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THE RECOVERY EFFECT FROM VIRUS DISEASES OF HOP PLANT (*Humulus lupulus* L.) ON THEIR GAS EXCHANGE, LEAF AREA AND YIELD FORMATION [1]

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Introduction

The effective utilisation of the hop plant biological capacity is close-knit with their health status. The viruses are only one group from the series of important pathogenic micro-organisms which make use of the metabolism and the energy system of the infected host plants. Their colonization is an irreversible process [SVOBODA 1991]. Their presence in hop plants decreases the yield and the quality of the hop cones, namely in the case when their presence is not accompanied by visual symptoms [KROFTA, KROUPA 1995]. The methods of meristem cultures and heat therapy are utilized for the hop plant recovery, but not for the full elimination of viruses [ADAMS 1975; SVOBODA 1992].

The aim of the study is to describe the effect of the recovery from the virus diseases on improvement of the physiological characteristics of the traditional old Czech hop plant varieties.

Material and methods

The hop plants cultivated from the isolated apical meristems by the method *in vitro* culture (hop plants recovered from virus diseases) and the non-recovered hop plants of the saaz semi-early red-bine Osvald's clone 72 variety were studied in an experimental hop garden in the Czech hop-growing region in years 2000–2001. The net photosynthetic rate, the photosynthetically active leaf area (vine leaves and axil leaves), the dry matter of vine, leaves and the yield formation of cones was assessed during their growing season in the selected phases of the the hop plants ontogeny. The presence of viruses was evaluated by ELISA test. The parameters of the net photosynthetic rate (P_N in mmol $CO_2 \cdot m^{-2} \cdot s^{-1}$) were measured in three compartments of the hop plants on photosynthetically active leaves using the infrared analyser of gas exchange LCA-4 (ADC Bio Sci-

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entific). Presented results are an average of the measured values. The statistical evaluation was done by the computer program Statgraphics. The relation between the yield formation physiological factors and the phases of the hop plants ontogeny was determined by the regression analysis.

Results and discussion

The Osvald clone 72 is the Czech classical variety of the finely aromatic hop but the non-recovered plants from virus diseases have a low yield. The breeding methods of hybridization bring the growth of the yielding capacity but the new varieties are significantly different from the present variety representation [RÍGR, BERÁNEK 1995].

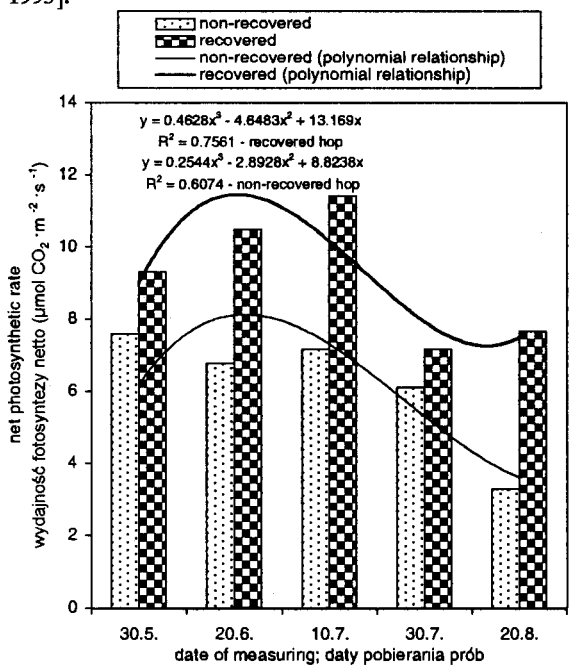

Fig. 1. Net photosynthetic rate of hop plants during growing season of hop (μmol $CO_2 \cdot m^{-2} \cdot s^{-1}$)

Rys. 1. Wydajność fotosyntezy netto roślin chmielu w okresie wzrostu (μmol $CO_2 \cdot m^{-2} \cdot s^{-1}$)

The hop plants recovery from virus diseases elongated the period of leaf photosynthetic activity as we can demonstrate on our experimental results - measurements of the net photosynthetic rate (Fig. 1) and the leaf area (Fig. 2 and 3) during vegetative season. On the contrary, the presence of viruses reduced the growing season in the non-recovered hop plants. The influence of this biotic stress factor accelerated the accession to the generative phase of development and at the same time shortened the time period of the hop cone formation. Our results support the conclusion that the virus-free hop plants give higher yield (Fig. 4 and 5) valuated by the total dry matter of hop plants consistent results were achieved (Fig. 6, 7).

