Review Article

How to Cut Down The Gap Between The Zn Requirement and Supply of Food Chain and Crop Growth: A Critical Review

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Abstract

Background and Aims: Zinc deficiency is increasing becoming a problem in human nutrition. Many researches are undergoing now a days on crop growth and environment to meet the total dietary requirement. This is how crop bifortification of Zinc (Zn) is taken for this study to narrow down the gap between the potential yield and actual yield. For rational use of plant nutrients combined soil plus foliar application of Zn is recommended in major area of plant research. Too much or too little application of nutrients poses serious threat to crop growth and environment.

General Observations: Tree spray with 0.6% ZnSO4 performed highest enlarge in Kinnow Mandarin height, crown width and stem girth, fruit diameter, fruit weight, ascorbic acid content and total phenolics compared to all other treatments. Zn has an ability of pomegranate trees to tackle against various disease and environmental stresses. The result of Zn application on fruit juice dry weight, density and TSS is highly significant. Both time and frequency of spraying offer an advantage for crop growth and development. In wheat if three sprays are applied should done at tillering, jointing and boot stage and if only two sprays to be done need to at tillering and 2nd spray at jointing stage.

Conclusion: So if only one micronutrient need to apply than Zn is the first choice. Application of ZnSO4 in the form of foliar spray is suggested.

Keywords: Biofortification; Zinc Sulphate; Stomata; Foliar application; Soil application; Fruit quality

Gap between food supply and the Zn requirement

Zinc (Zn) is a crucial micronutrient element for animals, human beings and plants worldwide (Myers et al., 2014). And it is projected that 10% of all the protein in human body i.e. around 300 proteins are Zn dependant (Krezel and Maret, 2016). Zn deficiency causing both in small and large scale can lead to stunted growth, eczema, delayed sexual maturity, mental development disorder and hair loss (Barokah et al., 2018). And more than two billion people currently are distress from lack of Zn nutrition (Myers et al., 2014). The adult body contains 2-3g of Zn in all parts with organs, tissues, fluids and cells. It is helping to increase height, weight and bone development, growth and cell division, immune system, fertility, taste, smell and appetite. Skin, hair, nail and vision loss are the certain features of low Zn content in the blood serum. Dwarfism, dermatitis, impaired neurology, reduced immune system, infection and death are the clinical features of severe Zn deficiencies in human. Some peculiar features are growth reduction, prolonged sexual and bone development. Skin lesions, diarrhea, alopecia low appetite and amplified susceptibility to infection caused disturbing the immune system and the appearance of behavioral changes.

There is a global concern over the diets of malnourished people in developing countries i.e. nutritional diversification, food enrichment and biofortification. Where, biofortification is the perpetual solution. Bioforticfication with plant breeding or agronomic approaches offers a major advantage like nutrient uptake, translocation, partitioning nutrients into cereal grains (Zaman et al., 2017). So there is a benefit of agronomic, breeding and biotechnological approaches of biofortification on food production and consumption.

Globally more than two billion are suffering from one or more chronic micronutrient deficiencies (Kumssa et al., 2015). And about 1.1 billion people are at the risk of Zn deficiency (Kumssa et al., 2015)

Out of the 90% people live in Asia and Africa suffering from stunting and death incidence for instance in children (Kumssa et al., 2015). Rice wheat cropping system occupies 26 Mha in south and southeast Asia. Out of these 80% is the Indogangetic plain. Zn deficiency is widespread in rice wheat cropping system. The major cause of Zn deficiency is sequential cropping of rice and wheat, high soil pH, and formation of insoluble complexes of zinc with carbonates and bicarbonates (Rehman et al., 2012). Now a day's crops are increasingly grown under suboptimal conditions (Wang et al., 2008). So the actual yields of crops are far below than the potential yield. For many crops the fertilizer application is the simplest way for making swift correction of plant nutritional status as in wheat (Potarzucki and Grzebisz, 2009). Zn supplementation on animal based diets is higher than the plant based foods. Moreover there is very little access to the food item of animal origin by poor people. Poor people mostly rely on cereals. Wheat and rice are considered to be as very low supplier of Zn (Cakmak and Cutman, 2017). These three cereals rice wheat and maize occupied 60 percentage of the daily energy intake (Cakmak and Cutman, 2017). There is large gap between daily requirement of the Zn and food grain supplies. Food grain supplies about 20 mg Kg^{-1} of Zn whereas human demand is 40-50 mg Kg^{-1}. So there is necessity of biofortification of the food grains with Zn grown all over the world. (Cakmak and Cutman, 2017). Increment in the grain production due to decades of effort in green revolution solely does not increase the Zn amount it is probably due to dilution effect (Cakmak and Cutman, 2017). So this study is specially designed to deal with reducing the Zn hunger in the crop and ultimately to cope with human hunger for the food.

It is projected that one third of the world population are lacking in Zn (Figure 2, Solanki and Laura, 2018). Zn deficiency is also defined as hidden hunger. Zn deficiency is most spread worldwide (Figure 2). It is essential to treat one third of the total human population by Zn. Dietary intake is the chief sources of Zn and Zn deficiency is high in a region where cereals are main sources food. Similarly, in the developing countries where cereal offer more than 70% of the diet (Myers et al., 2014). Comparing to diverse age groups, adult, infants children, adolescent, pregnant and lactating women have increased necessity for Zn (Solanki and Laura, 2018). Zn exists in five forms (a) as a free and complex ion in soil solution (b) as a nonspecifically absorbed cation (c) as an ion occluded mainly in soil carbonates and Al oxides (d) biological residue and living organism (e) as a lattice structures of primary and secondary minerals (Solanki and Laura, 2018).

Zn can be applied via soil, seed and leaves to increase grain Zinc concentration. Foliar application is much more useful method in grain Zn buildup than that of the soil incorporation (Zaman et al., 2017). On the other hand other group of authors states that soil incorporation is more successful in increasing grain yield. A combination of foliar and soil incorporation is superior for both Zn intake and grain yield (Cakmak, 2010). Fertilizer based on Zn biofortification approach is not always optimal solution from an economic point of view. Agronomic approaches can only complement breeding strategies.

Many research activities are being carried out which address the connection between micronutrient given to plant and allied crop growth and trace element. Such as Zn, Mn and Cu are increasingly required as essential when targeting far better yield. Zn deficiency reduces flowering and fruit development, lengthens growth periods, decreases yield and quality and emphasized in sub-optimal nutrient use efficiency. Some of the distinctive Zn deficiency symptoms in plants are light green, yellow or bleached spots in interveinal areas of the older leaves. New leaves are smaller in size and often termed as little leaf and showing rosetting i.e. the inter nodal distance become shorter so that all the leaves emerge to come from the same point (Solanki and Laura, 2018).

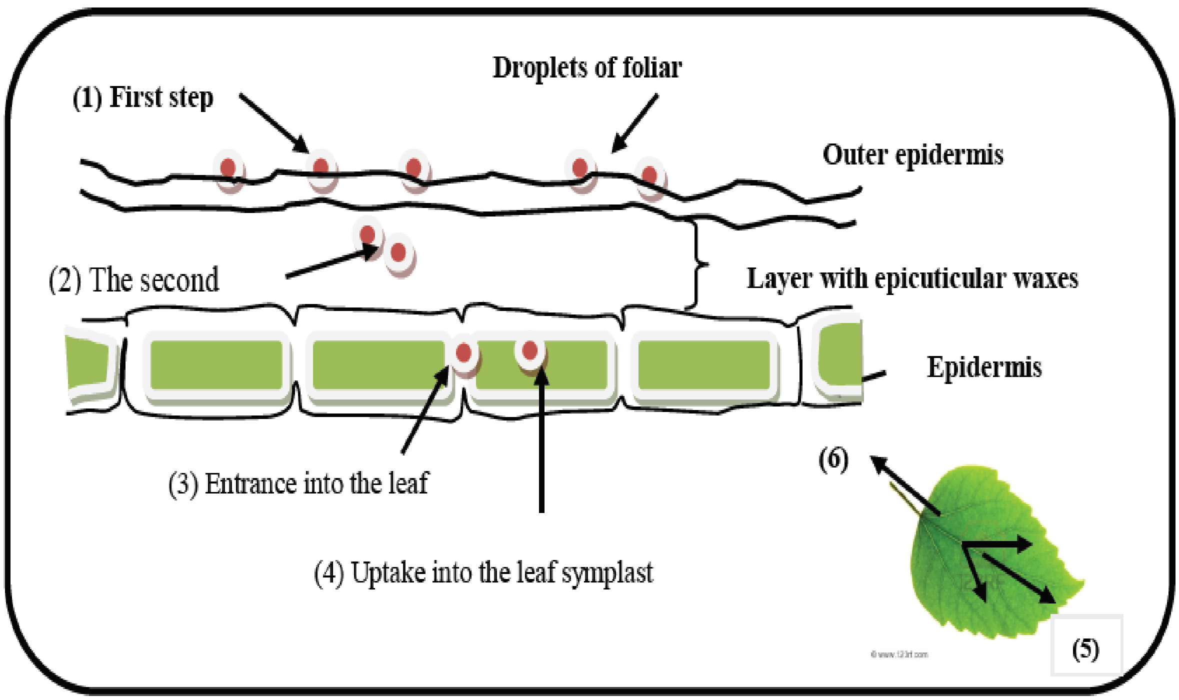

Figure 1: Stepwise representation of Zn retention in leaf after foliar application (1) Wetting of the leaf surface with fertilizer solution; (2) penetration across the outer epidermal cell wall; (3) entrance into the leaf apoplast; (4) uptake into the leaf symplast; (5) Distribution within the leaf; and (6) transport out of the leaf. (Source Alshal and El-Ramady, 2017).

