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Alleviation of zinc deficiency from humans through plants by organic sources: A Powerful Tonic

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Abstract
Zinc (Zn) is a structural constituent and regulatory co-factor in enzymes and proteins involved in many biochemical pathways. Many agricultural soils cannot meet the Zn requirements of crop plants, making Zn deficiency a common nutritional problem worldwide, particularly in low organic matter, highly limed, light-textured, salt resistant, and waterlogged soils. Hence, the Zn uptake and transport in plants and its consumption by humans and animals are considerably affected. Humans are more vulnerable to Zn scarcity because it controls the hormonal receptor sites, biologic membranes and plays a role in DNA and RNA metabolism. It participates in signaling, gene expression, and apoptosis. Hence, the scarcity of Zn in soil disrupts the whole food chain. Therefore, Zn shortage is a major agricultural and human health problem around the world. Compositing, bioslurry, and farmyard manure application could be a suitable option to remove all the above issues because they affect soil composition, and improve the soil properties in a more sustainable manner. Furthermore, they can increase the organic matter contents in soil and enhance the Zn concentration in grains, when applied with inorganic Zn fertilizers. The present review discusses the organic sources beneficial effects on various crops.

Keywords: Farmyard manure. Compost, Bioslurry, Zn deficiency, malnutrition, plant growth and yield

Introduction
Zinc (Zn) is needed in various enzymatic reactions, metabolic processes, and reduction reactions in animals, humans, and plants (Hafeez *et al*., 2013) [15]. It is also essential for crop nutrition. It is also needed to activate several enzymes involved in nitrogen (N) metabolism, energy transfer, and protein synthesis. Zn influences hydrogenase and carbonic anhydrase activities and the stability of ribosomal fractions, and the synthesis of cytochrome (Tisdale, 1984) [12]. Plant enzymes stimulated by Zn are involved in carbohydrate metabolism, cellular membrane integrity, protein synthesis, auxin synthesis control, and pollen creation (Marschner, 1995) [13]. Zn is needed to control and conservation of gene expression in plants to withstand environmental stresses (Cakmak, 2000) [14]. It is a catalytic and structural protein cofactor found in hundreds of enzymes (Hambidge *et al*., 2000) [16, 22]. It plays a critical structural role in protein domains that interact with other molecules. Transcription factor DNA binding and protein interactions are mediated by the "Zn finger" proteins (Sinclair and Kramer, 2012) [33]. Bioinformatic methods now predict Zn-binding sites from sequenced metal-binding motifs. According to these observations, the Zn proteome may account for around 9% of the entire proteome in eukaryotes and between 5% and 6% in prokaryotes (Andreini *et al*., 2009) [32]. Therefore, proper Zn concentration is essential for all the above possible mechanism.

Zn scarcity is almost pH-dependent and affected at higher or lower pH considerably (Gondal *et al*., 2021) [38]. Various soil types, including higher pH (calcareous soils), are also known as worldwide Zn deficient because Zn becomes inaccessible by calcium carbonate or through adsorption of clay particles (Marschner, 1995) [13]. The increased soil pH promotes Zn adsorption of soil constituent such as cation exchange sites (clay minerals and metal oxides), which reduces the availability of Zn in soil and Zn content in soil solution (soluble Zn) decreases dramatically by 30-fold to 45-fold with each unit rise in soil pH (Gupta *et al*., 2016) [36].

Its shortage symptoms differ considerably depending on the crop and soil quality. Symptoms occur at different times in different crops; for example, maize Zn shortage symptoms appear in two to three weeks (Viets *et al*., 1954) [3]. If the deficiency is extreme, symptoms appear during the season. Since Zn, like other nutrients, is immobile in the soil, its scarcity symptoms appear on fresh plants (Thorne, 1975) [2]. New leaves grow thinner, twisted, with fluctuating interveinal cholorsis configurations and necrotic elisions on leaf tips or margins. Plants have fewer branches and flowers due to poor bud growth, rosette formation, and internode shortening due to a lack of Zn (Boawn *et al*., 1964) [1]. Its scarcity is a well-known issue in crops worldwide, resulting in a significant development, production, and yield losses. Its absence prevents plants from growing in a variety of ways. Scarcity of Zn lowers yield by up to 20% without causing visual effects (Caulfield and Black) (2004) [20]. Its shortage has a detrimental impact on human and animal health and plant growth and yield (Hafeez *et al*., 2013) [15].

Zinc in human

Fe and Zn deficiency affect more than 3 billion people worldwide, and it is particularly prevalent in areas where the population is highly reliant on a monotonous diet of cereal-based foods, in which Fe and Zn are almost entirely processed in the husk and hence lost during milling and polishing (Cakmak, 2002; Graham *et al*., 2001) [18, 19]. Among the elements for which a human nutritional need has been identified, Zn is second only to iron. The average adult human body weighs 2 g (Hambidge *et al*., 2000) [16, 22]. Zn's biological role in the structure and function of proteins, such as enzymes, transcription factors, hormonal receptor sites, and biologic membranes, is now well understood. Zn plays various essential roles in DNA and RNA metabolism and participates in signaling, gene expression, and apoptosis. People eat a cereal-based diet with lower Zn levels, resulting in human Zn malnutrition (Biesalski, 2013) [43]. The average intake level of Zn in human is 3 to 16 mg Zn per day. Its improper uptake in the body causes various diseases in humans. More than 30% of the global mortal community agonized by Zn scarcity (Welch *et al*., 2002) [44]. Its lack leads to several disorders in humans as well.