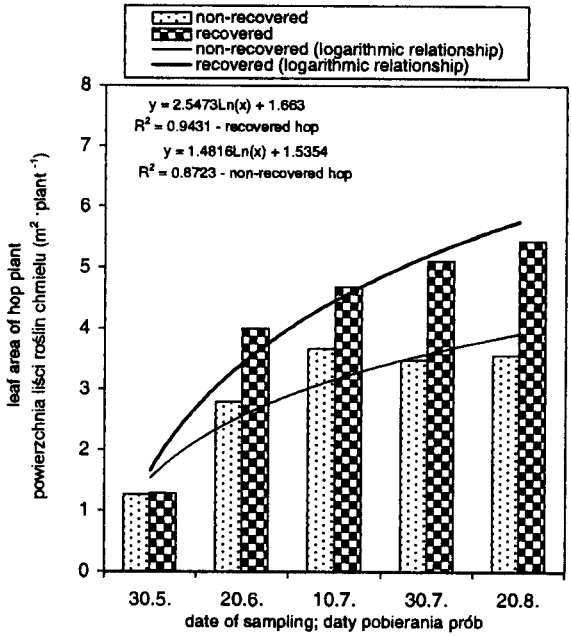

Fig. 2. The leaf area of hop plants during growing season of hop in the year 2000 ($m^2 \cdot plant^{-1}$)

Rys. 2. Powierzchnia liści roślin chmielu w okresie wzrostu w roku 2000 ($m^2 \cdot rośl.^{-1}$)

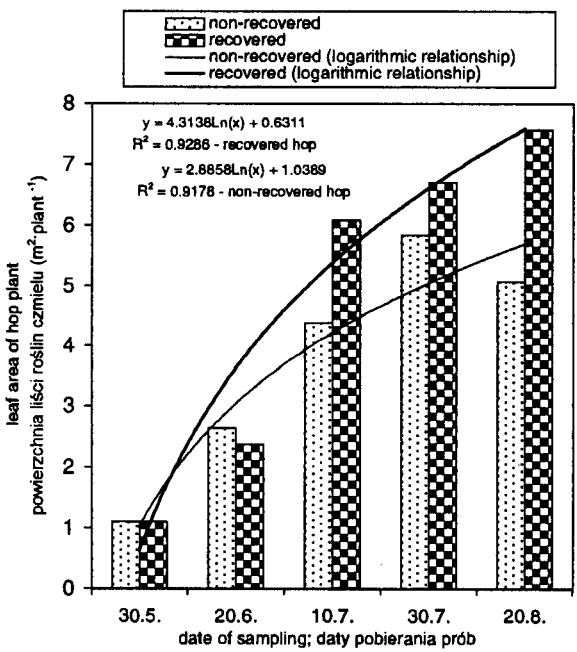

Fig. 3. The leaf area of hop plants during growing season of hop in the year 2001 ($m^2 \cdot plant^{-1}$)

Rys. 3. Powierzchnia liści roślin chmielu w okresie wzrostu w roku 2001 ($m^2 \cdot rośl.^{-1}$)

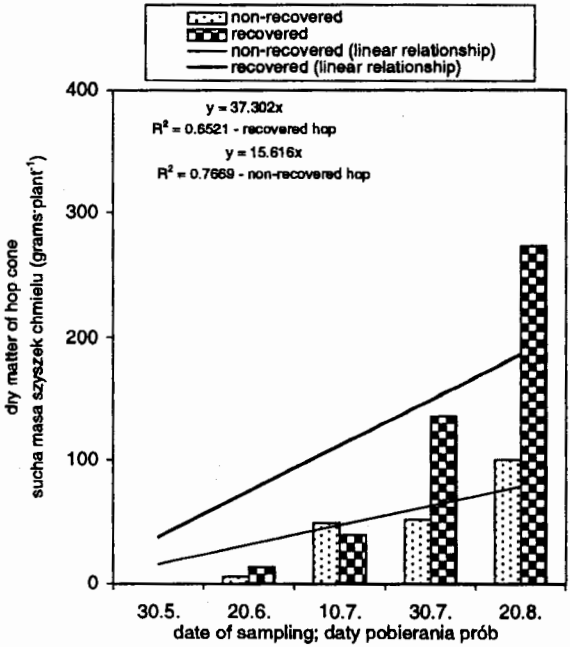

Fig. 4. The yield formation of hop cones during growing season of hop in the year 2000 (g·plant^{-1})

