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Fertilizer Focus

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Ma'aden Phosphate works with farmers from around the world to maximize their crop output by delivering high-quality fertilizer products.

Capacity of Phosphate Fertilizers

3 Million tonnes — 2011

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9 Million tonnes — 2024

- We remain committed to the pursuit of sustainable growth, innovation and excellence without compromising the well-being of the people and planet.

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The major challenges and opportunities to increase micronutrient use in agriculture

Written by

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There are 14 essential mineral nutrients for crop production: Nitrogen (N), phosphorus (P), potassium (K), sulphur (S), calcium (Ca), magnesium (Mg), iron (Fe), zinc (Zn), copper (Cu), manganese (Mn), boron (B), chloride (Cl), molybdenum (Mo), and nickel (Ni). Carbon (C), hydrogen (H) and oxygen (O) are essential to plants but are supplied from air and water. Three criteria need to be met for a nutrient to be classified as essential for plant nutrition:

1. The plant cannot complete its life-cycle without the specific nutrient
2. The role of the nutrient must be specific, with no other nutrient being able to completely substitute it
3. The nutrient must be shown to actively participate in the plant metabolism

The essential plant nutrients are divided into macronutrients (N, P, K, S, Ca, and Mg) and micronutrients (Fe, Zn, Cu, Mn, B, Cl, Mo, and Ni). This classification follows how much plants need each element—macronutrients

The impact of micronutrients on crop production is growing in importance

are required in larger quantities than micronutrients. The typical macronutrient levels in plants is 2-50 g/kg dry matter compared to 0.1-100 µg/kg dry matter of micronutrients.

For decades, soil fertility researchers and agronomists have focused on crop response and managements practices of macronutrients, especially NPK, despite knowing the importance of micronutrients. However, recently more importance has been given to micronutrients and their impact on crop production. There are several factors that explain this trend including the fact that more and more farmers understand and adopt good macronutrient management practices, which give micronutrients the opportunity to become the limiting factor from a plant nutrition stand point.

Additionally, contributors for increasing awareness and use of micronutrients are:

- Intensification of crop production
- Reduction of arable land
- Multiple worldwide studies showing the benefits of micronutrients

In addition to plant nutrition, several micronutrients are known to play an important role in human health. For instance, the lack of adequate Fe intake by humans is related to impaired cognitive abilities that cannot be reversed. The immune system is particular influenced by Zn deficiency, which shows the importance of this micronutrient for human nutrition. Biofortification is a strategy to use crops to deliver micronutrients to humans in regions where intake is limited.

Micronutrients

Micronutrients in soils are:

1. Part of primary and secondary minerals
2. Adsorbed to the surface of minerals and organic matter
3. Incorporated into organic matter and microorganisms
4. In the soil solution

The predominant form of a micronutrient in soils depend on the micronutrient and soil properties (e.g. pH, texture, soil organic matter content).

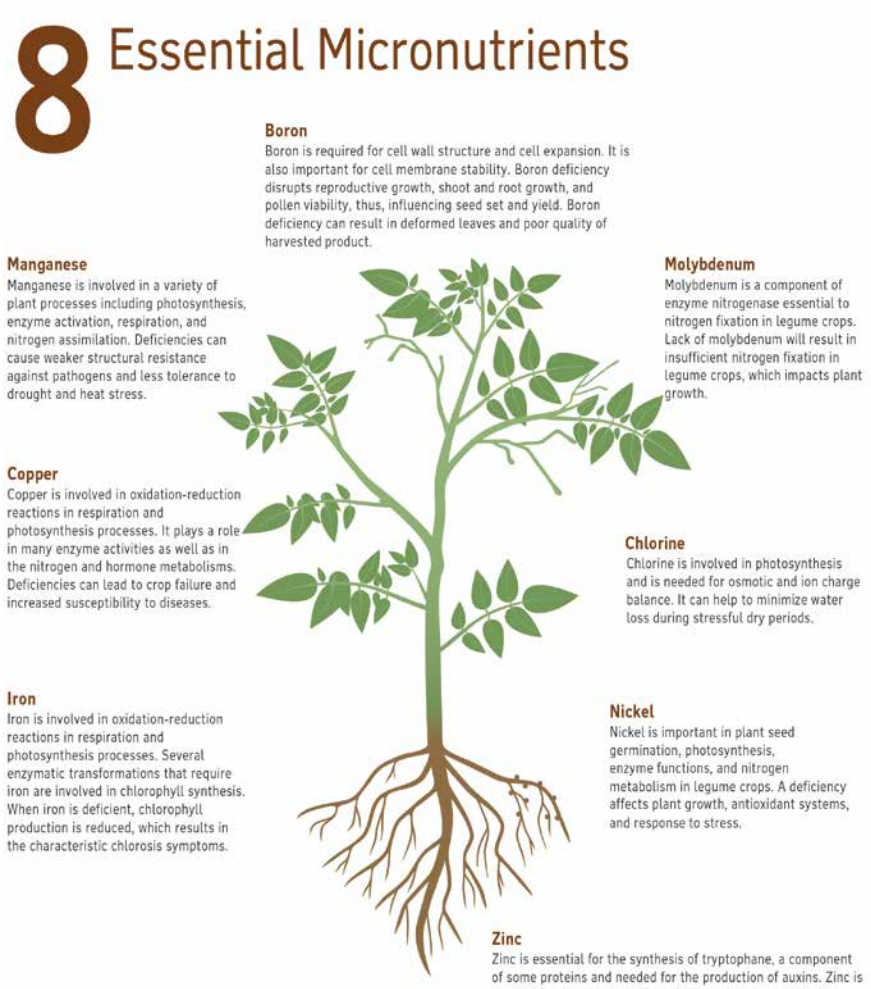
Soils deficient in micronutrients are widespread globally with parent rock (the rock from which the soil is formed) and environmental conditions being the major factors determining the natural levels available to plants.

