

Root exudates as drought insurance policy

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It should be noted that all modern products are mostly aimed at increasing plants productivity (i.e. profits) which is quite logical at first sight. However, today, due to declining rainfall and extreme temperatures and UV radiation, the main fear for a farmer is not getting profit at all (i.e. the financial crisis) and possible loss of all long-term assets. It is about this and how to prevent it that we shall talk further.

In our opinion, the task of a modern agronomist when choosing plant varieties and fertilizers is to foresee the lack of moisture combined with high temperatures and the level of solar UV, that is, to prepare for drought in advance, abandoning hopes for heavens. That is why BIO-GEL, the well-known biological product has been improved and is now produced under the BIO-GEL+ brand.

Unlike BIO-GEL, the new pro-prebiotic also contains signaling molecules (SM), which when seeds are inoculated transmit an alarm signal to the future plant, artificially simulating the onset of drought. All this happens before sowing seeds. The reaction of growing plants to the onset of drought is also enhanced if they are sprayed with this new product (foliar treatment).

Accordingly, the seeds treated in this way with signal molecules (SM) on getting into the soil generate primarily large roots as a guarantee of the plant survival in drought. In this case the germinating grain secretes an increased amount of root exudates - mucus-like secretions based on complex sugars (exopolysaccharides) which attract soil microbiota, thus creating a bacterial cover around the root, accelerating the predominant growth of the plant root rather than the top. Rhizobial cover in the form of mucus, filled with 97% moisture, 2-3% nutrient medium (matrix scientifically), in which the bacterial films of different beneficial bacteria and fungi colonies are securely attached to the roots, acts together with the plant as a single organic mechanism and besides accumulates additional

moisture. As a result, a young plant accumulates 6.57.5 times more water than its dry weight, while a plant without such treatment accumulates only 4.55.0 times more. The biofilm reliably protects the young plant from soil phytopathogens and attracts the soil microbiota to the root area due to the release of "sweet" polysaccharides by the root surface. As a result of the moisture accumulation the root surface area increases by 40-60% compared to control plants, which increases the chances of the plant to colonize a larger area, which will certainly effect both its survival during prolonged drought and increase plant productivity.

This technology almost guarantees a plant survival during the dry season reducing the risk of financial bankruptcy for the land user.

Note that a danger signal, such as an impending drought, is only effective when it is possible to respond adequately to it. In other words, you must have the necessary resources to respond to such a signal. Besides, to enable exopolysaccharide signaling molecules to attract microorganisms living in the soil, it is necessary to ensure sufficient quantities of such microorganisms. But present-day soils abounding in chemical fertilizers practically lack them. It should be stressed that the release of exudates is a difficult process for a young plant, because by giving an additional 15% of seed weight, the plant loses the same 15% of energy and building material for its own development, including the development of a branched and deeply located root system.

So what is the logical conclusion? Providing plants with new biological products containing signaling molecules, we should also provide them with the whole set of "building tools and materials", i.e. a set of natural soil bacteria, or probiotics, along with a food supply, i.e. prebiotics.

Modern inoculants grown on artificial nutrient media such as MPA (meat-pecton agar) contain one or more beneficial (in human opinion) bacteria. But, as we know, there is no meat in the soil, and therefore (in our opinion and this is the author's hypothesis),