A biological method to enrich Zn element in seed and food is called Zn biofortification. There are two approaches of Zn biofortification. First one is plant breeding or genetic engineering approach and the second one is application of field crops with Zn fertilizers (Bouis et al., 2011). Breeding of plant varieties with high accumulation of Zn is focused in plant breeding and genetic engineering approach. Also the use of crop varieties with high uptake of zinc is considered. Moreover the agronomic biofortification which is also the quickest method to supplement diet with Zn. Fertilizers are applied either foliar or soil application and their translocation to crops parts are studied (Bouis et al, 2011). However there are several challenges of the agronomic biofortification due to loss of nutrients by evaporation, seepage and runoff (Barokah et al., 2018).

In the world scenario half of the soil is deficient in Zn (Figure 2; Solanki and Laura, 2018). Natural concentration of Zn for cereals is low and decreased the Zn content even for the future use. To provide the food for growing 9 billion by 2050 requires highly advanced research on Zn biofortification. Evaluation of 256,000 samples all over the India showed 50% are Zn deficient (Solanki and Laura, 2018). By 2025 the Zn deficiency in India causes to be enlarged from 50-63%. This is also because expanding area of marginal lands is brought under rigorous cultivation without enough micronutrient application. Moreover more than 75% of the field test were illustrated to be deficient in Zn in 43 districts. Lack of Zn fertilization in the soil found low yield (Solanki and Laura, 2018). Major causes of Zn deficiency are (a) soil with low Zn content (b) soil with restricted zones (c) high soil pH (d) soil with low in organic matter (e) microbially activated Zn (f) High level of available phosphorous (P) (Solanki and Laura, 2018). Zn is primarily taken up by plants as divalent cations from plant roots (Figure 3). However in some instances plant roots absorb few ligands-Zn complexes. Depending upon the distinctiveness of ligands, efflux and afflux of nutrient occurred.

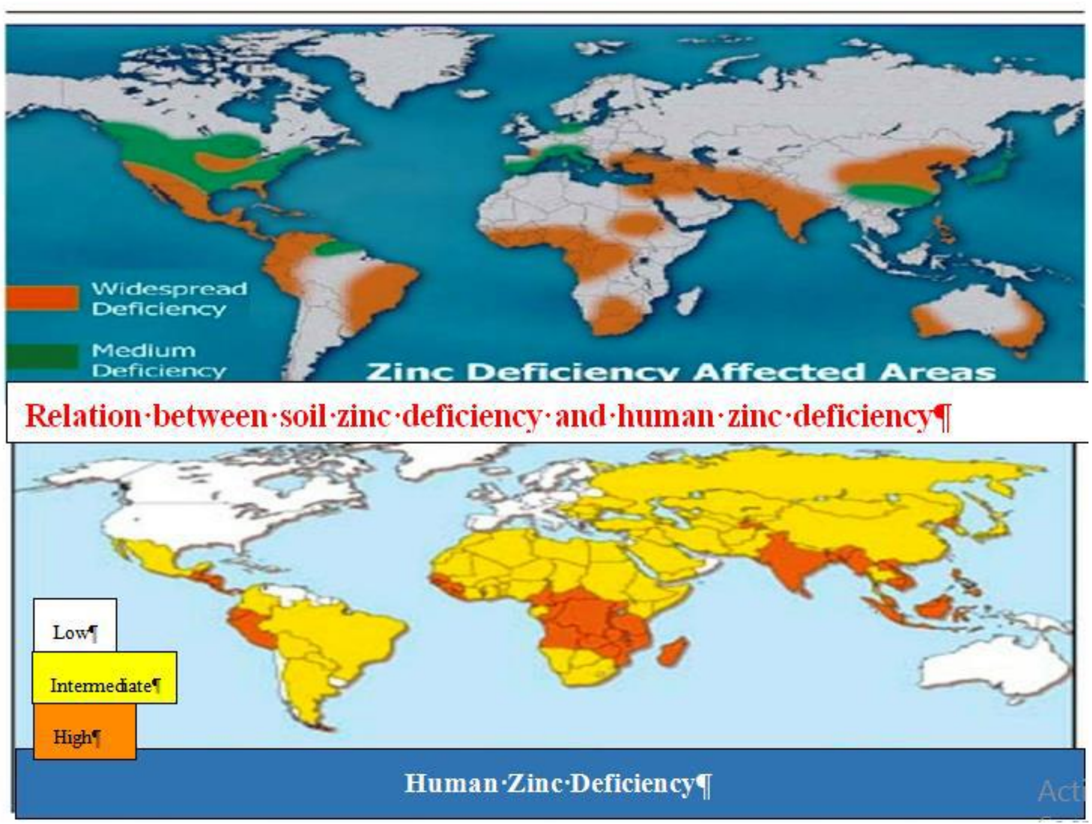

Figure 2: Showing the relation between soil zinc deficiency and human zinc deficiency (Source: Solanki and Laura, 2018).

Brief History of Zn application in Agriculture

Today the cause and consequences of Zn deficiency and methods of overcoming the deficiencies were declared in a well established agriculture (Nielsen, 2012). Zn firstly identified as plant essential nutrients in 1926 and for mammals in 1934 (Nielsen, 2012). Zn cures parakeratosis disease in swine. Poor growth, leg abnormalities, poor feathering etc are some features of Zn deficiency in chickens. Nearly one half of the world soil today was Zn deficient causing low Zn content and its productivity can be increased by the use of Zn fertilizers. The causal factors of the Zn deficiency can be met by grazing livestock in the pasture with Zn fertilization and allowing them to salt lick.

