MEDIUM CONTENT OF HEAVY METALS IN SOIL MAY PARTIALLY COMPENSATE DEVELOPMENT OF VIRAL INFECTIONS IN PLANTS

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Abstract

Increased heavy metals' content is clearly observed in environment nowadays leading to various physiological changes of plants. Due to wide-spread pollution of Ukrainian soils with heavy metal compounds, purpose of the work was to study relations between presence of heavy metals in soil and their effect on development of viral infection in plants. *Nicotiana tabacum* – potato virus X (PVX) model system has been used. Soluble salts of metals (Cu, Zn and Pb) were deposited in soil separately in the one-fold maximum permissible concentrations. Dynamics of chlorophyll content was shown colorimetrically by Arnon's method. Virus accumulation in plants was surveyed by indirect ELISA. Infected plants grown on non-amended soil showed symptoms of disease on 16 days post infection (dpi) as well as plants grown on soil with metals deposited. Surpisingly, combined effect of heavy metals and virus infection caused an increase of chlorophyll content comparing with intact plants, and partially compensated the effect of virus infection on experimental plants. Moreover, chlorophyll concentration in infected plants grown on soil with metals deposited was much more stable in time. Decrease of chlorophyll content after 47 dpi correlated with gradual increase of virus concentration in infected plants. This data shows that increase of heavy metals' content in soil up to the limiting concentrations may compensate effects of biotic stress caused by virus infection on plants.

Introduction

Due to intensive industry development, increased heavy metals' content is clearly observed in environment nowadays. Therefore, agrocenoses are seriously affected by stresses both of biotic and abiotic nature. Increase of heavy metals' content leads to various physiological changes of plants. Increasing of heavy metals' concentration as a factor of chemical pollution may lead to common, low-specific physiological and biochemical changes in plants, the most common from them could be membranes' damages, changes in enzymes' activity, inhibition of roots' growth, etc (Barcelo, Poschenrieder, 1990; Foy et al., 1978). Virus infection can be an inductor of biotic stresses in plants. The result of these interactions may be almost the same. Owing to serious pollution of Ukrainian soils with heavy metal compounds, purpose of the work was to study relations between presence of higher content of heavy metals in soil and their effect on development of phytoviral infection.

Methods

Experiments were conducted in *Potato virus X* - *Nicotiana tabacum* cv. trapeson plants. Copper, lead and zinc were deposited in pot soil in form of soluble salts ($CuSO_4x5H_2O$, $ZnSO_4$, $PbNO_3$) (Kabbata-Pendias, Pendias, 1986) in concentration corresponding to the estimated level of maximum permissible concentrations (MPC) determined for these metals in Ukrainian soils (Kostyshyn et al., 1995). Plants were mechanically inoculated with PVX in concentration of 50 μg/ml. Virus concentration in plant extracts has being determined every week during the experiment by indirect ELISA with polyclonal rabbit antiserum to PVX, as described in (Crowther, 1995). Chlorophyll concentration has being measured by Arnon's method (Wellburn, 1994) simultaneously with determining of virus content in plants.

Results and discussion

The point of these experiments was to reveal a separate effect of every single heavy metal tested on the development of plant virus infection, and to show possible changes in chlorophyll concentration that actually reflect photosynthetic activity and condition of a plant in general.

Results of the experiments showed that symptoms on virus-infected plants have been developed by 16 day post infection (dpi) independently from depositing (or not depositing) of heavy metal salts in the soil. There were typical PVX symptoms of mild mosaic with following black ringspots on tobacco plants (Fig.1). Analysis of chlorophyll content's dymanics demonstrated that, in the absence of heavy metals, virus-infected plants accumulated less total chlorophylls comparing to intact non-infected plants (Fig.2).

As it was revealed (Ulynets et al., 2001), inhibition of photosynthetic activity is shown to be a characteristic distinguishing feature of systemic virus infection at the level of plant organism. Contrary, in the absence of virus infection, plants growing in soil with deposited heavy metal had higher chlorophyll content in comparison with healthy plants w/o metal added (Fig.3). Moreover, all infected plants growing in deposited soil demonstrated higher content of chlorophylls comparing to even intact ones (no virus, no metal) (Fig.4). This means that, surprisingly, combined effect of heavy metal together with virus infection caused an increase of chlorophyll concentration in experimental plants. Decrease of chlorophyll content after 47 dpi correlated with gradual increase of virus concentration in infected plants.

Fig. 1. Typical PVY symptoms on Nicotiana plants.