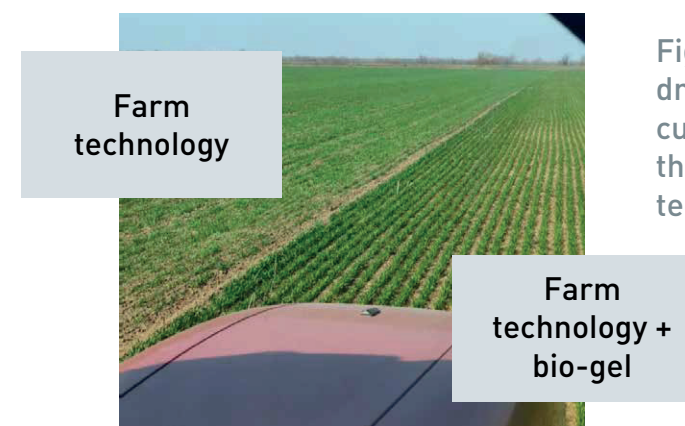


Fig. 1 - "Slavia-A" farm, Kherson region, during the drought period of 2020-2021. On the left, the wheat cultivated according to the farm technology. On the right, the wheat treated with BIO-GEL+ in addition to the farm technology.

and can be applied to the soils subjected to high temperatures. The part of the bacteria that dies secretes metabolites that are beneficial to soils and plants in response to temperature stress, including signaling molecules (SM) that bacteria generate before they die due to high temperatures.

Due to this, the BIO-GEL+ new pro- prebiotic contains:

1. **Signaling molecules (SM)** which transmit signals of the drought approach to the plant;
2. **Metabolites or products of bacterial activity** (auxins, cytokinins, gibberellins, etc.);
3. **Probiotics - various live drought-hardened soil bacteria**, including the so-called "useful" ones: nitrogen-fixing bacteria (*Azotobacter*, *Azotobacter chroococcum*), root nodule bacteria (*Rhizobium*, *Rhizobium leguminosarum*, *Bradyrhizobium*, *Baillillusillum*, *Azyr*), saprophytic bacteria (*Saprophyticus*), lactic acid bacteria (*Lactobacillales*), as well as aerobic bacteria (*Pseudomonas*), anaerobic bacteria (*Enterobacter*), rod-shaped bacteria (*Paenibacillus polymyxa*);
4. **Prebiotics - a natural nutrient medium** for all types of soil microorganisms based on only natural components, complex sugars, lignins, amino acids (18 types of non-animal origin), coenzymes;
5. **Complex of macro- and microfertilizers** for plant and soil nutrition: humic and fulvic acids, enzymes (glucosidases, gluconases, catalases, glycosyl hydrolases), vitamins A, B, E and biologically active compounds. All components are of organic origin only.

The economic feasibility of using BIO-GEL+ has been proven by its predecessor - BIO-GEL organic pro- and prebiotic!

The consumption of a new biological product makes 1-2 l/t for seed treatment, 1.5-2 l/ha for foliar treatment. The product is added to the tank mixture after introducing and mixing all other components.

SO LET'S OVERCOME THE DROUGHT TOGETHER!

getting into the real soil, the bacteria population decreases rapidly, becoming food (i.e. pro-, not prebiotic) for soil microflora. In addition, healthy soils have hundreds of microorganism species that live in harmony (i.e. in symbiosis) with each other. And it is hardly likely that they consider one another as "useful" or "useless". Moreover, by introducing certain types of bacteria into the soil, we change its bacterial profile (i.e. a portrait of a large natural family). That is why most countries are slowing down the import of new bacterial strains. Unfortunately, Ukraine's borders are still wide open to foreigners!

It is these reasons that led to the creation of BIO-GEL+ biological product, a purely Ukrainian pro- and prebiotic with signaling molecules and bacteria metabolites on the basis of the international application for the invention (PCT/UA2018/000114) and the Ukrainian patent № UA 119601. The new product is at the stage of patenting.

Signaling molecules (SM) are contained in the BIO-GEL+ biological product due to the unique hydrothermodynamic technology (HTD-technology®) used in the product production. The technology is based on the following:

- - Environmentally friendly components are used as raw materials, including organic peat, sapropel, compost, biohumus and other components, which include a variety of soil microflora.
- - Due to HTD-technology® components of raw materials inaccessible to bacteria are transformed into accessible ones. At that the temperature of the nutrient medium increases and the bacterial microbiota begins to multiply rapidly.
- - On raising the temperature according to a specially invented algorithm to 75°C, later use is made of those hardened bacteria that survived