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Popular Article

Agronomic Biofortification of arable crops: A sustainable approach to enrich the nutritional security

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Abstract

In the past few decades, the productivity of food crops has significantly increased in the developing world as a result of the green revolution. In spite of this, the nutritional aspect of the crops could not keep up with the rapid growth of the population as a whole. As a result of a lack of balanced nutrition, this has led to an increase in malnutrition problems, especially in developing countries. Agronomic biofortification, which involves using agronomic tools and techniques to boost the micronutrient content in arable crops, is considered a vital aspect in reducing the global rate of malnutrition. It has become a popular approach to providing iron, zinc, and other micronutrients in our everyday diets, in a quick, safe, and cost-effective manner. Due to the nature of agronomic biofortification as it done on already existing crop varieties, it is easy for consumers to accept the product.

Keyword: - Agronomic Biofortification, Fertilizer, Micronutrients, Soil health

Introduction

According to statistics, more than 2 billion people (or one in three) worldwide endure micronutrients deficiencies, sometimes referred to as a "hidden hunger" (Prom-u-thai *et al.* 2020). The prevalence of these deficiencies is typically more prevalent in developing countries, and it appears to be a problem that is more prevalent among children who are growing up, pregnant or lactating women, sport persons, and workers who do manual works. Especially micronutrient deficiencies like Fe, Zn, Se, and I, which have serious health consequences (Bailey *et al*., 2015) and cause significant economic losses (Godecke *et al*., 2018).

Agronomic biofortification is one of the ways to provide an increased level of micronutrients in arable crops as it has been shown that biofortified crops significantly increases the uptake of micronutrient and has positive impact on human health (Prahraj *et al*., 2021). In the agronomic biofortification techniques that are used in order to increase micronutrient levels in crops, the simplest method to boost the levels of microelements in crops is to use mineral or foliar fertilizers as well as improving soil mineral solubilization and mobilization by supplying micronutrients that can be directly absorbed by the plants. It has also been recognized as one of the economical and cost-effective ways of reducing the mineral deficiency in the human diet. For crops, there is extremely narrow concentration of nutrients like Fe, Zn between beneficial and toxic impact, so in order to produce crops with high nutritional quality, it is necessary to choose plants enriched with microelements carefully and also select the correct concentrations as well as forms of fertilizers from the right source.

Why Agronomic biofortification is needed?

Our bodies require very trace number of micronutrients as well as minerals. In spite of this, their deficiencies are extremely impactful and can lead to serious ill health (WHO) such as weekends our immune system and reproductive system, poor physical as well as mental performance. More than 2 billion people (or one in three) worldwide endure micronutrients deficiencies, sometimes referred to as a "hidden hunger". In developing countries, Zn and Fe deficiencies are most severe and persistence and found particularly in children and women. A simple and potent approach of enhancing the micronutrient concentrations in arable crops is agronomic biofortification.

Approaches of agronomic biofortification

The science of agronomic biofortification is the premeditated use of mineral fertilizers, adopting appropriate agronomic practices to increase the concentration of a target mineral in edible parts of arable crops in order to increase dietary intake. Some important agronomic approaches are given below

1. Enhancing the soil health

To keep soil healthy, its physical, chemical, as well as biological properties should be maintained, and this is enabled by using numerous agronomic practices. In order to improve soil health, nutrient sources can be diversified, with an emphasis on organic sources, conservation

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agriculture principles can be applied, soil microbial diversity can be improved, resources can be recycled efficiently by integrated farming systems, and amendments can be added to correct soil reactions. Using crop residue, agro-industrial waste like phosphogypsum, basic slag as soil amendments can maintain soil health and provide nutrients to crops.

2. Integrated nutrient management

An important step in the agronomic methods of biofortification is the use of nutrients in integrated manner. The best way to achieve sustainable biofortification would be to integrate compost, manure, organic and inorganic fertilizer, microorganisms, and organic and inorganic fertilizers together.

a) Use of organic matter

Soil organic matter is the organic component of soil. It consists of organic material from plants and animals, and material that has been converted by microorganisms in the soil at different stages of decomposition. Soil organic matter has direct benefits for arable crops. Healthy soils with stable levels of soil organic matter are also better equipped to prevent and fight soil-borne diseases. Soil organic matter helps in enhancing soil fertility and quality, as well as play a vital role in agronomic biofortification.

b) Use of fertilizer

The application of mineral fertilizers to soils or plant leaves to increase nutrient contents in edible parts of crops – and it's potential to fight hidden hunger. There is evidence that agronomic biofortification can increase yields and the nutritional quality of arable crops. The relevance of integrated soil fertility management is demonstrated by the fact that micronutrient fertilisation is most efficient when used in combination with NPK, organic fertilisers, and better crop types.

3. Tillage

Nowadays, zero tillage or reduced tillage is becoming more popular, but for them, soil compaction is the key issue since it hinders root proliferation. Stipesevic *et al.* found that in winter wheat concentration of Zn in the plant tissue at the beginning of heading did not differ significantly due to tillage treatments in the first 2 years, but in the third year it was 11.7 mg kg^{-1} in the conventional tillage plots and only 6.4 mg kg^{-1} in the zero-till plots. The nutrient uptake by the crops is also increased by some enhanced tillage techniques, such as ridge and furrow planting and furrow irrigated raised bed planting (FIRB).

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4. Water management

Soil moisture is the main factor that affects nutrient concentration in crop products because most of the nutrient uptake is done by mass flow and diffusion. A sufficient amount of moisture promotes better root development, enhances the solubility of nutrients, and makes them available to plants. Both excess as well as deficit water reduce nutrient concentration from the root zone by leaching or reduced mobilization. Proper management of water in all the critical stages is important for improving the quality of the product.

5. Application of micronutrients

Micronutrients applied to the soil can enhance the amount of nutrients in grains like soil application of Zn increase Zn concentration in cereal crops for 2–3 times depending on crop species and crop genotype. Foliar application of 0.2 % zinc sulphate recorded a higher Zn concentration in rice, whereas Zn-coated urea (ZCU) as $ZnSO_4.H_2O$ registered the highest total Zn uptake. The foliar spray facilitates the quick transfer of nutrients from the application location to the site of utilization. Fe, Zn, and Mn are applied in chelated form, and higher translocation was observed within the plants.

6. Use of PGPR (Plant growth promoting rhizobacteria)

PGPR contributes to the rhizosphere's nutrient content in a variety of ways.

i. They secrete growth promoting compounds and various enzymes which play an important role in the cycling of nutrients.
ii. They improve root morphology that enhance the area of root surface, which facilitates greater nutrient uptake.
iii. PGPR secret Phyto-siderophores which enhance the availability micronutrients in soil.

Conclusion

Agronomic methods provide a short-term solution as compared to breeding approaches. It has been found that fertilization with both micro and macronutrients improves the nutritional status of a crop's edible part. In fruit as well as vegetable crops other than cereals, foliar application of Fe and Zn fertilizers has been demonstrated to be a simple and successful method of yield and nutrition enhancement. Water management in cereal crops at the post-anthesis phase was helpful for enriching grain quality and nutrient status relevant to the processing and human consumption and addition of organic matter in various forms like compost, green manure, as well as biochar and biosolids.

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Biofortification has limited acceptance among society and expensive, complicated governmental approval procedures. Despite these difficulties, the future of biofortified crops is very promising because they have the power to eliminate micronutrient malnutrition among billions of poor people, particularly in emerging nations.

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