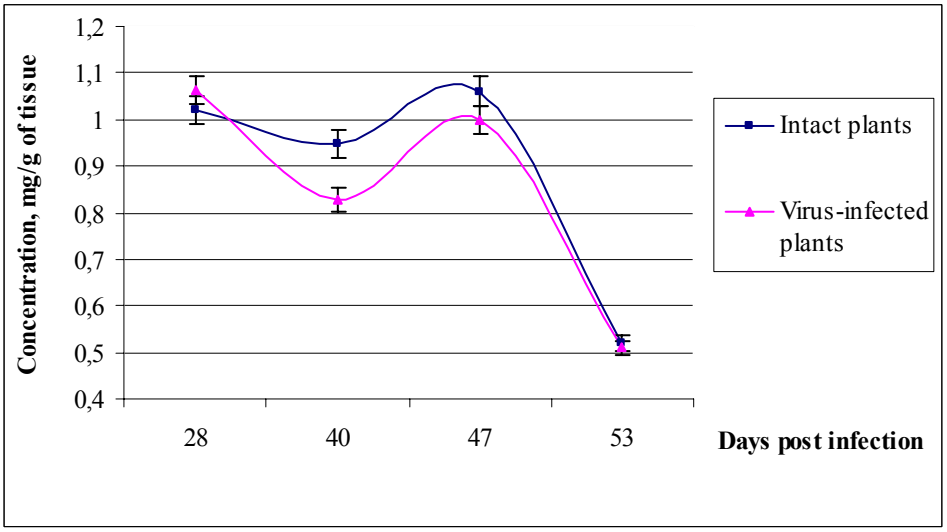

Fig.2. Total chlorophyll content in virus-infected plants.

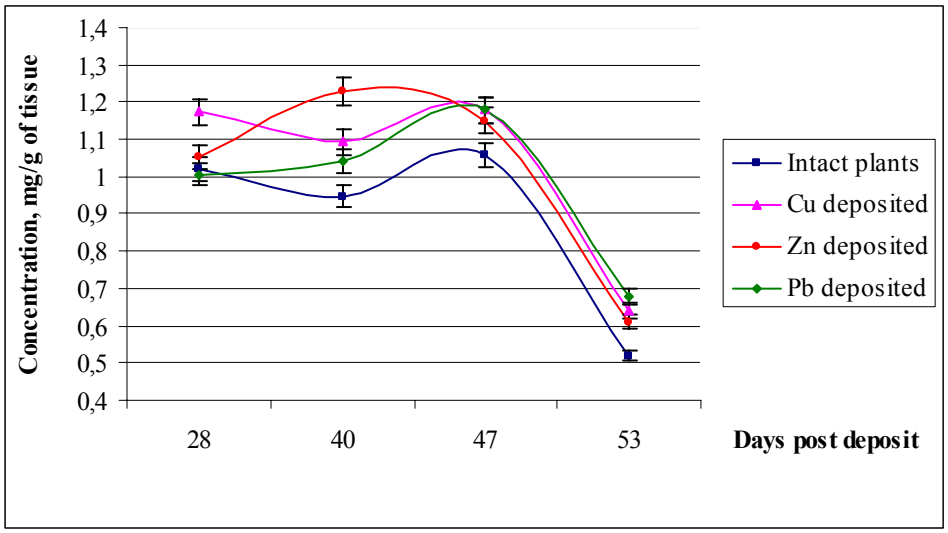

Fig.3. Total chlorophyll content in plants grown in soil polluted by heavy metals in MPC.

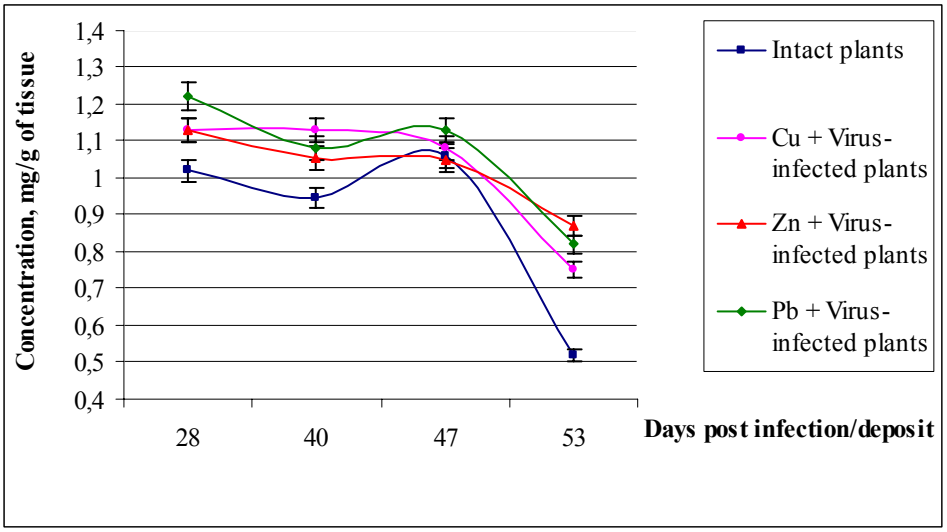

Fig.4. Total chlorophyll content in virus-infected plants grown in soil polluted by heavy metals in MPC.

Conclusion

Decrease of chlorophyll content in plants grown in soil polluted by heavy metals correlated with gradual increase of virus concentration in infected plants.

Presence of separate heavy metals in concentration close to MPC partially compensated the impact of virus infection on plants.

Slight increase of some heavy metals' content in soil may grade in part the influence of the biotic stress caused by plant virus infection.

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