EFFECTS OF DIFFERENT INDUSTRIAL WASTES ON THE PLANT GROWTH AND DEVELOPMENT IN THE AGRO-ECOSYSTEM

BRIGITTA TÓTH[1] – NÓRA BÁKONYI[1] – SZILVIA VERES[1]

1 Department of Agricultural Botany and Crop Physiology, Institute of Plant Sciences, University of Debrecen, 4032 Debrecen, Böszörményi út 138. Hungary, btoth@agr.unideb.hu

Abstract:
An agro-ecosystem can be characterized by a much simple composition of species living in the given system and by a simpler energy flow than a natural, stable ecosystem. Unthinking use of pesticides disturbs this balance due to the poisonous effect on several organisms in the soil.
The aim of this work is to give a brief overview of the effects of some industrial wastes (flue-gas dust, extruded poppy-heads). These materials contain lots of useful elements for plants (e.g. potassium, iron, phosphorous). But, their aluminium and chrome contents also are considerable. The dry matter accumulation and relative chlorophyll contents were measured.
The flexibility of plant responses depends on composition, origin of examined wastes. Disadvantageous and advantageous physiological effects of flue-gas dust and extruded poppy-heads were proved. The compensation effect of environment is excluded, however, the neutralisation of environment loads are not endless among natural circumstances.

Keywords: industrial wastes, plant growth and development

Introduction

Agro-ecosystem sustainability depends on the ability of farmers to maintain soil productivity. As plant nutrition issues are redefined by society, new applications emerge for a basic understanding of nutrient use-efficiency in soil-plant processes to avoid excess on rich soils (van Noordwijk, 2001). Over-application of fertilizers in poorly managed cropping systems can result in serious environmental problems, such as pollution of groundwater and eutrophication of surface waters (Socolow, 1999). In many developing countries with a tremendous requirement for food, continuous nutrient is flat and low usage of mineral fertilizers is the concerns, not the environmental pollution (Gruhn et al., 2000).

The global crisis in micronutrient deficiencies is the result of dysfunctional food systems that cannot deliver enough of these nutrients to meet the nutritional requirements of all throughout the year. Because agriculture is the primary source of all micronutrients for humans, agricultural systems must be contributing to this failure to meet nutritional needs (Welch et al., 1997). How can agriculture be change in ways that will result in enough micronutrient output of farming systems to assure adequate nutrition for all? Importantly, if agricultural technologies are directed at improving the nutritional quality of food crops, they must encompass a holistic food system perspective to assure that the planned interventions will be sustainable, and agriculture sector must adopt a specific goal of improving human nutrition and health, and the nutrition and health sectors must adopt agricultural interventions as primary tools to fight this growing crisis. All operation and methods, which try to reduce the pollution of food chain, have a main role in our life (Lévai et al., 2008).

[Ide írhatja a szöveget]

Materials and methods

Sunflower *(Helianthus annus L. cvs. Arena)* were used in the experiments. The seeds were sterilized with 18% hydrogen peroxide, and then washed in distilled water. Then they were germinated on moistened filter paper at 25 ^{o}C. The seedlings were transferred to continuously aerated nutrient solution of the following composition: 2.0 mM $Ca(NO_3)_2$, 0.7 mM K_2SO_4, 0.5 mM $MgSO_4$, 0.1 mM KH_2PO_4, 0.1 mM KCl, 1μM H_3BO_3, 1μM $MnSO_4$, 0.25 μM $CuSO_4$, 0.01 μM $(NH_4)_6Mo_7O_{24}$. Iron was added to the nutrient solution as Fe-EDTA at a concentration of 10^{-4}M. The filtrates of flue-gas dust and extruded poppy-heads were added to the nutrient solution in different quantities. 82 ml dm^{-3} was given from the flue-gas dust and 91 ml dm^{-3} from the extruded poppy-heads to the nutrient solution because of different solution. The seedlings were grown under controlled environmental conditions (light/dark regime 10/14 h at 24/20 ^{o}C, relative humidity of 65–70% and a photosynthetic photon flux of 390 $mEm^{-2}s^{-1}$. The number of repetitions was three. The contents of elements were measured with ICP, the relative chlorophyll contents with SPAD 502 (Minolta). The samples were dried at 85 Cº, the dry matter of shoots and roots were measured.
The flue-gas dust originated from Hajdu Komm Environmental Protection Ltd. (Eastern Hungary) and the extrusion poppy-head came from Alkaloida Chemicals Co. Ltd. (East Hungary).

