Inhibition of *Solanaceae* Plants by Combined Effect of Increased Concentrations of Heavy Metals and Viral Infection

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Abstract

On plants of a *Solanaceae* family cultivated on a ground with increased concentrations of metals (Cu = 10; Pb = 21.5; Zn = 13.2 mg/kg) was shown both propagation and development depressing and decreasing of common protein. The superposition of a virus infection (TMV, PVX) results in considerable accumulation of viruses and early plants death. The contamination of soil by heavy metals results in plants propagation and development depressing, that in turn entails considerable development of viral and other infections resulting in crop losses.

Keywords: phytoviral infections; *Solanaceae;* biotic and abiotic stress; *Nicotiana debneyi*; heavy metals pollution

INTRODUCTION

Similar stressful situations of an abiotic nature are imposed on biotic stresses (e.g. viral infections) and in a complex may result substantial damages (GARMASH 1989; KABBATA-PENDIAS & PENDIAS 1986).

Our investigations have shown uneven pollution Ukraine agrocenosis by heavy metals, as well as unequal abundance of phytoviral infections. In laboratory conditions we have simulated and studied developed of phytoviral infections influenced by heavy metals concentrations some as in polluted regions.

MATERIALS AND METHODS

From three regions of Ukraine: Volyn region (Shatsk National Park); Kyiv region (Boguslav area); Kharkiv region (area of Zmeevska Power Plant) the samples of *Solanaceae* agricultural plants *(Lycopersicon esculentum, Solanum tuberosum, Nicotiana tabacum)* and weeds (*Solanum nigrum, Datura stramonium, Hyoscyamus albus*) has been collected for analyzing using immunoferment assay (ELISA) (CROWTHER 1995), electronic microscopy (ROBERTS 1996) and biological testing. Also soil samples for heavy metal content investigation in arable player using atomic adsorbence spectroscopy (AAS) (NEDRA 1986) has been collected.

In diagnosis were used antiserums against the following RNA-content viruses for different taxonomical groups: *Burley yellow dwarf virus* (BYDV, *Luteovirus*) – Moscow State University, Russia; *Sugar beet mosaic virus* (BMV, *Potyvirus*) – Moscow State University, Russia; *Potato virus Y* (PVY, *Potyvirus*) – ICM, Ukraine; *Tobacco mosaic virus* (TMV, *Tobamovirus*) – Russia; *Cucumber mosaic virus* (CMV, *Cucumovirus*) – ISM Ukraine.

Heavy metals and viral infections influence on experimental plans total protein content was studied accordingly Bradford (DAWSON *et al*. 1991).

RESULTS

Investigations on heavy metals such as cadmium, lead, copper, zinc, nickel in soils of mentioned regions have shown their different concentration (Figure 1). Kyiv and Volyn region has almost equal heavy metal content in soils, while Kharkiv region had remarkable concentrations of these heavy metals, although consuming capacity in Kharkiv and Kyiv region almost at the same level. Increased heavy metals level in Zmeevska Power Plant area (Kharkiv region) obviously concerned with hydro power plant activity, while Volyn agrocenosis located on the National Park territory, as for Kyiv region any substantial anthropogenic distortions were not observed (POLISCHUK *et al*. 1998).

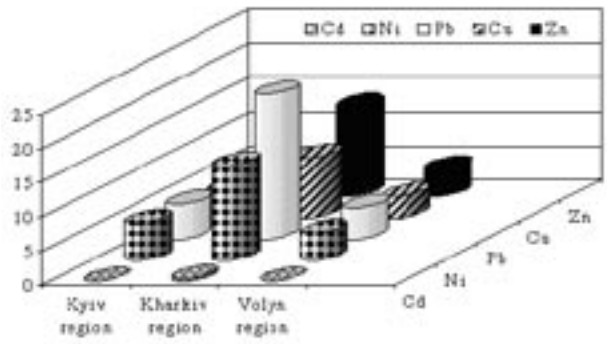

Figure 1. Microelements concentration in soils (mg/kg), tested on phytoviral antigenes presence

Analysis of these regions on virus antigens presence reveals more often occurrence of TMV, BMV, CMV and PVY (Figures 2 and 3). Accordingly with heavy metals, adsorption of virus particles also depends on the soil features such as mechanical compounds, pH, humus horizon, etc. Analyzing virus content detected in Volyn region compare with Kyiv and Kharkiv region it was observed significantly less antigens concentrations due to the mechanical compounds differences, also, probably, due to the anthropogenic pressure absence. This tendency observed both for agrocenoses and wild landscapes areas. Although, compare virus antigens concentrations in Kyiv and Kharkiv regions we can see higher concentration in Kharkiv, contrary to the same mechanical soil content and the consuming volume.

