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УДК 811.111

THE FERTILIZER'S QUALITY
(ЯКІСТЬ ДОБРИВА)

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В статті представлені види та якість добрив, які забезпечують посіви необхідними поживними речовинами, завдяки чому посіви ростуть більше, швидше і виробляють більше їжі.

Ключові слова: *мінеральні добрива, органічні добрива, промислові добрива.*

The article presents the types and quality of fertilizers that provide crops with the necessary nutrients, so that crops grow bigger, faster and produce more food.

Key words: *mineral fertilizers, organic fertilizers, industrial fertilizers.*

Fertilizers are added to crops in order to produce enough food to feed the human population. Fertilizers provide crops with nutrients like potassium, phosphorus, and nitrogen, which allow crops to grow bigger, faster, and to produce more food. Nitrogen in particular is an essential nutrient for the growth of every organism on Earth. Nitrogen is all around us and makes up about 78% of the air

you breathe. However, plants and animals cannot use the nitrogen gas in the air. To grow, plants require nitrogen compounds from the soil, which can be produced naturally or be provided by fertilizers. However, applying excessive amounts of fertilizer leads to the release of harmful greenhouse gases into the atmosphere and the eutrophication of our waterways. Scientists are currently trying to find solutions to reduce the environmentally harmful effects of fertilizers, without reducing the amount of food we can produce when using them.

Fertilizer is any substance or material added to soil that promotes plant growth. There are many fertilizer varieties, and most contain nitrogen (N), phosphorus (P), and potassium (K). In fact, fertilizers sold in stores have an N-P-K ratio on their packaging. Fertilizers are applied all around the world to keep lawns green and to produce more crops in agricultural fields. Fertilizers can be divided into three groups:

Mineral fertilizers (phosphorus and potash) are mined from the environment and crushed or chemically treated before being applied. **Organic fertilizers** (manure and compost) are made from animal feces, and plant or animal decomposed matter. **Industrial fertilizers** (ammonium phosphate, urea, ammonium nitrate) are produced industrially by humans through chemical reactions.

While organic and mineral fertilizers have been used to increase crop yields in agriculture for a long time, industrial fertilizers are a relatively new development. Even so, industrial fertilizers are the most widely used fertilizers today. Nitrogen is one of the elements, or nutrients, that all living things (microorganisms, plants, and animals) need to grow. Although, there is a lot of nitrogen all around us (~78% of the air we breathe), most of the nitrogen on Earth is present as a colorless and odorless gas, called nitrogen gas (N2). Unfortunately, plants and animals cannot directly use nitrogen gas. As humans, we get our nitrogen from the food we eat. High protein foods like meat, fish, nuts, or beans are high in nitrogen. Plants get their nitrogen from the soil and nitrogen is the most common nutrient to limit plant growth. There are two ways nitrogen gas is naturally transformed or “fixed” into nitrogen-containing compounds that can end up in soil, without human intervention.

Lightning: Lightning strikes generate enough energy to split nitrogen gas in the atmosphere creating nitrogen-containing compounds, which end up in soil.

Biological nitrogen fixation: Some microorganisms can use nitrogen gas directly as a nutrient. These specialized microorganisms convert nitrogen gas to ammonium (NH4+) and are called “nitrogen fixers.” Some nitrogen-fixing microorganisms live in soil, and some can form a close relationship with the roots of certain plants, like beans or clover.

However, even with all this natural nitrogen fixation. The process of converting nitrogen gas into nitrogen containing compounds. Nitrogen fixation can occur naturally through lightning strikes, be performed by specialized microorganisms, or be accomplished industrially., low nitrogen levels

in soils often still limit plant growth. This is why most fertilizers contain nitrogen compounds and why industrial fertilizers are essential in order to produce enough crops to feed the human population. Humans now add as much or more industrially fixed nitrogen (~150 billion kilograms) to the environment each year, than is naturally fixed. One hundred and fifty billion kilograms (~330 billion pounds) of anything is hard to imagine, but this is equal to the weight of ~24 million fully grown adult elephants! The short answer is that nitrogen-containing fertilizers help crop plants grow faster and helps to produce more crops.

Some soil microorganisms can transform nitrogen provided in fertilizers into nitrogen-containing gases, which get released into the atmosphere like the greenhouse gas nitrous oxide (N2O). Greenhouse Gases that trap heat in the atmosphere much like the roof of a greenhouse traps heat to protect the plants growing in it from cold weather and frost. are one of the main factors accelerating global warming. Nitrous oxide has a warming potential ~300 times greater than the most commonly mentioned greenhouse gas, carbon dioxide (CO2).

In waterways, the addition of external nutrients (like excess nitrogen) is called eutrophication. A change in an environment's nutrient status caused by high levels of nutrients (nitrogen or phosphorus) entering waterways (lakes, rivers, or oceans). One major consequence is harmful algal blooms and the loss of aquatic life.. Eutrophication is an unwanted fertilization of a waterway and it promotes the growth of microorganisms, algae, and plants, just like the fertilization of soil. However, the fast growth of microorganisms and plants can use up all the oxygen in these waterways and turn them into so-called dead zones, because aquatic animals cannot live without oxygen. Eutrophication can also lead to the growth of algal species that produce toxic chemicals, called harmful algal blooms. When cyanobacteria and algae grow very fast because of large amounts of nutrients (nitrogen or phosphorus) present in the waters they live in. These cyanobacteria and algae release harmful chemicals—toxins—into the waterway..

While we need nitrogen from fertilizers in our agricultural soils, we do not need or want additional nitrogen in our atmosphere or waterways. This means we have to balance the positive benefits of nitrogen fertilization (more food) with the negative consequences of excess fertilizer (environmental problems). Scientists are currently working to find this balance to improve our current situation.

One main goal of fertilizer related research is to decrease the amount of industrially fixed nitrogen that is lost (~12 million elephants worth) to the atmosphere and waterways. This solution is called improving the nitrogen use efficiency of agricultural environments. Here are a few examples of ongoing fertilizer research:

Microbiologists and soil scientists are working on ways to improve field conditions to promote the growth of naturally occurring soil nitrogen-fixing bacteria. In addition, they are also

working on ways to prevent the growth of soil microorganisms that contribute to fixed nitrogen being lost to the atmosphere or waterways. Together, this would reduce the overall amount of nitrogen-containing fertilizer needed to get the same crop yield.

Chemists are working on designing fertilizers that are stable in soils over longer time periods and are less likely to be broken down by microorganisms. These slow release fertilizers release little bits of nutrients at a time, so nutrients are available throughout the lifetime of the crops. This approach is still dependent on nitrogen-containing fertilizers, but it would reduce the amount of fertilizer needed and decrease the nitrogen lost.

Plant biologists are trying to genetically engineer crops that would require less nitrogen from fertilizers [5]. These crops would be able to fix their own nitrogen from nitrogen gas, just like the specialized nitrogen-fixing microorganisms. These crops would need less fertilizer to produce the same crop yield (Figure 3).

Computer scientists and soil scientists are working together to design smart fertilization systems, which can monitor soil and air conditions in agricultural fields. These systems can then add small amounts of fertilizer only when needed. This minimizes the amount of fertilizer added, makes fertilizer additions targeted to the crops needs, and decreases the amount of nitrogen lost.

Fertilizers provide crops with essential nutrients like nitrogen, so that the crops grow bigger, faster, and produce more food. However, applying too much fertilizer can be a problem because it leads to the release of greenhouse gases and eutrophication. Scientists are currently trying to find solutions to reduce the amount of fertilizers needed, without reducing the amount of food produced.

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