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Micronutrients: Role in Plants, their Spatial Deficiency and Management in Indian Soils: A Review

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ABSTRACT

Soil fertility and plant nutrition, both are governed by criteria of essentiality (Arnon and Stout in 1939 and further modified by Arnon in 1954). Earlier there were 16 essential elements and now it is 17. Researchers, policymakers and farmers mostly concerned themselves for the primary nutrients *i.e.* NPK to manage the crops and it further aggravate the deficiency of micronutrients which is now major concern for all because it is affecting human and animal nutrition along with plants. This deficiency is concerns not only the plant nutrition but has far reaching implication in form of nutritional insecurity among the livestock and marginal section of population. Thus it is important to study the importance of the micronutrients to take care these challenges and the management of micronutrients in crop production is based on their spatial distribution. Therefore, an attempt has been made to summarize importance of micronutrients for crop production according to their spatial distribution in India.

Key words: Management, Micronutrients, Micronutrient deficiency in soil, Nutritional insecurity, Spatial distribution, Soil fertility, Plant nutrition.

INTRODUCTION

Agriculture is one of the oldest practices of human. It has transformed the nomadic life to a settled one. The cultivation of wheat and barley started in 7500 BC followed by cultivation of maize and rice in 4400 BC and 2000 BC, respectively (Reddy and Reddy, 2016). The interest in agriculture increased with the evolution of mankind. As time progressed, various aspects of the agriculture also segregated. One of the important aspects of agriculture has been of soil fertility and crop nutrition. Justus Von Liebig is considered as the founder of modern agriculture with the development of the theory of mineral nutrition and formulation of the law of minimum (Van der Ploeg *et al*. 1999). Soil has been considered as primary source of nutrients. As demand of food increased, subsequent addition of chemical fertilizers to increase the production also increased. This was also intensified with the development of improved varieties which were more fertilizer responsive. Though the first fertilizer industry established in Ranipet in 1906, green revolution proved to be watershed for the fertilizer use in Indian Agriculture. As per reports of FAO (2005), the fertilizer consumption increased from 0.78 mT in 1965-66 to 12.73 mT in 1991-1992 and further increased to 16.8 mT in 2003-04 (Nutrient wise, it was 11.08 mT for N, 4.12 mT for P_2O_5 and 1.60 mT for K_2O). This shows that the major rise in consumption has been due to the three primary nutrients *i.e.* Nitrogen, Phosphorous and Potassium. While the recommended ratio of use of the NPK fertilizers is 4:2:1, this ratio for India in 2018-19 was 7.1:2.7:1 (FAI, 2019).

With the increased use of chemical fertilizers (NPK) after 1960, the crop productivity has increased, consequently of which the soil nutrient reserve start depleting and crop started responding to micronutrient application (Gupta, 2005). Introduction of high-yielding varieties and higher use of nitrogen (N), phosphorus (P) and potassium (K), however, increased crop production several fold higher after the green revolution but this has led to micronutrient deficiency in most of the Indian soils (Singh 2001; Sahrawat *et al.* 2010).

Micronutrients are though essential to plants, are required in relatively smaller quantity (Arabhanvi *et al.* 2015). Macronutrients are needed in concentrations of 1000 µg g^{-1} of dry matter and more, whereas micronutrients are needed in tissue concentrations equal to or less than 100 µg g^{-1} of dry matter (Reddy, 2014). However, their role can't be underestimated. The range of sufficiency is narrow for micronutrients compared to macronutrients, as slight excess or deficit may lead to depression in yield. Its impact of the product quality also determines the nutritional security of the human beings and livestock. It is essential to focus on increasing the micronutrient status of the soil for long term sustainability of soil fertility and productivity. The different

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Table 1: Concentration of Micronutrients in plants. Source: (Rattan and Goswami, 2012).

Micronutrient	Deficient (mg/ kg)	Sufficient/ normal (mg/ kg)	Toxic (mg/kg)
Fe	<50	100-500	>500
Mn	15-25	20-300	300-500
Zn	10-20	27-150	100-400
Cu	2-5	5-30	200-100
B	5-30	10-20	50-200
Mo	0.03-0.15	0.1-2.0	>100
Cl	<100	100-500	500-1000
Ni	0.1	—	—

micronutrients are required in different quantities. The approximate concentration of micronutrients in plants is presented in the Table 1.

Functions of micronutrients

Arnon and Stout (1939) proposed the criteria of essentiality, accordingly, there were seven elements classified under micro-nutrients *i.e.* Zinc, Boron, Iron, Manganese, Copper, Molybdenum and Chlorine. Nickel was added as the eighth micronutrient in 1987.

Zinc is a constituent of the enzymes carbonic anhydrase, alcohol dehydrogenase and superoxide dismutase. Zinc is essential for the reproductive growth of plants and low supply of Zn results in reduced size of anther, poor pollen producing capacity, reduced pollen size and its viability (Pandey *et al.,* 2006). Masev and Kuatcek (1966) reported that the optimum concentration of Zinc has reported higher concentration of tryptophan and auxin compared over control, however, excess zinc concentration has led to their decrease below the control. Vice versa, it is also reported that auxin signaling is associated with the Zn uptake, transport and chelation in rice seedlings. (Begum *et al.* 2016).