Rys. 4. Kształtowanie się plonu szyszek chmielu w okresie wzrostu w roku 2000 (g·rośl.$^{-1}$)

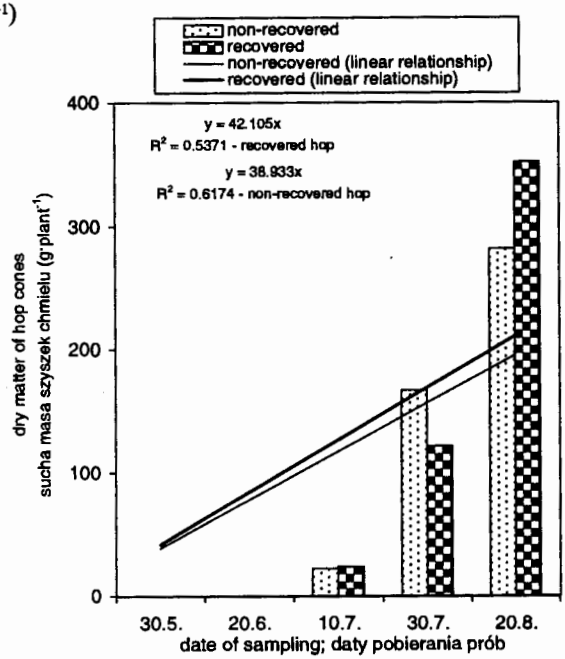

Fig. 5. The yield formation of hop cones during growing season of hop in the year 2001 (g·plant^{-1})

Rys. 5. Kształtowanie się plonu szyszek chmielu w sezonie roku 2001 (g·rośl.$^{-1}$)

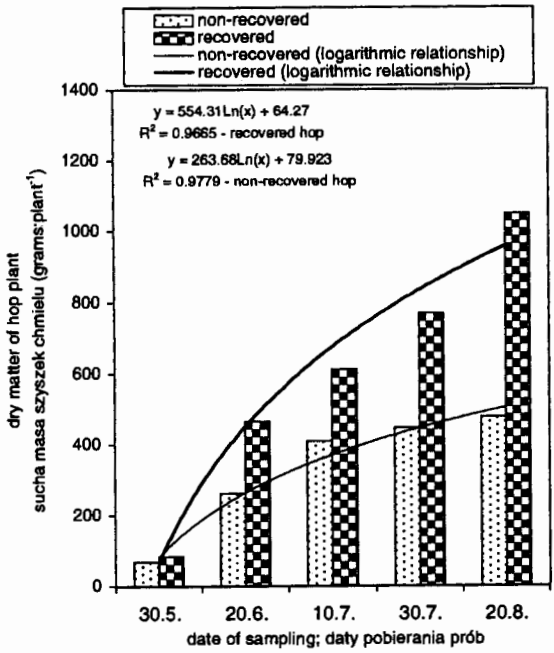

Fig. 6. The dr matter formation of hop plants during growing season of hop in the year 2000 (g·plant^{-1})

Rys. 6. Tworzenie suchej masy roślin chmielu w okresie wzrostu w roku 2000 (g·rośl.$^{-1}$)

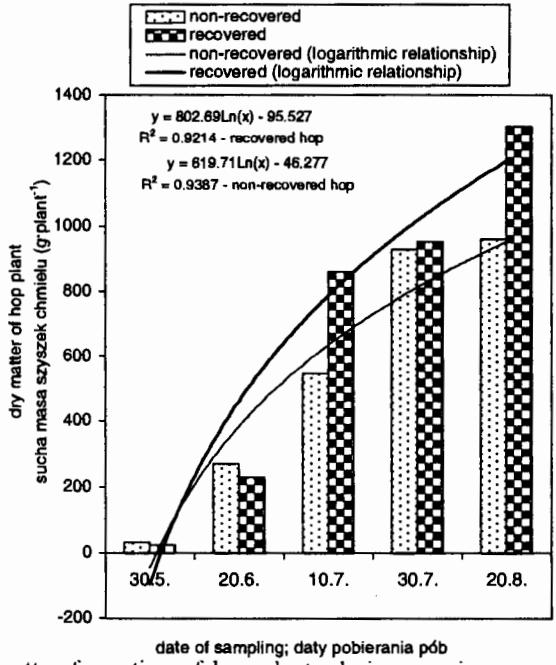

Fig. 7. The dry matter formation of hop plants during growing season of hop in the year 2001 (g·plant^{-1})

