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Editorial

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Using Soil-Plant Interactions for Climate Change Mitigation

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Future increase in crop production will greatly depend on how effectively agriculture adapts to climate changes. There are developed a lot of adaptive measures for agriculture to respond to extreme changes of weather conditions, namely, technological farming methods, political adaptation plans of action and research projects. A strategy of adapting agriculture to climate change has already been developed or at the design stage in a number of countries. In most case these strategies include actions favouring major changes in land use, such as a switch to growing biomass crops, afforestation or significant changes in livestock production approaches. However, traditional measures of mitigation climate change don't take into account the importance of water-nutrients interaction. For instance, only 16 from 138 research projects at the European Climate Adaption Platform are related to soils, and only one examined soil-plant interaction at least partially [1]. Unfortunately, investigations regarding the main directions of adaptation of plant production to extreme weathers don't follow a multidisciplinary approach, as each issue is considered separately. On the contrary, combine the methodology of soil science, agrochemistry, plant physiology and microbiology allows to create new possibilities for enhance resilience of soil-plant system to abiotic stresses.

The effects of drought on plant growth and water relation have been widely studied in recent years [2]. However, studies on the effects on nutrient uptake and the consequences for physiological processes are scarce. Meanwhile, the overwhelming majority of researches by exploring the soil-plant system self-regulation to climate change show that aridity affects the balance between C, N and P in soils and the availability of essential nutrients. These effects are due to a large warming and pronounced decrease in precipitation, especially during the spring and summer seasons. Water and nutrient availability of the soil-plant system shows many interactions and has numerous mechanisms of self-regulation. Balanced fertilizer system increases water use efficiency and helps crops achieve optimal performance under limited moisture condition. Thus, management of soil nutrients might increase water use efficiency by 10-25%.

The observations for long-term dynamics of nutrients in the soils show that the abnormal change of moisture modes in soils under conditions of high insolation leads to negative changes in plant nutrition and has a significant influence on the processes of lateral and radial migration of N, P, K, S, Ca, Mg, Zn, Fe, Mn, Co, Cu and so on [3]. Drought causes deficiency of available forms of orthophosphate and sulphate in the soil and determines the formation of grains with low content of protein and gluten. At present is studied the impact of agrochemicals and stress-protectors (synergists and antidotes of agrochemicals) on winter wheat isotopic ionome, which are aimed at obtaining new knowledge about possible approaches to the management of water and nutrients revenues.

The most of soil-plant interactions are temporary and not expected at the time of sowing. Mutualistic interactions between roots and microorganisms during periods of slow or no root uptake continuously provides roots with available N according to plant demand [4]. In addition, it was found a releasing of significant amount of nutrients (nitrogen, phosphorus, zinc, copper, manganese, etc.) during the cyclical renewal of labile soil organic matter that improve soil nutrient regime for a short period [5]. Thus, the management of root secretion affects on mobility a number of elements in soil and improves plants nutrition. This phenomenon has a significant impact on productivity of natural and anthropogenic biomass in periods of abiotic stresses.

Effect of stress usually has combined character (e.g., cold stress induces lack of phosphorus, salt stress relates to lack of water, thermal stress - to lack of potassium, etc.). That is why new knowledge and methods for assessing changes of the nutrient regime in the face of climate change and increasing the action of external stress (such as drought, temperature rise, etc.) lead to innovative solutions in the crop management under stressful conditions. The new ways to reduce the influence of abiotic stresses on plant productivity might be like as:

Choice of varieties and hybrids of plants according their combine resistance to water and nutrient limitations;

Integrated use of various synthetic/natural stress protectors, stimulators and fertilizers;

Targeted differentiation of the root layers of soil on the nutrient content and physical properties, improvement their water-holding capacity.

Choice of Varieties and Hybrids of Plants according their Resistance to Water Limitations

A technique to adapt agriculture to climate change, which is being used in the USA and Europe, is genetic improvement of crop plants. Improvements in water use "efficiencies" are often voiced as important targets for genetic modification in cropping systems. A similar approach can be applied to the choice of varieties according to their demands for nutrients. The ratio N: P: K in winter wheat grain varies such as 1:0, 25-0, 37:0, 17-0, 28 [6]. This indicates the wider ratio of nitrogen to phosphorus in the modern breeding varieties, which aims at increasing the efficiency of nitrogen use by plants. So, taking into account specific demands of varieties in a fertilizer system we might help plants adapt to sharp weather fluctuations.

Integrated Use of Various Stress-Protectors, Growth Stimulators and Fertilizers

Various abiotic stresses increase the production of free radicals which cause oxidative damage to plants leading to reduced growth,

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biomass, seed and fruit production. The antioxidative defence system of plants comprising of antioxidants and antioxidative enzymes, reduces the effects of such stresses. The application of 24-epibrassinolide to different varieties of wheat and millet under normal and stress conditions increase in the resistance to hyperthermia, dehydration and salt stress, thanks in the activity of antioxidant enzymes and sugar content [7]. However, to date, these and other stress-protectors don't widely used in the fertilizer system. Recent studies show a great potential of combination traditional fertilizer with microelements and stress-protectors for stabilizing yield in various weather conditions.

Targeted Differentiation of the Root Layer of Soil on the Nutrient Content and Physical Properties

Having nutrients in the right place – vertically and horizontally – ensures that plant roots can absorb enough of each nutrient at all times during the growing season. Placement systems can be used to position fertilizer in relation to the growing roots. In recent years, availability of precision farming technology has made it also possible to varying the level of fertilizer application within the field, to account for variability of available nutrients. The right place also depends upon the characteristics of the fertilizer material being applied. Therefore, for crops to access these nutrients, roots must contact the fertilizer reaction zone around the point of application. In particular, placement in or near the seed-row may increase access of crops to the nutrient early in the growing season and provide a "starter" effect that improves early-season growth. Localization of fertilizers deeper than usual promotes enhance efficiency of using nutrients especially in drying years [8].

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