In series of experiments on TMV – *Nicotiana tabacum* and PVX – *Datura stramonium* modeling systems cases of planting in soils with different heavy metals concentrations were analyzed. The results of visual observing has shown absolutely normal outlook on control plants, whereas, plants grown on soils with heavy metals have grows inhibition. Plants infected with virus, rises virus infection symptoms (leaves deformation, enations, yellowing) in two weeks. Plants grown on the polluted soil and infected with virus demonstrated high growth decreasing virus infection symptoms in ten days (earlier then pollutant-free) and died 20 days after infecting.

Testing of experiment plants on TMV antigens reveals its absence for control and grown on soils with heavy metals addition plants. Whereas, in infected plants grown as on polluted as on clear soils virus antigens were detected plenty. Also, plants grown on clear soils have higher virus concentrations then the same ones grown on soils with heavy metals addition. Comparing these results with virus infection and heavy metals addition influence on plants common wealth it may be considered that simultaneous affect of viruses and heavy metals leads to the worse physiological state, and consequently decreases virus infection development and total virus concentration in plant.

We believe, the results of these model experiments show increased virus contamination of plants from environment on soils polluted by heavy metals due to inhibition of physiological activity (immune state), so, making possible virus infection development and secondary soils contamination by viruses.

In the following experiments with TMV – *Nicotiana debney* model system the effect of copper, lead and zinc in concentrations estimated for Kharkiv region (Zmeevska Power Plant area) on plant growth and development with simultaneous virus infection has been studied.

DISCUSSION

On plants of a *Solanaceae* family cultivated on a ground with increased concentrations of metals was shown both propagation and development depressing and decreasing of common protein. The superposition of a virus infection (TMV, PVX) results in consider-

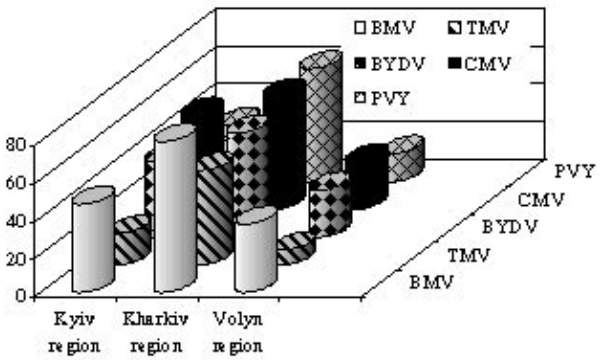

Figure 2. Agrocenosis ivestigation results of different Ukraine regions on plant viruses antigenes presence

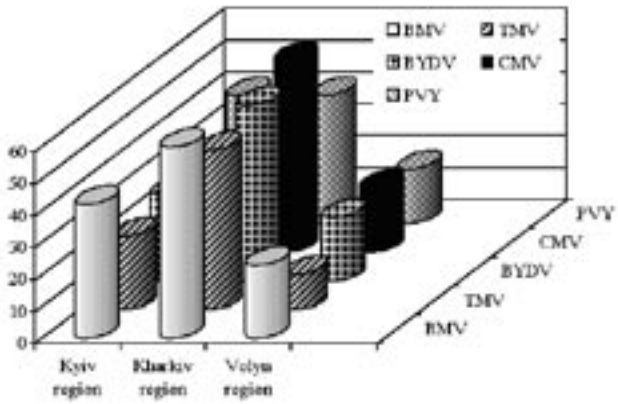

Figure 3. Ivestigation results for wild landscapes in different regions of Ukraine on phytoviral antigenes presence

able accumulation of viruses and early plants death. The contamination of soil by heavy metals results in plants propagation and development depressing, that in turn entails considerable development of viral and other infections resulting in crop losses.

Considering achieved results and known literature data (ALLEN 1984; BARCELO & POSCHENRIEDER 1990; KEGLER & SPAAR 1995; KOENIG 1988) one can formulate common rules of environment pollution effect on plant viruses. Pollutant from environment is able to affect soil (due to pH, metal ions concentration, organic substances concentrations, humidity and soil fermental activity changes), plants ontogenesis leading to plants immune state changes, interaction processes between virus and plant or virus and vector, or directly affect virus particles. Simultaneous or separate these factors effect may cause formation of new viruses, even more pathogenic or change their infectivity.

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