Rys. 7. Tworzenie suchej masy roślin chmielu w okresie wzrostu w roku 2001 (g·rośl.$^{-1}$)

The results of KROFTA and KROUPA [1995] similarly proved that the virus-free hop plants gave higher yield. The virus-free hop plants had a considerably higher content of α-bitter acids than the non-recovered hop plants. The hop bitter acids and the hop oil analyses proved that the virus-free hop plants hold most of their typical genetic features of saaz semi-early red-bine hop.

Conclusions

The virus-free hop plants of Osvald clone 72 give a higher yield with the higher quality than the non-recovered plants and hold most of their typical genetic features of saaz semi-early red-bine hop. The knowledge of the physiological rules of the growth and the production processes in this virus-free hop plants is very important for further enlargement of the virus-free hop garden area in the Czech hop-growing region. The results of our research proved the difference between the recovered and the non-recovered hop plants which was demonstrated by the different terms of the decisive developmental phases beginning (critical periods) that are important for the hop cone yield formation. The acquired information is very well applicable in the period of the preparation of the virus-free hop growing technologies and in the process of plant breeding.

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Key words: hop plants, recovery, gas exchange, leaf area, yield formation

Summary

The aim of the presented study is to demonstrate the recovery effect from the virus diseases on improvement of physiological characteristics and the yield formation of the saaz semi-early red-bine Osvald clone 72 plants, the Czech classical variety of the finely aromatic hops.

The recovered and the non-recovered hop plants were studied in the experimental hop garden in the Czech hop-growing region in years 2000 and 2001. The photosynthetically active leaf area (vine leaves and axil leaves), the net photosynthetic rate, the dry matter of vine, the leaves and yield formation of cones were assessed during a growing season in the selected phases of the hop plants ontogeny. The presence of viruses shortened the growing season of the non-recovered hop plants. The influence of the biotic stress factor accelerated the accession to the generative phase of their development and at the same time shortened the time period of the hop cone creation. The hop plant recovery elongated the period of photosynthetic activity of leaves and formation of hop cones. The virus-free hop plants gave higher yield. The recovered and the non-recovered hop plants have a different accession to the critical developmental periods important for the hop cones yield formation. The acquired information is very well applicable in preparation of the virus-free hop growing technologies and in the process of plant breeding.

BADANIE WYMIANY GAZOWEJ, POWIERZCHNI LIŚCI ORAZ PLONOWANIA ROŚLIN CHMIELU (*Humulus lupinus* L.) PO PRZEBYTEJ INFEKCJI WIRUSOWEJ

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Słowa kluczowe: chmiel, wymiana gazowa, powierzchnia liści, plonowanie szyszek

Streszczenie

Celem prezentowanej pracy było wykazanie wpływu stanu po-infekcyjnego wywołanego chorobą wirusową na niektóre parametry fizjologiczne oraz plonowanie 72 roślin chmielu średnio wczesnego klonu klasycznej, bardzo aromatycznej czeskiej odmiany Osvald.

Doświadczenie przeprowadzono na roślinach po-infekcyjnych i wcześniej nie infekowanych, ale wykazujących obecność wirusa, w eksperymentalnym ogrodzie znajdującym się w czeskim regionie uprawy chmielu w latach 2000-2001. Fotosyntetycznie aktywna powierzchnia liści, wydajność fotosyntezy netto, sucha masa, formowanie się liści i plonowanie szyszek mierzono podczas sezonu wegetatywnego w wybranych fazach ontogenezy chmielu. Obecność wirusa skracała okres wzrostu roślin wcześniej nie infekowanych. Wpływ stresora biotycznego przyspieszała wejście w fazę generatywną i skrócenie okresu powstawania szyszek. Rośliny będące w stanie po-infekcyjnym charakteryzowały się wydłużonym okresem aktywności fotosyntetycznej liści i formowania szyszek. Rośliny wolne od

wirusa wydawały wyższy plon. Rośliny pozbawione wirusa i wykazujące jego obecność różniły się tempem wchodzenia w okresy krytyczne, istotne dla plonowania szyszek. Nabyte informacje mogą być przydatne w technologii uwalniania roślin chmielu od wirusa oraz w pracach hodowlanych.

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