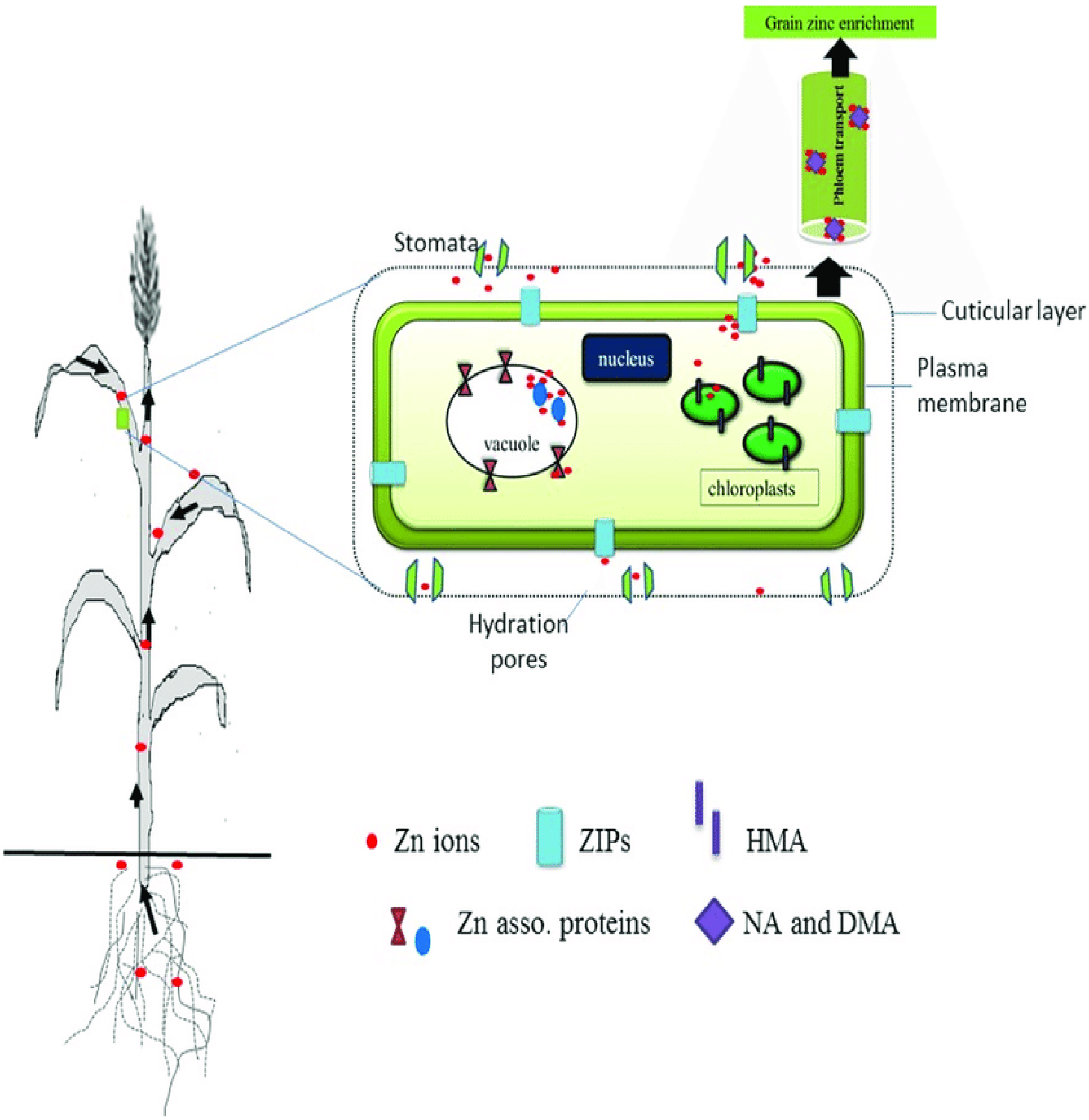

Figure 3: Diagrammatic representation of wheat plant showing Zn uptake from root and leaves (Source: Deshpande et al., 2018).

In 1869 Paulin student of Louis Pasteur reported that Zn is essential nutrient element for the growth of *Aspergilius niger*. Later, Bertrand and Javillier demonstrated requirement of Zn for hydroponically grown maize. Similarly Sommer and Lipman reported Zn was required for the growth and development of Sunflower and Barley (Nielsen, 2012). The first signal that Zn might be required by animals is shown in 1905. Zn was a major part of respiratory pigment in snail. The nutritive function of Zn appeared after examining cow and human milk. Zn was essential for growth and development of rat. Zinc is unavailable through absorption by clay or $CaCO_3$. In waterlogged soil Zn deficiency exists because of the production of sparingly soluble Zn compounds in the oxidized rhizosphere. Now Zn deficiency problem is prevalent all over the world. The problems also appeared in the flooded rice in the world. An increase in Zinc/phytate ratio in grains also improved Zn bioavailability for humans. The dosage of Zn for growing or finishing pigs was found to be 24-33mg/Kg diets. Also 50-100 mg Zn was suggested for lactating or finishing pig. Chicks provided with the low Zn based diet showed frizzled features, shortening and thickening of the long bones (Nielsen, 2012). Although chicks are provided with the 26 mg/Kg of Zn diet had ordinary leg and normal growth and development. Chicks provided with Zn 2-7 mg/Kg should exhibit the symptoms of Zn deficiency. A deficient embryo showed abnormal skeleton development with the curvature of the spine. Shortened and fussed lumbar vertebrate and in some cases lacking toes. Newly hatched chicks from egg or not excessively deficient, hens are weak could stand eat or drink. The Zn dosage set for layers is 50 mg/Kg diet and brooders is 65mg/Kg diet, calves fed 40mg/Kg did not demonstrate the symptoms of parakeratosis. The amount of Zn concentration of pasture forage in Guyana was 18-42 mg/Kg. Actually it is showed that Zn application in the pasture from 17-20mg/Kg ruminant diet. In the pasture it should be around 30 mg/Kg dry matter and 7-18 mg/Kg Zn is required for the lambs. In goat kids range from 15-23, gestation 26-48 and lactating 40-70 mg/Kg. Salt lick grazing with 1-2% Zn usually provides sufficient nutrient intake of grazing animals (Nielsen, 2012). The normal dose of Zn in children is 5 mg per day for a child of seven months to three years and 10 mg/day is recommended for older children. Zn deficiency is common in children under the age of five years. Lack of dietary diversification in lactating and pregnant women caused several abnormalities. Therefore Zn biofortified cultivar of staple cereals is on demand. It was generally reported that Zn biofortified wheat accumulates Cd and Pb in grain concentration. It is already known that Zn application decrease the root uptake and grain accumulation of Cd in wheat. Wheat variety Zincol-2016 has higher Zinc demand than Faisalabad 2008 (Hussain et al., 2019).

Role of Zinc in plant growth and development

Plant growth and development is enhanced by effective application of proper amount of soil nutrients in the root zone. Failure to apply the proper amount of soil nutrition will have adverse effect in growth and development. So not only Zn but also each and every nutrient required for balanced fertilization i.e. an application of macro and micro nutrient elements such as N, P, K, Ca, Mg, S, Fe, Mn, Zn, B, Mo, Cu, Cl, etc in proper amount (Kumar et al., 2012). Zinc in soil and plant nutrition is becoming major concern over the more than forty different countries worldwide (Alloway, 2008). About more than 50% of the soil grown in wheat are deficient in Zn element. Some examples of soil which are deficient in Zn are calcareous soil, sandy soil, tropical weathered soil, saline soil, waterlogged soil and heavy soil etc. (Alloway, 2008). In the soil solution there is decrease in Zn by 30 fold with each unit increase in pH from 5- 7. When soil pH is higher than 8 the Zn bound more strongly causing poor availability of the Zn in soil solution. Other factors causing Zn deficiency is soil moisture. Under drought condition there is lack of Zn uptake in wheat (Cakmak and Cutman, 2017). While cultivating rye bread wheat, triticale and durum wheat there is decline in the yield of crop by 80% due to Zn deficiency (Rehman et al., 2017). Among all the cereals wheat is one of the crop affected badly with Zn deficiency (Rehman et al., 2017).

Zn is crucial element for many physiological processes including protein synthesis, nucleic acid and carbohydrate metabolism, enzyme activation (Cakmak, 2000). Zinc increases the quality of wheat grain by increasing the concentration of globulin, glidans,, albumin, glutenin etc. Also the Zn is cofactor of Zn finger proteins and RNA and DNA polymerases. Zn is cofactor of more than 300 enzymes and activates several hormones (Cakmak, 2010, Cakmak and Kutman, 2017)). Also Zn is essential for numerous biochemical processes such as nucleotide formation, auxin metabolism, enzyme activation and chlorophyll formation (Cakmak, 2010). Zn has a special role in fertilization as pollen grains have very high concentration of Zn. Zn has also important concern with a lot of physiological processes. Plant growth and metabolism, carbohydrate, lipid, protein synthesis, nucleic acid metabolism, gene expression and regulation (Chang et al., 2005). Activity of superoxide dismutase carbonic anhydrase depends on Zn availability. In Zn efficient wheat genotype the ratio of Cu/Zn SOD is up regulated and in Zn inefficient wheat genotype the ratio of Cu/Zn SOD is down regulated (Hacisalihoglu et al., 2003). Zn is required for chlorophyll synthesis and repair of photosystem II by. transferring the damaged D1 protein, increases the chlorophyll fluorescence ratio and accelerates carbonic anhydrase activity. Soil concentration of Zn is 17-125μg g^{-1} approximately 64μg g^{-1} for uncontaminated soil. In Zn deficient soil it is10μg g^{-1} and contaminated soil it is more than 200μg g^{-1} (Rehman et al., 2017).

Zn interaction with other nutrient elements and abiotic factors

Interaction study of Zinc with other nutrient element is noteworthy. Some species of plant even accumulate three times more Zn in their tissues than the crop. Better fertilization with nitrogen improves the Zn uptake in several crops (Cakmak et al., 2017). Three times higher the Zn concentration is observed in potato after foliar application of Zn to the crop (Cakmak et al., 2017). To measure the activity of the enzyme carbonic anhydrase is the means of accessing physiologically active Zn. A reduction in the enzyme activity which can be correlated with increased Zn in Zn deficient in several species (Swietlik, 1999, Fageria, 2001). Heavy fertilization with Nitrogen is reported to have Zn deficiency in citrus of Florida. This is because that the application of Nitrogen increases tissues numbers and sizes and eventually increases Zn hunger. Similarly Nitrogenous fertilizer increase acidity in the soil which increases Zn availability (Swietlik, 1999). Likewise there is positive correlation between Iron (Fe) and Zn in crops (Swietlik, 1999). Also Zn showed its positive effect in accumulation of Boron and B toxicity or toxic effects of excessive B in Barley and in other crop plants (Swietlik, 1999; Fageria, 2001). However it is not understood where is the interaction between Zn and other nutrient takes place either in soil or plant (Fageria, 2001).