Results and discussion

The examined matters were produced in large quantity by the above-named companies. These materials contain lots of useful elements for plants (e.g. potassium, phosphorus, iron) and some harmful elements in addition (e.g. chrome, aluminium). The plants can uptake these elements and may cause different effects on the development and growth of plants. The up taken elements are shown in the Table 1.

Table1. Concentration of examined elements (Al, Cr, K, Na, P, Fe) in the shoots and roots of sunflower seedlings (mg kg^{-1}) effecting by flue-gas dust and poppy-head

Elements	Controll		Flue-gas dust		Extrused poppy-head	
	Shoots	Roots	Shoots	Roots	Shoots	Roots
Al	7.25	34.80	19.41	87.76	7.59	582.66
Cr	1.20	1.22	0.54	1.20	0.59	1.16
K	44,366.33	58,219.67	43,015.00	84,413.00	47,317.33	55,937.00
Na	204.00	3,686.33	216.00	2,786.67	287.33	4,334.33
P	4,455.00	7,148.33	3,925.33	4,472.67	4,595.66	7,294.00
Fe	117.33	454.33	91.63	4,901.33	90.73	438.33

Larger concentrations of aluminium were measured in the roots than in the shoots. We suppose that the Al were accumulated in the roots and the root- to- shoot transfer is retarded. The Al concentrations were highest in the roots of treated plants, and as a consequence the observed growth of the shoots and roots were over the control. The concentrations of Al were about 18 times higher than the control. The toxic effects of aluminium are primarily root-related (Taylor, 1988). The root system becomes stubby as a result of inhibition of elongation of the main axis and lateral roots (Klotz and Horst, 1988). The severity of inhibition of root growth is a suitable indicator of genotypic differences in aluminium toxicity (Foy et al., 1967). Aluminium toxicity is therefore often expressed simultaneously in two ways, namely induced deficiency of mineral nutrients, such as magnesium, and inhibition in root elongation (Tan et al., 1992).

The concentrations of chrome were below the control value in the shoots when flue-gas dust and extruded poppy-heads were added to the nutrient solution; these concentrations were lower in the shoots than in the control. The Na and P concentrations were lower in the shoots and roots when flue-gas dust was used and higher when the nutrient solution was completed with extruded poppy-heads. The quantities of K were extremely high (84,416.00 mg kg^{-1}) in the roots of sunflowers when we treated them with flue-gas dust.

Differences were observed also in dry matter accumulation of sunflower seedlings during the experiment. The results are shown in Table2.

Table2. Effects of different matters (flue-gas dust, extruded poppy-heads) on the dry matter accumulation of shoots and roots of sunflower seedling (g $plant^{-1}$) n=3

Control				Flue-gas dust				Extruded poppy-head			
Shoots		Roots		Shoots		Roots		Shoots		Roots	
Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
0.960	0.169	0.212	0.042	0.723	0.359	0.187	0.036	0.838	0.258	0.157	0.016

In nearly all the cases, the values were below the control values. The dry matter of shoots and roots decreased when flue-gas dust and extruded poppy-heads were used.

Low chlorophyll contents affect photosynthetic activities. The decreasing dry matter accumulation can be explained by the lower level of the chlorophyll contents (Table3).

Table3. Relative chlorophyll contents of sunflower 1st leaves on the measurement of 10th, 13th and 15th days (Spad Units) n=35

Treatments	10th		13th		15th	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Control	47.5667	1.9255	50.6250	1.3419	50.3333	0.3987
Flue-gas dust	46.1167	0.8567	46.4833	2.1538	44.4667	3.4388
Extruded poppy-head	45.5000	2.9454	48.3583	0.8755	47.6750	0.9744

When plants are grown under controlled conditions, cc. 80% of the iron is localized in the chloroplasts in rapidly growing leaves, regardless of iron nutritional status. Iron can be stored in plant cells in the stroma of plastids as phytoferritin (Seckbach, 1982). Its content is high in dark-grown leaves (up to 50% of the total iron), but rapidly disappears during regreening (Mark et al., 1981), and remains very low in green leaves. The chlorophyll contents will be larger due to the larger iron contents (Machold, 1968).