Iron forms the component of Fe-S protein such as PSI, ferrodoxin and various metabolic enzymes (Connorton *et al.* 2017). Miller *et al.* (1995) reported that ferrodoxin and chlorophyll content was lower in iron deficient leaves when compared to the normal leaves. Iron plays an important role in the electron transport chain of respiration and photosynthesis, however, it becomes toxic when accumulated to higher level (Connolly and Guerinot, 2002). Iron is prosthetic group of various enzymes such as cytochrome oxidase, catalase and peroxidase.

Manganese is the component of oxygen evolving complex in the plants, cofactor of Mn-superoxide dismutase in mitochondria and peroxisomes for the detoxification of Reactive oxygen species, cofactor of enzymes involved in isoprenoid biosynthesis, chlorophyll production and can replace Mg is some of the active sites of enzymes of the photosynthetic pathways (Mousavi *et al.* 2011; Alejandro *et al.* 2020). Impairment of lignin biosynthesis in Mn-deficient plants, especially in the roots, is associated with increased pathogenic attack, particularly soil-born fungi, since lignin serves as a barrier against pathogenic infection (Marschner, 2012).

Cell wall synthesis and stability is determined by boron which form complex with pectins (Shireen *et al.* 2018). Whittington (1957) experimentally demonstrated that deficiency of boron leads to the reduced branching and flower differentiation due to the rapid cessation of cell division. Among the field crops, highest requirement of Boron is in oilseeds followed by pulses and then tubers (Meena *et al.* 2007). Application of boron increases pollination, fruit set, fruit yield and quality of temperate fruits (Ganie *et al.* 2013), similar results were obtained with boron in sunflower having significantly higher number of filled grains, lower number of unfilled grains, lower percent of chaffiness and thus, higher grain yield (Kulkarni *et al.,* 2002). Maximum grain yield in rice has been reported with soil application of boron at flowering stage (Hussain *et al.* 2012). Boron is also involved in transportation of sugars (Broadley *et al.,* 2012).

Copper as an essential micronutrient for normal growth and metabolism of plants is well documented (Sharma and Agarwal, 2005; Singh *et al.* 2007). Copper is part of plastocyanin, important enzymes such as cytochrome oxidase, superoxide dismutase, ascorbate oxidase, polyphenol oxidase and required for lignin synthesis (Broadley *et al.* 2012). Increasing copper concentration in bean plants led to the decrease in leaf area, however, net photosynthetic rate per unit leaf area was increased owing to the increase in chlorophyll concentration. (Cook *et al.* 1998). A 60 per cent increase in the Copper sulfate concentration in duck weed led to the decrease in Chlorophyll a concentration and reduction in photosynthetic CO_2 uptake from water, showing the acute toxicity. (Filbin and Hough, 1979). Copper and Molybdenum are likely to become critical in the future for sustaining high productivity in certain areas of India (Singh, 2004).

Molybdenum forms the essential component of nitrate reductase enzyme and nitrogenase, thus required for N metabolism. In wheat, molybdenum starvation was also shown to reduce maximum NR activities (lower potential V_{MAX}) irrespective of the regulatory control of NR by light and dark periods (Yaneva *et al*. 2000). Molybdenum promotes fixation of nitrogen (Arabhanvi *et al.* 2015) and also improves the Phosphorus uptake by plants (Arabhanvi *et al.* 2015; Jones 1987). Lower Erucic and eicosenoic acid content were reported in Indian mustard with application of Molybdenum @ 4kgha^{-1} when compared to control (Arabhanvi *et al.* 2015).

Nickel is important for many bacterial enzymes, including key enzymes in the nitrogen-fixing symbiont, *Bradyrhizobium japonicum* (Kamboj *et al.* 2018). Nickel is an important component of urease enzyme and it participates in the plant anti-oxidant metabolism (Fabiano *et al.* 2015). Levy *et al.* 2019 reported that there is significant correlation between Nickel supply and plant growth and biomass accumulation in soybean; however, it depends on the texture of the soil. Supplying 10 ppm Ni has reported significantly higher number of branches and plant height in *Tagetes minuta* as compared to control (Ch and *et al.* 2015).

Chlorine regulates the water balance in plants and imparts drought resistance in these (Franco-Navarro *et al.* 2014). Two Cl^- molecules are required to maintain the coordination structure of the Mn(4)Ca cluster and thus, serve as essential cofactor for splitting of water molecule and evolution of oxygen in photosynthesis (Colmenero-Flores *et al.* 2019). The quality and yield of crops such as cotton and onion are dependent on supply of chlorine in deficient soils (Chen *et al.* 2010).