Beside this nutritional factor, availability of Zn is affected with light, temperature and moisture. Lower light intensity has lower requirement of the Zn in biochemical and cellular function. Whereas higher light intensity increased function of biochemical and cellular availability in the requirement of Zn is high. Colder part of the earth has lower requirement of Zn whereas the warmer part of the earth has higher requirement of Zn. This is because of root growth and microbial activity. Mainly microbial activity helps in adsorption and translocation of the nutrients. Similarly soil moisture has a role in Zn availability of the plant. Low moisture restricts the root growth and hampered uptake of the Zn by lower adsorption either by the low root growth or diffusion to the root surface. Also in flooded rice there is deficiency of Zn.

High level of nitrogen application causes Zn deficiency due to higher dilution effect and at lesser degree by changing the soil pH to more alkaline (Sadeghzadeh and Rengel, 2011). Also nitrogen application decreases root to shoot ratio. Decreasing total root mass decrease the Zn uptake and utilization in plant (Sadeghzadeh and Rengel, 2011). Changes in soil pH from acidic to basic reactions cause decline in Zn uptake. Zn uptake decreased significantly with increasing soil pH from 4.6-6.8. Also in the calcareous soil Zn availability decreases due to increasing soil pH. Increasing soil pH from 8-8.3 doubled the Zn binding strength to the $CaCO_3$ mineral calcite. Similarly high soil pH reduces the Zn bioavailability due to formation of insoluble complexes with carbonates and hydroxides (Rehman et al., 2017). Also soil with low organic matter content has low Zn content and there is high Zn in a soil with high organic matter content. There is positive correlation between Zn and organic matter content. Also the crop growing season has an effect on Zn mineralization. In cool season the mineralization of soil is reduced and there is reduction in Zn mineralization. Low temperature restricted organic matter decomposition and root growth. Zn also can help with recovering crop with B toxicity. It is also found that there is positive interaction between Zn and N and negative interaction between Zn and P. The other nutrients which has positive interaction with Zn are K, Mg and Ca and negative interaction with Cu，Mn and B (Rehman et al., 2017). Zn has positive interaction with arbuscular mycorrhizal fungi (AMF). The root growth and Zn solubilization were increased by combined interaction of plant growth promoting rhizobacteria and AMF. (Rehman et al., 2017). The major causes of Zn deficiency in rice wheat cropping system is parent material, high pH, high P, high bicarbonate etc. But Green manure crops increases the Zn bioavailability. There are few examples of crops where biofortification has been done. Antagonistically, phosphorous (P) interacts negatively with Zn. Zn and P interaction determines the grain yield and the dry matter production. High Zn seed caused production in drought, waterlogging and salinity conditions. The better performance if high Zn under abiotic stress may be due to enhanced antioxidant activity. Plant with high intrinsic seed Zn could ameliorate the adverse effects of these stresses by reactive oxygen species damage through accumulation of proline and total soluble phenolics to reduce oxidative stress (Faran et al., 2019). Phosphatic fertilizers: Either native phosphorus or due application of phosphate fertilizer can cause Zn deficiency. Zn extractability and plant availaibility is negatively related to the phosphate content of the soil. Also type of the parent material from which soil originates from limestone or sandstone had lower Zn content. Phosphorous fertilization reduces the Zn concentration in the soil solution. There will be reduction of Zn^{2+} ion in soil solution. In contrary to the situation between negative Phosphorous to Zn interaction can be caused by an insoluble form of Zinc Phosphorous combination $Zn_3(PO_4)_2$. Phosphorous antagonism with Zn is that when there is high Phosphorous there is less physiologically available Zn in soil solution. It raises the question why there is high supply of Phosphorous increases the Zn deficiency symptoms in the crop. Soil with high in P decreases Zn solubility. Large application of P in soils reduces the availability Zn (Nielsen, 2012). High application of soil P reduces the Zn concentration in the root zone and subsequent effect on Zn uptake and utilization (Sadeghzadeh and Rengel, 2011). Similarly the P fertilization the absorption rate of Zn is reduced. Under high P application there are two ways for Zn deficiency one is due to affecting the rate of translocation and the other is by reducing the rate of absorption ((Sadeghzadeh and Rengel, 2011). On the other hand the higher application of Zn keep the soil P low causing lower yield due to shriveled grain in wheat (Sadeghzadeh and Rengel, 2011). Cationic micronutrient i.e. calcium potassium and magnesium keep low root Zinc level. In a wheat seedling the higher concentration of $Ca(NO_3)_2$ from 0-20 mM decreased the Zn concentration. Also the cationic micronutrient Cu^{2+} decreased the Zn concentration (Sadeghzadeh and Rengel, 2011). The interaction of Zn and Fe is complex. Increasing Fe supply the Zn concentration either increased, same or low (Sadeghzadeh and Rengel, 2011).

Quartz has very low Zn content. The total Zn concentration varies between10-300µg/g with an average of 50µg/g But the available Zn varied from 1-3µg/g. Zn deficiency occurs in alkaline soil rather than acidic soil. A soil having high pH would usually contain a small amount of available Zn. The lower availability of Zn in alkaline soil is due to the precipitation of Zn(OH)2 or ZnCO3. The pH and uptake of Zn by plants shows a negative correlation pH above 6.5 results in decrease extractability and plant availability of Zn. Also a positive correlation was observed between the organic matter and Zn uptake. Soil with low organic matter has lower Zn content. Likewise lighter texture for instance sand has low Zn content. Fine textured soil with high CEC and high Zn uptake. Soil application of foliar fertilizer imparts negative impact as the rates of conventional fertilizer are low. So only application of foliar fertilizer in a huge amount the chemical to be added which may be hazardous to the soil plant and environment. This is why application of Zn nano particles is recommended. Zn nano particles may have a high potential to be used as a fertilizers for increasing the growth of plants. Nano particles are helpful to address the Zn deficiency by combating human deficiency of Zn (Solanki and Laura, 2018).

Combined application of Zn and N increase wheat productivity and quality of grains. Here a study was conducted to investigate the interaction of projected climate (PC) and N and Zn supply on growth, yield and yield determinants and nutritional quality of wheat. The positive effect of elevated CO_2 has an effect on temperature only in the ambient temperature not in elevated temperature. However no information is available on the impact of elevated CO_2 and increased temperature and Zn application as well as interactive effect of predicted climate with Zn and N application on wheat. Recently interactive study of elevated CO_2 Zn application on wheat yield was taken. The projected climate change condition reduced time to complete earlier stage of plant life cycle. Plant height is shortened comparatively by N application whereas plant height is increased by Zn application. Overall adequate Zn, Low N and ambient condition (AC) treated plants were tallest whereas the low Zn adequate N and AC plants were shortest. PC treated plants decreased overall grain yield by 12% whereas adequate Zn and N treatment increased grain yield by 38 and 90 % respectively. The interaction between climate and Zn is insignificant; adequate Zn increased grain yield of AC and PC treated plants. PC reduced straw yield by 13% as compared to AC. Whereas N and Zn increased straw yield by 68 and 24 % respectively. Nitrogen reacted with climate resulting in highest straw yield in plants grown under adequate N and AC following by these PC and low N. Nitrogen also interacted with higher response to Zn supply. Harvest index was not affected by climate or the Zn treatments. Zn treatments significantly interacted with climate increasing 94mm in low Zn to 101-103 mm in adequate Zn spike length. Zn treatment significantly interacted with main spike length, grain yield at adequate N compared to low N plants. Whereas plant grown under AC increased grain Zn concentration from 9.9-11.4 mg/Kg. Similarly N application significantly increased 9.3-12mg/Kg of the grain Zn concentration. Grain protein concentration is increased by adequate N treatment fourfold compared to low nitrogen plants. Under AC condition adequate nitrogen increase yield by 74% whereas under adequate Zn condition these increase was about 138%. Under low condition the effect of Zn and climate has low effect. Under adequate condition the grain yield reduction was through decreasing number of spikes per plant and no of tillers and spikes per plant during vegetative growth. Since PC condition hastened plant development and reduced duration of time to complete successive growth stages. Receiving less radiation during the vegetative stages result lower number of spikes but also results in reduction of photosynthetic energy harvest. Adequate N supply there is increase in 52 and 50% grain yield increment in AC and PC conditions respectively. Harvest index was unaffected by most of the treatment. Adequate nitrogen treatment increased the harvest index than low N treatments. Grain Zn concentration increased by both adequate Zn and N application elevated CO_2 is one to decreases grain Zn concentration. Combined effect of elevated temp and CO_2 to simulate the predicted climate change scenario and found no decrease. The negative effect of elevated CO_2 or grain nutritional quality is the consequence of enhanced grain yield rather than climate effect. Lowering the yield under PC condition would threaten the global food supply. High input agriculture can be under threat of Applying N and Zn. Growth cycle is reduced under predicted climate condition. N supply increased grain yield mainly through increasing the number of spikes, plant adequate Zn fertilization influence grain yield through increased spike length, number of grains and grain yield per spike. Adequate Zn improved grain quality by increasing grain Zn concentration, while adequate N increase protein concentration (Asif et al., 2018).