However, as global crop production intensifies, the original levels of micronutrients are being depleted resulting in more soils reporting deficient levels of micronutrients in several countries. The micronutrients that become deficient in a specific cropping system are therefore determined by a combination of natural process (e.g. parental rock, climate) and anthropogenic actions (e.g. crop mix, cropping intensification).

To determine the need of micronutrients in a cropping system, soil fertility researchers and agronomists have developed soil and plant tissue analysis as well as critical levels that inform farmers if fertilization is needed. Sampling procedures and analytical methods vary broadly which can create confusion and inconsistencies.

As with macronutrients, it is difficult - or even impossible - to rank micronutrients from the most important to the least important. But based on global demand, Zn and B are the most used micronutrients fertilizers globally with consistent crop response.

Figure 1. The role of micronutrients in plants



Source: 20 Mule Team, Borax

Micronutrient fertilizers and fertilizer management practices

There are several micronutrient fertilizer products in the market that try to meet farmers' needs. Sulphates are popular for Zn, Cu, Fe, and Mn in soil application while chelates are popular for foliar application. Sodium borate is commonly used for soil application of B while boric acid is mainly used to make liquid B fertilizer for foliar application and fertigation. For Mo, Mo trioxide was used for soil application but ammonium and sodium molybdate are more popular today for foliar application and seed treatment. Such a wide range of micronutrient fertilizer options gives farmers the flexibility to adopt micronutrients into their fertilization programmes.

Regarding the methods of applications for micronutrients, there are three major categories: Foliar, fertigation and soil. However, there are different delivery mechanisms under soil application including:

1. Direct soil application
2. Bulk blends
3. Coating/impregnation of NKP blends
4. Compound fertilizers

Figure 2. The 4Rs nutrient management concept

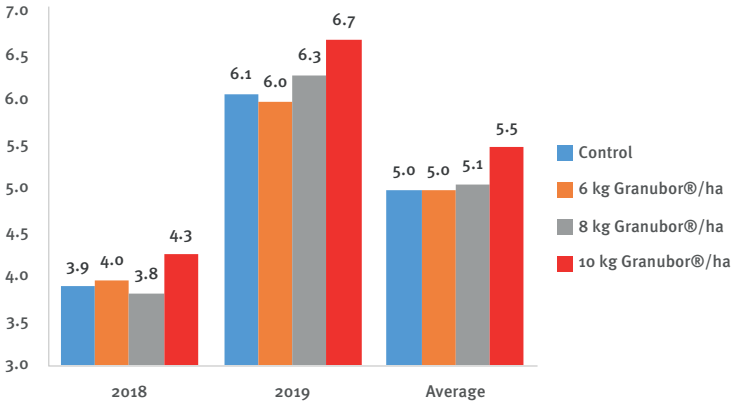
RIGHT SOURCE
Matches fertilizer type to crop needs.

RIGHT RATE
Matches amount of fertilizer to crop needs.

RIGHT TIME
Makes nutrients available when crops need them.

RIGHT PLACE
Keeps nutrients where crops can use them.

