŚĆ I JAKOŚĆ PLONU ZIEMNIAKA ODMIANY JELLY

Streszczenie. Ziemniak *(Solanum tuberosum L.)* jest jedną z czterech najpopularniejszych roślin uprawnych w Polsce. Wielkość produkcji ziemniaka w 2013 roku w kraju wynosiła ponad 270 tysięcy hektarów. Istotnymi czynnikami kształtującymi wielkość i jakość plonów ziemniaka są między innymi uprawa roli i ochrona plantacji. Jednakże do najważniejszych czynników mających podstawowe znaczenie w kształtowaniu ilości i jakości uzyskiwanego plonu ziemniaka jest nawożenie. Celem przeprowadzonych w 2014 roku doświadczeń mikropoletkowych było określenie wpływu nawożenia dolistnego technologią Dr Green na zdrowotność roślin oraz na jakość i wielkość plonu ziemniaka odmiany Jelly. Uzyskane wyniki badań i przeprowadzonych obserwacji wykazały, że dolistna aplikacja nawozami Dr Green Ziemniak, Dr Green Start oraz Dr Green Energy korzystnie wpłynęła na jakość, wielkość i strukturę plonu bulw badanej odmiany ziemniaka.

Słowa kluczowe: ziemniak, nawożenie dolistne, technologia Dr Green