Ways to cut down the gap between Zn requirement and food supply

Biofortification

Currently one half of the world population is malnourished, lacking micronutrients such as Zn which is essential for human health. Biofortification of essential minerals vitamins and micronutrient is taken for the study. Diet diversification and mineral supplementation are recognized approaches to get rid of micro nutrient deficiency. Use of fertigation, foliar spray, generation of new crops and their varieties, breeding or genetic engineering are some of the achievement of biofortification. The general mechanism of Zn uptake as well as soil condition conducive to Zn deficiency is described. Overexpression of genes these are responsible for uptake, transfer and accumulation of Zn in plant tissue such as rice grains. Biotech crops with reduced accumulation of antiutrients such as phytic acid are also under developed through the use of RNAi technology (Hefferon, 2019)..

Last 20 years have been the years of biofortification in wheat, rice cassava, maize, sorghum and other major food crops. Zinc deficiency is the first discovered in 1960. Zn deficiency may be result of poor diet and poor soils. Zinc is transported either in Zn^{2+} form or an organic acid (Figure 3). Zn has different functions in plants. Zinc accumulation is high in seed. Most of the world arable soil lack adequate levels of Zn. Binding of Zn with $CaCO_3$, soil erosion, industrial runoff and irrigation water cause Zn toxicity. Today 17.3% of the world population is Zn deficient. Around 400,000 children below five year die due to Zn deficiency. Zn deficiency is responsible for growth and cognitive retardation, poor immune function as well as reproductive problems. Beside iron Zn is the second most important metal found in the humans. Zn homeostasis can change depending on the Zn availability and physiological requirements of an individual. Symplast to symplast movement of Zn and also through apoplastic spaces. Moreover cell to cell communication of Zn is from xylem to phloem. And foliar application. In grain filling stage grain Zn concentration increase from 3.7 to 5.6 fold and grain Zn concentration increased to 60 mg Zn per Kg. The overexpression of allele 284 in transgenic rice lines resulted in a high accumulation of Fe and Z. Both uptake and root shoot translocation of Zn increased and this enhancement was sustained for days afterward. Through plant breeding it would be extremely cost effective. In Bangladesh it is 22% and out of which mainly women 73-100% Zn deficiency occurs. Transgenic plant could be developed for the agronomic biofortification reduced antinutritional factors such as cyanogens and phytate. Increase in ferritin in rice and OsYSL2 in rice endosperm the transgenic rice produced higher levels of iron and Zn. The transgenic produced higher levels of iron such as 6 fold in green house, 4.4 fold in paddy and 1.6 fold in Zn. Here it is to emphasize that multiple gene activation is more effective than single gene activation. Introduction of soybean ferritin gene driven by two ensosperm specific promoters is helpful (Hefferon, 2019).

Zn and its role in Biofortification

Peoples around the world are suffering from hunger and malnutrition. Animal and plant sources of food are main sources for feeding the growing billion. Among them main staples is wheat which is fundamental to human. Total protein share of human diet is varied from wheat 21%, rice13% and corn 4% (Asif et al., 2018). Wheat is the most widely grown crop in the world. But production of wheat is affected by biotic and abiotic factors. Sustaining food productivity over long term or short term effect of these stressors needs to be access in the field conditions. So development of new climate resilient variety is challenging while that of the climate change component the cheaper in CO_2 and temperature is prominent. A rise in 3^oC in temperature due to high 400 micro molar/molar and predicted to increase 700 micro molar/molar in the coming century. RuBisco function is accelerated because the function of RuBisco increase there is increase in yield and biomass production (Asif et al., 2018).

Zn is essential micronutrient in wide array of physiological and biochemical processes. The critical Zn concentration for the youngest emerged wheat leaf is

14mg/Kg, at tillering 16.5mg/Kg, and at anthesis 7mg/Kg and whole grain is 10 mg/Kg (Rehman et al., 2017). Zn is constituent of carbonic anhydrase and required for the activity of ribulose 1,5 biphosphate carboxylase, reduced chlorophyll concentration and lowers the chlorophyll a:b ratio cause damage to the photosystem II. Early spillover from PSII-PSI. Such damage to photosynthetic centers results in leaf photosynthetic capacity susceptible to photo damage (Zaman et al., 2017).

Zn is the most widespread micronutrient deficiency problem in agricultural lands around the world, especially in cereal cultivation soils. Several plant biochemical process such as photosynthesis, protein synthesis, pollination, antioxidant activity, growth regulation and disease defense mechanism. This is why Zn nutrition in human health is of public concern. Human needs 15mg Zn per day. Daily intake is below recommended doze. Food fortification requires continuous financial outlays and it is out of accessible to all socioeconomic levels of the population (Gomez-Coronado et al., 2015).

Zinc deficiency in higher plant was first reported by Sommer and Lipman 1926. Now more than forty country worldwide are facing Zn deficiency (Alloway, 2004). Almost 30% of agricultural land worldwide is Zn deficient (Alloway, 2008). Cereals with lower yield and poor quality grain have low Zn content and its growth stages are affected severely. Low Zn decreased Zn contents of the crop. Grain Zn content can be reduced upto 80% when the wheat is grown in Zn deficient soil (Rehman et al., 2017). Wheat is more sensitive to Zn content. In Zn deficient soil upto 32% increment in wheat grain Zn content is recorded. According to the report of Cakmak et al 1996 an increase upto 550% in the grain yield of wheat is possible. Zinc deficiency cause poor root growth eventually leading poor water uptake. Zinc deficiency alters the movements of ions across the plasma membrane. Similarly Zn deficient plants have low level of IAA and caused poor seed setting due to increased level of ABA. Also the Zn deficiency alters the structure and function of the stigma and pollen grains (Rehman et al., 2017).

Biofortification work in wheat

Wheat is the staple food for the more than 35% of the people in the world and grown inherently low in Zn. Major wheat based cropping system, rice-wheat, cotton wheat, maize wheat are prone to Zn deficient due to high demand of Zn to these crops. Lack of Zn in the daily food is the most common micronutrient deficiency affecting human health. Although an application of the Zn through seed treatment has improved the grain yield and Zn status in wheat. Increment in the wheat yield by seed application of nutrient Zn is major concern. Incorporation of legume increases the soil content of Zn. Moreover available soil Zn pool can be increased by application of Zn in soil or foliar spray. Also seed enriched with Zn increased plant Zn status. Both agronomic biofortification and genetic improvement has been recommended in crop growing under Zn deficient soil (Goloran et al., 2019).

A major work of Zn biofortification has been done in wheat (Triticum aestivum, durum). Irrespective of cultivars Zn increased yield in wheat in different varieties grown (Yilmaz et al.,1997). In comparison to control increase in yield were recorded upto 260% with soil application. Similarly 204% higher in yield with soil+leaf and seed+leaf application. And there is a record of 124% increment in yield with leaf application alone (Yilmaz et al., 1997). Soil application of Zn is economical and has long term effect on a Z deficient soil. When high Zn concentration in the grain and high grain yield is to be achieved one can follow soil+foliar application of Zn (Yilmaz et al., 1997). At least double the leaf application is needed to correct the Zn deficiency in wheat crops. And it is stated that seed and leaf application of Zn alone were not as effective as soil, soil+leaf and seed+leaf application in wheat. So a combination of application approaches which yield was demanding for the future. Soil application of 28 Kg/ha as $ZnSO_4$ was enough to correct deficiency in plants for four to seven years. In contrary to this Zn application in the soil with 1-1.5 Kg/ha in maize increased the marketable yield in maize (Potarzucki and Grzebisz, 2009). Soil+leaf application should be considered as an effective method (Yilmaz et al., 1997). Higher level of Zn on grain yield will have beneficial consequences for human health.

Zn plays crucial role. Zn deficiency are widespread in India, Pakistan, China, Turkey and most of the other countries. Particularly in the calcareous soil of the arid and semi arid region, where the 50% of the cereal grown areas of the world is Zn deficient. In wheat the most abundant micronutrient deficiency is Zn. Correcting Zn deficiency to achieve the goal of bumper production. Balanced fertilization is indispensable for correcting growth of plant, nitrogen metabolism, photosynthesis and resistance to biotic and abiotic disease. Leaf Zn associated with a 50%yield reduction in radish ranged from 36-1013 mg/Kg dry weight. Two sprays of Zn 0.5% was given at vegetative stage and the other at corn ear formation. The critical soil P level is 18 mg per Kg. Spraying of Zn increase leaf Zn from 32.8 to45.2 mg/Kg. Because Zn is relatively unavailable in calcareous soil of pH 8.2. When soil is alkaline it is becoming unavailable to plants. Bicarbonates concentrations of the soil solution is strongly correlated with the occurrence of Zn and Fe deficiency. Zn foliar application is simple way of quick correction of plant nutritional status. There are three main methods of Zn application is effective tool but costly for the resource poor farmers, because of the lack of amount of fertilizer, equipment and labor required for spraying. For maize frop1-1.5 kg/ha is required, the lowest and the highest mean Zn concentration is at leaf 32.8-45.2 mg/Kg at no Zn and Zn spraying levels. The ratio of P:Zn and Fe:Zn in the shoot at tillering and pod formation stage are good indication of Zn deficiency. Leaf Zn concentration below 15 mg/Kg is regarded as Zn deficient. In deficient condition the level of Zn in wheat grain is below 15-20 mg/Kg. Under water deficient condition the deficiency symptom appear more severe and earlier (Aref, 2011).