Figure 3. Rice response to boron fertilization in Vietnam



Rice variety: OM5451
Soil pH 5.25 and B content of 0.39 mg kg^{-1}
Experimental design: Randomized Complete Block with four repetitions
Treatments consisted on different B rates (0, 0.9, 1.3 and 1.5 kg B ha^{-1}) using the fertilizer *Granubor®* as the B source
Treatments were applied 7 days after rice transplanting
The lower yield level in 2018 happened due to excessive rain
Average yield increase of 10% by applying 10 kg *Granubor®* ha^{-1} compared to the control

Source: Cuu Long Delta Rice Research Institute, 2019

For soil application specifically, there is a lot of debate among farmers, agronomists and consultants about the best method to deliver micronutrients to plants. Direct soil application and bulk blends are very popular in several countries, but coating technologies and compound fertilizers are gaining popularity because of uniform distribution and availability of micronutrients to crops by using a macronutrient fertilizer as a carrier. The most important question is not which delivery mechanism is better, but which one best fits the farming practice. The opinion of many in the fertilizer industry is that these different methods of application are important to have in the 'farmer's toolbox' and that they are likely to co-exist in the long-term.

Regardless of the fertilizer and method of application, an important concept in managing micronutrients is the 4Rs nutrient management concept (right source, right rate, right time, and right place). The 4Rs has the goal of optimizing fertilizer use efficiency while minimizing nutrient losses to the environment.

The most important question is not which delivery mechanism is better, but which one best fits the farming practice

Major challenges for micronutrients

Micronutrients are not the 'silver bullet' in crop nutrients. Micronutrients need to be seen as part of a balanced nutrition approach to support plants grow so farmers can achieve the highest yield and quality potential while preserving the environment. There is plenty of data showing the benefits of adopting micronutrients in fertilization programmes. Figure 3 shows just one example of a study conducted in Vietnam on rice. Granubor is a compacted sodium borate fertilizer (15% B) designed for bulk blends. Unfortunately, the adoption of micronutrients is still not widespread as it is for NPK.

Depending on a region's cropping system and unique economics, micronutrients face several challenges:

1. Relative lower awareness of micronutrients in agriculture compared to macronutrients, mainly in developing economies: In this case, farmers and agronomists are not well-connected with the benefits of micronutrients and have barriers to use them. Continuous education, with robust data and demonstration plots, is the best solution to overcome such a challenge.
2. National regulations sometimes work as a barrier by not allowing, for instance, micronutrient contents to be labelled in the fertilizer bag. Lack of inspection is another example. Such regulations confuse farmers and prevent them from using micronutrients.
3. Government programmes that remove the incentive from the private sector to invest in micronutrient technologies. The best examples are fertilizer subsidy programmes that create market distortions.
4. Companies need to keep a customer-centric approach when developing micronutrient fertilizers. Products need to be compatible with existing farmers', distributors' and retailers' operations to be more easily adopted.

The size of the opportunity

One thing that is still different between macro- and micronutrients is the fact the latter holds the status of value-added fertilizers. The global micronutrient market is growing faster in volume and revenue than macronutrients - making them an attractive product segment for distributors/retailers in several countries.

A recent market study estimated the global micronutrient market at around USD3.6 bn in 2020, with the Asia-Pacific market representing 41.2% of the market value followed by North America (23.6%) and South America (14.4%). The same study estimated the global market value to reach USD5.5 bn by 2025 (CARG of 8.7%). The growth rate will be region-dependent with Asia-Pacific growing at the highest rate (9.5%) followed by South America (9.0%) and North America (8.0%).

Micronutrients are fundamental for balanced nutrition and a tremendous tool to help farmers increase crop yield and quality. Their adoption in fertilization programmes faces several challenges that need to be overcome to keep pushing productivity levels while preserving the environment. The value chain, in most parts, is well connected from crop production to human health with the good value and returns generated by the micronutrients segment. We now need to help educate framers on what a big opportunity it is for them.

Note: Granubor® is a trademark of U.S. Borax ■

About U.S. Borax
U.S. Borax, part of Rio Tinto, is a global leader in the supply and science of borates—naturally-occurring minerals containing boron and other elements. We are 1,000 people serving 500 customers with more than 1,700 delivery locations globally. We supply 30% of the world's need for refined borates from our world-class mine in Boron, California, about 160 km northeast of Los Angeles. Our local agriculture experts understand the uses and benefits of boron on crops. In addition to a global sales team, we have a number of agronomists on staff to help fertilizer distributors maximize the benefits of borates in agriculture applications. Our agriculture team can answer growers' questions and concerns about their particular crops.