[Ide írhatja a szöveget]

The flue-gas dust and extruded poppy-heads contain some iron (contain of iron in flue-gas dust: 2,362 mg kg^{-1} in the raw matter and 1,873 mg kg^{-1} in the filtrate; contain of iron in extruded poppy-heads are 181 mg kg^{-1} in raw matter and 258 mg kg^{-1} in the filtrate).The relative chlorophyll contents did not change between the 10^{th} and 13^{th} days (46 Spad Units) but later it was reduced when flue-gas dust was applied. The Spad Units were increased on the 13^{th} days in leaves treated with extruded poppy-heads, the relative chlorophyll contents decreased on the 15^{th} days.

Conclusions

The effects of the examined materials are particularly unravelled – supposedly- because of the potential compensation effects of soil micro organisms. The laboratory experiment has also evidenced the harmful effects of examined industrial side-products, but injurious deformations were not observed on the plants. Further examinations are needed to clarify the effects of applied matters on the plants and on the (agro) ecosystems.

Acknowledgements

I would like to say many thanks to those companies for their help that have made the examined materials available to us: Ore, Mineral and Waste Recycling Works of Borsod Private Company Limited by Shares, Hajdu Komm Environmental Protection Ltd., Alkaloida Chemicals Co. Ltd.

References

Gruhn P, Goletti F and Yudelman M.:2000. Integrated nutrient management, soil fertility, and sustainable agriculture: current issues and future challenges. Washington DC. International Food Policy Research Institute. Food, Agriculture and Environment Discussion Paper 32.

Foy, C.D., Fleming, A. L. and Armiger, W.H.: 1967. Characterization of differential aluminium tolerance among varieties of wheat and barley. Soil Sci. Soc. Am. Proc. 31, 513-521.

Klotz, F. and Horst, W.J.: 1988. Genotypic differences in aluminium tolerance of soybean (*Glycine max.*L.) as affected by ammonium and nitrate-nitrogen nutrition. J. Plant Physiol. 132, 702-707.

László Lévai, Szilvia Veres, Ilona Mészáros, Nóra Bákonyi, Éva Gajdos: 2008. Interaction between wood ash and bio fertilizer in crop nutrition. Proceedings. 43th Croatian & 3rdInternational Symposium on Agriculture, Opatija, Croatia, 544-547 pp

Machold O.:1968. Einfluss der Ernährugsbedingungen auf den Zustand des Eisens in den Blättern, den Chlorophyllgehalt und die Katalase- souie Peroxydaseaktivität. Flora (Jena), Abt. A. **159**, 1-25.

Mark F.van der, Lange T. de and Bienfait H. F.(1981). The role of ferritin in developing primary bean leaves under various light conditions. Planta **153**, 338-342.

Seckback J.:1982. Ferreting out the secrets of plant ferritin- a review.J. Plant Nutr.**5**, 369-394.

Socolow R.H.:1999. Nitrogen management and the future of food: Lessons from the management of energy and carbon.Proc. Natl.Acad. Sci. USA 96, 6001-6008.

Tan, K., Keltjens, W. G. and Findenegg, G.R.: 1992. Aluminium toxicity with sorghum genotypes in nutrient solutions and its amelioration by magnesium. Z. Pflanzenernähr. Bodenk. **155**, 81-86.

Taylor, G.J.:1988. The physiology of aluminium phytotoxicity. In 'Metal Ions in Biological Systems' (H. Sigel and A. Sigel, eds.) Vol. **24**, pp.123-163. Marcel Dekker Inc. New York

Van Noordwijk M . :2001. Plant nutrition: its role in sustainability of simple and complex agro-ecosystems. In Plant nutrition- Food security and sustainability of agro-ecosystems. 2-3.

Welch R.M., Combs G.F.Jr., Duxbury J.M.:1997. Towards a "greener". Revoulution Issues in Sciences and Technology, **14**, 50-58

[Ide írhatja a szöveget]

[Ide írhatja a szöveget]