Seed priming, foliar and use of soil are the key areas of agronomic biofortification, Also hybridization, choice and genetically engineered crops loading in xylem grains and sequestration in endosperm can further improve the kernel Zn concentration. Zn is the first leading health risk factor for causing disease in developing countries. One third of the world population is suffering from Zn deficiency. Where as in developing countries more than half of the pregnant women and children are suffering from Zn deficiency So biofortification approach in cereal based diets is noteworthy. Keeping in view that the due importance of Zn for human health is focused (Maqbool and Beshir, 2008)

In healthy individual Zn bioavailability is affected by three different factors. They are status of the individual, total Zn concentration in the diet, availability of soluble Zn from blood. Phytic acid binds to the Zn. Phytic acid in maize ranged from 0.62-1.17 g/100g. Genetic variation and phosphorous fertilization affects phytate concentration. According to WHO molar ratio of Zn/Phytate 15:1and according to the ZINGG Zn/Phytate 18:1 are exclusively associated with the inhibition of Zn absorption. Bioavailablitiy of the Zn can be increased by the hydrolysis of PA or by increasing the activity of the phytate enzymes. Different treatments like soaking, germination and fermentation promote the of inorganic ions reduces the availability and possibly citric acid release from the protein keep the Zinc soluble or protein binds with phytate. Binding of Zn with soluble chelates or ligands also increase the Zn solubility and Zn absorption. Dietary diversification is one of the approach to supply Zn. (a) agricultural strategies (b) promotion of consumption of animal based food (c) food processing at domestic or commercial bases are to increase the Zn absorption from plant based diets. Agricultural strategies include kitchen gardening, increasing consumption of red meat, consumption of milk and cheese (Maqbool and Beshir, 2008)

Biofortification work in citrus

Zinc deficiency is the most prevalent nutritional disorder in citrus orchard worldwide. Two conventionally used method are foliar application and soil application. Flowering intensity, fruit set, tree volume etc is measured. Citrus is highly nutrient responsive perennial crop. After N, Zn is the most widespread deficiency element. Zinc fertilization affect both flowering and fruit set. Soil application showed superiority over foliar application. Increasing number of fruit set is a causal over fruit weight of high yield in foliar application (Srivastva and Singh, 2009)

Both methods and amount of application of Zn has major importance in citrus fruit quality and production (Razzaq et al., 2013).Citrus (*Citrus reticulata* Blanco) production comprises a variety of environments worldwide. In this scenario, yield and mineral nutrition of citrus plant fetch due attention. Supplying of optimal doze of nutrition has major attention in citrus production. Application of both macro as well as micro nutrients put forward a major emphasis on the citrus production areas. Here an attempt has been made for the reviewing of citrus with application of Zn. There are many methods of Zn application in plants. Either it is done through foliar application, soil application or treating seeds or seedling. Application of Zn upto 0.6% is beneficial for growth and productivity of the citrus orchard (Razzaq et al., 2013). Use of 0.6% foliar spray increase height, crown width and stem girth. Similarly fruit diameter, fruit weight, vitamin C content and total phenolices were increased in compared to non Zn treated plants (Razzaq et al., 2013).

Biofortification work in mango

Mango growing areas in Asia are calcareous, mostly intercropped and receive less than optimum dose of fertilizers. There is Zn deficiency mainly due to calcareous nature of soil. Exhaustive nature of intercropped plant reduced the uptake of plant nutrients. Higher fruit shedding and lower fruit weight were observed in control plots than in the treated plants. Combined application of B and Zn in soil increased the yield and fruit retention. Increase mango fruit quality and yield in response to the combined application of Zn and B due to increase in sugar, boron and some physiological features. No competition between P and Zn is found in Mango (Ahmend et al., 2018).

Agronomic bifortification

There is also combination of plant breeding and agronomic biofortification approach for the increasing Zn in food crops. Agronomic biofortification is a time saving and effective approach for improving Zn bioavailability in wheat grains. Genetic or breeding approaches where wild emer wheat had great potential in breeding program. Plant breeding approaches is cost effective and long term strategy. However agronomic biofortification is fast and effective solution. The combined foliar+soil application would be most promising solution of Zn biofortification. There is a strong correlation between Zn and Fe concentration in wheat. Moreover dietary risk to consumers due to deposition of Zn in the endosperm of cereals. Zinc fertilization is cost effective intervention to all the crops. Agronomic biofortification includes application of Zn fertilizer. Application of Zn fertilizers soil and/or foliar seemed to a practical approach to improving grain Zn concentration. To increase the Zn concentration of cereals developing new genotype so it can have high Zn in grain. Some criterias which influence the Zn grain concentration are as (a) Keeping sufficient amount of available Zn in soil solution (b)adequate Zn transport (c)optimizing the successes through breeding trials (d) Foliar application of Zn fertilizer greatly contribute to grain Zn constituent.

Soil application

Soil application of Zn enhances upto 40% of the Zn concentration in Maize (Nielsen, 2012). On the other hand soil application of 50Kg/ha $ZnSO_4$ (Cakmak, 2008) is not economical because of its high cost. Seed application by seed priming and seed coating is preferred over soil application. Significantly higher stover yield, maize grain yield and biological yield are obtained with a wheat variety 'PBW 343' with application of 15Kg $ZnSO_4$ per ha (Kumar et al., 2019). In wheat, maximum yield recorded with application of 25 Kg/ha $ZnSO_4$ per ha. Similarly in maize yield increased was recorded with application of $ZnSO_4$ to 50 Kg per ha ((Kumar et al., 2019). Higher effective tiller per m^2, grain per spike and grain diameter during the second year was observed in wheat than in the control. Effective tiller increase due to application of 25 Kg $ZnSO_4$ ha^{-1} by 6, 10 and 11% over 12.5 kg $ZnSO_4$ ha^{-1} Boldness in grain in the wheat variety 'PBW 343' was due to Zn application. Zn alone does not have a role in increasing grain yield and straw yield. Yield increment is achieved together in combination with phosphorous (Kumar et al., 2019).

Foliar application

Addition of fertilizer is a routine practice in modern agriculture. Zn is required as micronutrient in coffee and its deficiency can cause low yield and quality. There is increasing demand for high quality coffee with further investigation on the utilization, technical application and uptake of Zn. Soil condition with limited availability of nutrients high loss rates of soil applied fertilizers and limitation brought forth when the environmental conditions constraint nutrient deficiency to plant organs. Foliar fertigation has proven to mitigate micronutrient deficiencies avoid toxicity symptoms and reduce fertilizer related problems like runoff and leaching losses (Rossi et al., 2018). Foliar application is one of the best methods suited for micronutrient application in several crops. Foliar application has prime role in Zn fertilization and has major advantage of keeping away from leaching through the soil profile. Foliar application has consistent delivery and fast plant responses to the nutrient applied. There is Negative effect of available Zn content when applied with 6.1 mg/Kg to a depth of 0-30cm. Zn content of 1.5mg/Kg was applied for the threshold of the soil Zn deficiency (Gao et al., 2019)

Zn application especially foliar Zn application alone or in combined with soil Zn application resulted insignificantly increase in grain Zn concentration in all cultivars studied. An increase in 260% of the Zn concentration was observed. Grain zinc concentration increased from year to year. Based on the soil DTPA extractable Zn variety INSAV-1 reached the highest target level of 45mg/Kg Zn. Zn concentration should be increased by 10 mg/Kg. Soil applied Zn is beneficial for increasing grain yield. The cost of soil application is 25$/ha would be covered by the grain yield Foliar treatment alone in or combination with soil application was the most cost effective due to phloem mobility of Zn. It was observed that 38% in the year 2010-2011 and 65% in 2012-2013 drought condition during flowering limited the efficacy of foliar applied Zn. Foliar application about 20mg/Kg and 30mg/Kg respectively with combined application. The combination of soil or foliar application produced larger grain yield than soil application alone. The cost of foliar application 4$/ha must be covered either by concerned authorities or by consumer (Gomez-Coronado et al., 2015). Foliar application of $ZnSO_4$ has been proved to be an effective way to increase grain Zn concentration and to overcome Zn deficiency. Time of foliar application is at when plants are at flowering. This is a cheaper solution with easier and economical approach. In maize yield increased in the second year, also in wheat effective tiller increases from 6, 10, 11 percentages. The yield advantages of 0.35, 0.26, 0.28 and 0.43, 0.23, 0.29 t/ha was recorded with application of 25 Kg $ZnSO_4$ per ha and foliar spray respectively (Kumar et al., 2019).