Sources of zinc

Organic fertilizers are rich in vital nutrients that boost soil properties and, as a result, yield increases (Gondal *et al*., 2021) [38]. Furthermore, these fertilizers are less expensive, more environmentally friendly, less toxic, and more readily available. Farmyard manure (FYM), composting, and liquid or dry bioslurry are examples of organic amendments (Mahmood *et al*., 2017) [10] that improve Zn availability to plants. It can be used to enhance plant growth and Zn levels in grains. Besides another inorganic form of Zn is perchlorates, cyanides, Zn-ammonia salts, alkali metal zincates, sulphates, thiocyanates, halides, Zn-ammonium phosphate, Zn sulphate, nitrates, fluosilicates, Zn hydroxide, acetates, Zn carbonate (Gangloff *et al*., 2006; Lindsay, 1979) [27, 17].

Bioslurry

The BS is an anaerobically fermented organic material released as a byproduct from a biogas factory. In this process, methanogenic bacteria drive the fermentation process in a biogas digester, anaerobically. Cow dung, buffalos waste, and FYM wastes are the organic materials used in BS production. It can be used as an organic fertilizer because it provides many primary nutrients, including N, P and K, and organic matter, which is easily ingested by plants and soil microbes (Islam, 2006; SNV, 2009) [11]. It improves soil structure stability, porosity, water-holding capability, nutrient retention, and pH, especially in nutrient-deficient soils and tropical and sub-tropical areas. Since it includes higher concentrations of growth hormones, amino acids, and antibiotics, it also acts as a biopesticide, protecting the plant from various stresses and promoting plant growth. BS can be used as a bio-manure in crop processing (Khan *et al*., 2015) [15]. It provides a better environment for the development of microflora, especially N-fixing bacteria and phosphate-solubilizing bacteria, and reducing soil erosion (Hossain *et al*., 2018). The BS increases the physical, chemical, and biological content of soil by increasing soil composition, reducing soil bulk density, water-holding capability, preventing nutrient leaching, CEC, and providing nutrients to soil micro-flora and fauna (Fentaw, 2010) [37]. As a result, BS is an excellent organic fertiliser that can be used in conjunction with inorganic nitrogenous fertilizers to improve soil fertility (Satyanarayana *et al*., 2002; Garg *et al*., 2005) [39, 40]. Most plants, especially vegetables, fruit-bearing trees, and other horticultural crops, are said to benefit from it (Mohabbat *et al*., 2008) [35]. Previous studies revealed it has significant effects on almost all crops. For instance, Zhang *et al*. (2012) [41] used liquid BS as a soil modification to improve soil fertility, especially in acidic and nutrient-deficient subtropical and tropical soils.

Compost

Compost is a natural commodity that results from the supervised biodegradation of biologically degradable materials like food waste. The compost application raises soil fertility, which aids in resolving farmer issues and contributes to increased oil production, reduced disease and pest attack, and eventually increased crop yield (Madeleine *et al*., 2005) [34]. It may be used as mulch, in the soil, or as potting media for various reasons and provides all of the required plant nutrients. It often releases nutrients steadily over months or years, while synthetic fertilizers release nutrients quickly, and compost-enriched soil preserves fertilizers longer (Diaz *et al*., 2011) [4]. Less fertilizer pollutes wetlands and buffers the surface, neutralizing both acidic and alkaline soils and bringing pH levels to the ideal range for plant nutrient supply-compost aids in aggregating aggregates clumps of soil particles that have strong soil structure. Heat, precipitation, and nutrients are kept in place by tiny air channels and pores in such soil. Compost aids in the retention of water and nutrients in sandy soil and the loosening of closely attached particles in clay or silt soil, allowing roots to disperse, water to flow, and air to pass through (Hue and Liu 1995) [6]. Compost changes the soil's composition, rendering it less prone to eroding, which avoids soil spattering on plants, which can transmit disease. It can also retain nutrients tightly enough to keep them from washing out but lightly sufficient for plants to soak up if required (Agnew *et al*., 2003) [5]. In the earth, compost carries and feeds a variety of organisms. Bacteria, fungi, flies, worms, and other microorganisms aid in the development of healthy plants. Compost bacteria break down organics into plant-available nutrients, and certain bacteria turn nitrogen from the environment into a plant-

available nutrient (Diaz *et al*., 2011) [4]. Compost improves the ability of soil to hold water and reduces runoff. By transporting dirt, fertilizers, and chemicals to local waterways, runoff pollutes the environment. Composting is a cost-effective and environmentally sustainable way to avoid pollution that ends up in landfills (Lasaridi *et al*., 1998) [7]. By replenishing soil organic matter and providing nutrients, compost will increase soil quality and fertility and the long-term viability of agricultural production.

Farmyard manure

The FYM plays a crucial role in the productivity of numerous agricultural systems by supplying essential nutrients through substrate and decomposition to produce organic matter. The soil microbial activity is increased by incorporating FYM (Ghimire *et al*., 2017) [10], which may increase the decomposition rate of organic matter. The organic matter improves soil physical characteristics such as soil hydraulic conductivity, soil porosity, and soil water-holding capacity considerably, which are the essential components of soil quality (Shepherd *et al*., 2002) [9]. The production of aromatic and aliphatic hydroxyl acids due to the decomposition of FYM can also increase the complexing of exchangeable and free aluminum ions and lower the pH (Malav *et al*., 2020) [8].

Conclusion

Low plant supply of soil Zn is a significant issue in cereal production, resulting in a substantial decline in yield and grain nutritional quality. Plants show various symptoms due to lack of Zn in soil, and produced yield will be Zn deficient. Therefore a high priority research subject, particularly in Zn-deficient areas, is the application of organic fertilizers such as compost, BS and FYM singly or in combination with Zn inorganic fertilizers practiced.

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