After application of treatment foliarly the production and quality of fruit was increased significantly. Foliar feeding is technique for feeding plants by applying liquid fertilizer directly to their leaves. It is not the substitute for soil application but has advantage over other techniques. It is recommended for application of micronutrients to cure deficiencies. Now day's different products has been developed and certain growth hormones, natural plant sugars, microorganism and other ingredients. Use of spray techniques is the cost effective approach of applying micronutrients use of high or low pressure equipments is recommended for spraying. Spray equipment provides better placement less loss by dripping and more effective coverage of the foliage, than most other methods of foliar application. It is found out that 0.5% micronutrient Zn solution concentration is the best suited doze to increase the Guava in arid region (Arshad et al., 2016). Foliar applications of Zn have been successfully used to increase tree vigor, fruit set and yield in apple and orange trees.

Three Zn concentrations 0, 1050 and 1750 mg L^{-1} has been applied. Application of 1050 mg/L Zn and B 174mg/L has an effect on pollen germination, fruit set, vegetative growth, nut weight, kernel percent, nut and kernel length and chlorophyll index. Zinc deficiency in walnut is visually expressed as small leaves and nuts, delayed opening of vegetative and floral buds. Leaf chlorosis between the lateral veins, wavy leaves with upward folded lest margins and terminal dieback Foliar application enhances Fe concentration and decrease Cd toxicity in maize and other cereals. AMF has potential advantage to increases Zn uptake from soils ((Nielsen, 2012).

Foliar application of Zn fertilizer is one of the approaches for the correction of Zn deficiency in a variety of crops. Use of poultry manure or in combination with $ZnSO_4$ increased grain Zn concentration. Major bottleneck of agronomic biofortification are storage of excess Zn in root vacuoles, dependence of grain Zn concentration on leaf

Zn translocation rather than Zn uptake during seed filing and discontinuous xylem at the base of each grain soil (Rehman et al., 2017). Growing of plant in poor Zn soil with foliar application increase the target beyond. Foliar apply increased endosperm Zn concentration. Soil application with two foliar spray or two post harvest spray is recommended (Cakmak, 2010).

Cimbined soil plus foliar application

Combined foliar cum soil application of the Zn fertilizers reported to significantly improve the kernel Zn concettration. Kernel Zn concentration is positively correlated with Kernel iron (Fe) conectration. However there are also some contrasting reports which suggest that there is weak or no correlation between Zn and Fe concentrations. Experimental studies has shown that there is significant correlation between Fe and Zn concentration and yield increasing Zn concentration and increasing bioavailability of Zn are two approaches for Zn bioavailability (Maqbool and Beshir, 2008).

Genetic bofortification finds enough to produce grains with enough Zn and it should be complemented with agronomic biofortificatin. Greater than 20 mg/Kg increase in Zn than foliar application reaching the target of 45 mg/Kg. Soil application cause yield increase more than 350 Kg/ha. Soil+foliar application increases in the grain Zn concentration greater than 20 mg/Kg Zn with good bioavailability in cultivars (Gomez-Coronado et al., 2015). The highest fruit yield of 49 Kg/tree and the heaviest fruit of 202 g was recorded in combined soil+foliar application of N+Zn. The lowest yield of 35 Kg/Tree and the smallest fruit size of 175 g/tree were recorded in control treatment. Ratio of N/Ca, K/Ca and [Mg] +K/ca in fruits were found suitable for the fruit quality production. Fruit firmness was 77 Kg/cm^2 (Amiri et al., 2008).

Zinc fertilization with Nano Particles

Application of $ZnSO_4$ has been proved to be enhanced grain concentration in wheat. It seems continued application of soil and foliar Zn fertilizer is the most helpful way to maximize grain Zn concentration. Also plant performance and grain yield is important. Now a day's use of nano technologies has been equally effective. Nano technology is one of the most important ways in the modern agriculture. However with significant forthcoming benefit there are considerable uncertainties with regards to probable hope to human health and to the environment need to be clarified.

Use of nano technology materials smaller than 100 nm are nano particles found in production, processing, storage, packing and transportation of agricultural products. Naofertillizer foliar spray has proven to be convenient for field use because they can feed plants gradually and in more controlled manner, than salt fertilizer. Thus reducing the toxicity symptoms than may occur after soil application of the same micronutrient. Nutritional imbalance and phytotoxicity are the two main injuries by oversupply of Zn. Nano fertilizer has the ability to overcome it. Both fresh weight and dry weight is increased in application with ZnO nano particles. The highest amount of ZnO nano particles has affected biomass, fresh and dry weight Zn in low concentrationn is essential for plant but cause phytotoxicity at higher concentration (Rossi et al., 2018).

Zn Biofortification against salt stress

Salinity causes loss of agricultural sector and more than 800 million hectares of land is salt affected. Salinity stress adversely reduced the seedling growth whereas Zn application increased the plant biomass production.

A rice variety KSK-133 was regarded as salt tolerant. The soil application of Zn-EDTA increased the plant growth and yield while under saline conditions. Foliar applied $ZnSO_4$ proved as a good source. Zn application reduced the adverse effect of salt stress by improving the agronomic attributes and could be used as an effective tool for rice production. Zn play important role in regulating Na and K. There are several soil, environment and plant complexes affecting Zn bioavalability. Foliar applied Zn is higher in rice genotypes than the soil application (Jan et al., 2016).

Zn biofortification against drought stress

Drought affects 40-60% of the world's agricultural land. Wheat is already low in Zn content. Further deficiency in Zn cause vulnerable to stress situation. Some causes of Zn in plants are affecting seed vigor and biomass productions are the early stages of growth affected by Zn deficiency. High rates of cell division, elongation enzyme activity, gene expression and protein synthesis occur in the axis during germination. Superoxide dismutase which can help the plant to combat abiotic stress. High level of intrinsic Zn may improve abiotic stress tolerance in wheat seed with high level of intrinsic Zn content could improve wheat performance under drought, water logging and salinity stress. Wheat plants with high intrinsic seed Zn preformed better in terms of growth, morphological and yield related traits. Well watered plants with high intrinsic seed Zn 49mg/Kg had the tallest plant larger leaf area and highest grain number per spike. For plant raised from low intrinsic seed Zn 35mg/kg drought stress has a negative impact on the measured morphological and yield related traits. The soil containing plant with high intrinsic seed Zn and the highest total N and exchangeable K. DTPA extractable Zn and Cl concentrations are normal under drought stressed conditions (Faran et al., 2019).

Influence of Zinc application on plant growth yield and fruit quality

Zn application boost shoot length. Zn treatment had distinctly higher positive influence on shoot growth and development under deficit irrigation (DI) compared to full irrigation (FI). Copper (Cu) concentration in the Zn applied leaves was continuously lower than this of untreated one. Zn pulverization markedly reduced the occurrence of parthenocarpic berry on fruit cluster. Zn treatment determined that occurrence of 124% and 60% lower parthenocarpic fruit in DI and FI respectively (Sabir and Sari, 2019). Zn had a negative effect on the yield, yield component, oil content, and citral content of all three varieties compared to untreated plant. Combined effect of B and Zn produced the highest level of yield, yield component, oil content and citral content for all the varieties. So foliar application of B and Zn needs to be done for improved practices. Zn and B are not only known to be involved in cell wall synthesis, cell wall structure integrity, photosynthetic respiration, carbohydrate metabolism RNA metabolism and other biochemical activities. But also participate in the catalytic and regulatory activities of more than 300 enzymes (Gao et al., 2019). Zn and boron are the major nutrients for maize crop growth and development. In calcareous soil of Iran Zn and B experiment were conducted. There is antagonistic relation was observed between B and Zn (Aref, 2011). Two and three foliar spray is not significantly different. So two foliar sprays are recommended in wheat. If three sprays are applied should done at tillering, jointing and boot stage and if only two sprays to be done need to at tillering and 2^{nd} spray at jointing stage (Arif et al., 2006). Application of Zn to mature leaf is worth less. The best time for foliar spray is just after the senescence of the pistillate flower. Both B and Zn have positive effect on chlorophyll content. The yield of hazelnut was highest when treated with 2000 m/Kg B and 1000 mg/Kg Zn. Gladiolus length and number of effective leaves by addition of 2-3Kg Zn per ha (Keshavraz et al.,2012). Application of N, P, K and S fertilizers generally increases nutritional quality as well as crop yield. Higher application of N increases TA, TA/TSS ratio, soluble sugar, soluble solids, Mg, Ca and vitamin C in some crops. Similarly, incorporation of micronutrients Cu, Mo, Zn, Ni, Se improved fruit quality (Wang et al., 2008). Zn concentration of different edible parts of the plant is shown in (Figure 4).

Zn deficiency is common in pomegranate orchard. 0.4% application Zinc in four varieties of pomegranate increased juice dry weight, density and concentration of solid material and mineral and the number of unmarketable fruit is reduced. Zn application increased significantly Zn concentration of all leaf in all cultivar and fruit juice in three cultivars. However seed Zn concentration was not affected in all cultivars. Based on the result different cultivars responded differently to Zn fertilization under irrigation with saline water. An application of 0.25% of $ZnSO_4.7H_2O$, iron and manganese sulphate with boric acid 0.15% increase pomegranate yield from 18.5-26.37 Kg per tree and juice content form 65.6-74.8% more than 1.3 t/ha yield was achieved in pomegranate orchard in Iran with foliar application 0.5% $ZnSO_{4.}$ Zn fertilization significantly reduced unmarketable fruit yield. Zn may have ability of pomegranate trees to resist disease and environmental stresses. The effect of Zn fertilization on fruit juice dry weight, density and TSS was highly significant. Vitamin C did not increase significantly by Zn application;. Leaf Zn deficiency index is 14 for apple, 30 for Pecan, 20 for avocado. Sufficiency in pomegranate ranges from 38-45. In this experiment the average concentration of leaf in four pomegranate varieties was between 12-19.8 mg Kg^{-1}(Khorasandi et al., 2009). Zinc concentration on different edible parts of plant is shown in the Figure 4. In the Figure 4 except few cases the concentration of Zn in edible parts are below 100 mg Kg^{-1} dry matter (White and Broadley, 2011).

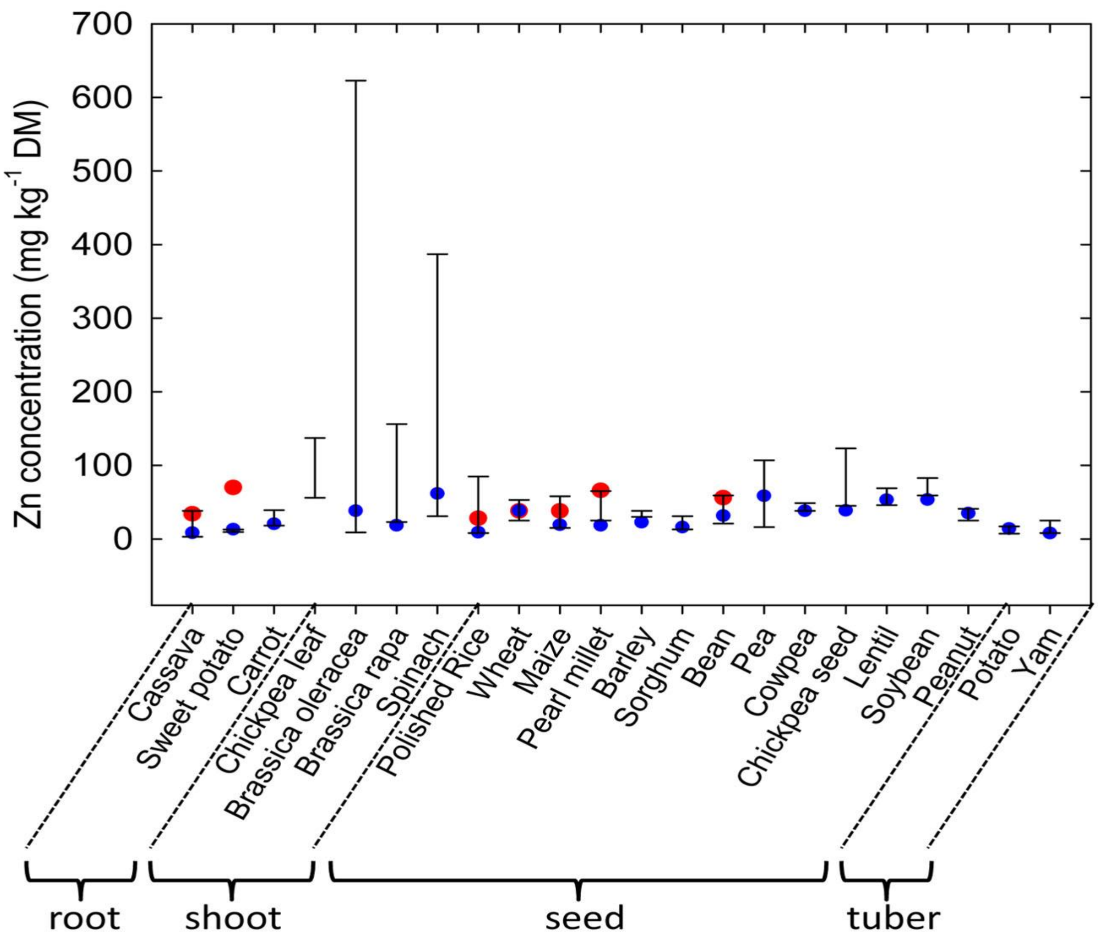

Figure 4: Zinc (Zn) concentration in different edible parts of the plant (Source: White and Broadley, 2011)

No significant increase in grain yield due to Zn fertilizers. Grain yield was not significantly higher in foliar application but increased about 10% in soil application and 7% in soil+foliar application respectively (Gomez-Coronado et al., 2015). Zn showed the highest influence on yield and yield component, spike length and Kernel protein content (Narimani et al., 2010). Irrespective of the method of application of Zn significantly increased yield in all cultivars. Compared to the control increase in yield were about 260% with soil, soil+leaf, 240% with seed and 124% with leaf application of Zn. Soil application of Zn was economical and had the long term effects for enhancing grain yield of wheat grown in Zn deficient soils. When high grain yield and high Zn concentration in grains are desired, soil+leaf application of Zn was most effective method of Zn application. At least a double spray of Zn is required for an effective correction of Zn deficiency, seed and leaf application of Zn alone were not as effective as soil, soil+leaf applications to increase soil application of 28 Kg Zn/ha as $ZnSO_4$ was adequate to control Zn deficiency in plant for four to seven years. Soil+Leaf application should be considered as an effective method. Higher levels of Zn on grain have beneficial consequences for human health (Yilmaz et al., 1997). Tree spray with 0.6% ZnSO4 exhibited highest increase in Kinnow Mandarin height, crown width and stem girth, fruit diameter, fruit weight, ascorbic acid content and total phenolics compared to all other treatments. In conclusion foliar spray upto 0.6% is beneficial for growth and productivity of orchard. Due to high phloem mobility foliar application of Zn is recommended. In soil applied Zn less mobility and high fixation occurs. Marketable and unmarketable yield, total antioxidants and total phenolics no work is done (Razzaq et al., 2013).

Conclusion

Globally more than 800 million people are under malnutrition and more than two billion have one or more types of micronutrient deficiencies. More than 6% of global death is occurring with low feeding and lack of micronutrient. In 2011, 1.1 billion people are vulnerable to Zn deficiency due to insufficient dietary supply. The global world mean dietary provision of Zn in 2011 was 16±3 g per person per day. Between 1992 and 2011 world risk of dietary Zn reduced from 22-16%. Almost 90% of these are at the danger of lack of Zn in Africa and Asia. Nutritional diversification by food and agricultural involvement with enough supply of biofortified food by the use of micronutrient fertilizer has significant challenge.

Introduction of crop varieties with high Zn content are to decrease Zn malnutrition. Native soil Zn condition is a key cause for the agricultural production. Grain Zn concentration differed from 8-47 mg/Kg in a one genotype to another. In all soil fertilizer Zn was used up as observed by 50-200%. Increase in total plant Zn content was between 43-95%. Increased in grain or straw Zn content stays highly unchanged with a maximum of 6%. Genotypic variation is the key quality in Zn deficient soil. Concentrations of 11-24 mg/Kg and from 34-36 mg/Kg in high upland Zn rich soil is increasing. However it may be challenging to develop cultivar that respond to Zn fertilizer with higher grain yield and higher grain Zn concentration. If only one micronutrient is to be use than apply the Zn element. Utilization of the three elements Fe+Zn+Cu can be done in the form of foliar spray. Due to calcareous soil properties micronutrient deficiency is highly prevalent. Some of the unsafe causes of micronutrient deficiency is initiation of stress in plant that consists of low crop yield and quality, imperfect and plant morphological structure, disease and pest attack, too activation of phytosiderophores and lower fertilizer use efficiency.

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Conflict of interest

The author declares that there is no conflict of interest.

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