Distribution of micronutrients in Indian soils

Basic rocks (intermediate between the ultrabasic and acidic rocks) have higher content of Mn, Co, Ni, Cu and Zn and sedimentary rocks are rich in Mo and B, their abundance in the mineral is decided by their chemical affinity (Deb *et al*., 2012). Organic matter addition to soil build up the micronutrient content of the soil and increase its availability to plants through chelation, release of organic acids and consequent lowering of soil pH and reduction in redox potential (Dhaliwal *et al*., 2019). The availability of the micronutrients is determined by the pH of the soil. Generally the availability is favored by the lower pH. Few micronutrients are exception *e.g.* Molybdenum is available at alkaline pH and Boron is available at neutral pH. The soils under high rainfall conditions are subject to the leaching and are deficient in micronutrients. The growing of soil exhaustive crops along with the restricted application of only N, P and K fertilizers has also aggravated the micronutrient deficiency. ICAR-IISS, Bhopal, during the period of 2011-2017, carried out the analysis of more than 2.0 lakh samples from 508 districts of country and reported that on an average, 36.5, 12.8, 7.1, 4.2 and 23.2% soils are deficient in Zn, Fe, Mn, Cu and B, respectively. (Shukla *et al.* 2019).

Zinc is the most deficient nutrient in Indian soils, followed by Boron. The major areas of Zinc deficiency in India are calcareous and old alluvial soils of Bihar, acidic and highly leached soils of West Bengal, Odisha and red laterites of Karnataka (Deb *et al*. 2012). Initially, the incidence of Zn deficiency was observed more in cereals, particularly rice and wheat belts of the country, but with passage of time, distribution of Zn deficiency has covered the whole country across the crops and cropping systems (Shukla and Tiwari, 2016). Zinc is the single most elements whose deficiency is widespread across the citrus belt in India (Shrivastava and Singh, 2004).

The boron deficiency in Indian soils has increased to 52 per cent from 2 per cent in 1980 and its deficiency is more prominent in sandy soils of Haryana and Rajasthan, red and lateritic soils in South India, sub-mountaneous soils of Northern Himalayas and NE hill states and calcareous soils of Bihar, Easter Uttar Pradesh, Saurashtra and Tamil Nadu. (Prasad *et al.,* 2014)

Iron deficiency is more common in upland crops, particularly those growing on the calcareous alkaline soils of arid regions, soils with high calcium carbonate, highly permeable coarse textured soils and soils low in organic carbon content. Though Indian soils are comparatively rich in available Fe, its availability in some states like Gujarat, Haryana, Maharashtra, Telangana and andhra Pradesh is posing threat to the crop production (Shukla *et al.,* 2014). Oxidation- reduction processes in soil are one of the important determinants of the iron availability by conversion of Fe (III) to Fe (II) (Lindsay, 1984), therefore, coarse textured soil due to its higher aeration and lesser water holding capacity disfavors the reduced condition and ultimately reducing its availability.

The behavior of manganese is similar to iron in terms of its deficiency under upland and coarse textured soils and toxicity in the reduced conditions. The reduction of manganese and iron occurs immediately after nitrate at the redox potential of +280 to +220 mV and +180 to +150 mV, respectively. However, the deficiency of manganese in Indian soils is not a major issue, except in the few regions having coarse textured alluvial, leached and deep black clayey soils. Manganese deficiency has been reported after rice has replaced the kharif season crops in maize-wheat and groundnut-wheat cropping systems of coarse textured soils (Deb *et al.* 2012). The leaching of manganese occurs in the rainy season during rice crop cultivation and succeeding wheat crop suffers acute manganese deficiency.

In India, Cu deficiency is not a major concern showing deficiency in 4.2% soils only. (Shukla *et al.* 2019). Copper deficiency is generally found in soils having high organic matter (Histosols), lateritic, highly weathered soils (Ultisols,), sandy textured soils and calcareous soils. Copper deficiency more prevalent on peaty soils of Kerala. (Deb *et al.* 2012)

Molybdenum is the least found micronutrient in the lithosphere (Behera *et al.* 2014). Molybdenum deficiency is common in the acidic, sandy and leached soils. Mo deficiency is highly localized in some parts of MP, Maharashtra and acidic soils of Odisha and West Bengal, particularly where pulse crops are grown. (Shukla *et al.* 2014). Deficiency of Chlorine and nickel has not been reported in Indian soils so far. (Deb *et al.* 2012). Micronutrients deficiency is also common in combination (Table 2).

Management of micronutrient deficiency

Table 2: The deficiency of combination of micronutrients in major states of India (Shukla *et al.* 2014).

Combination of micronutrients	Major states having deficiency
Zn+B	Maharashtra, Bihar, Tamil Nadu, Odisha, Jharkhand.
Zn+Fe	Maharashtra, Telangana, Tamil Nadu, Madhya Pradesh, Andhra Pradesh, Haryana, Gujarat.
Zn+Mn	Punjab (rice growing areas)

There are peculiar deficiency symptoms for each micronutrient, however, the mere diagnosis on the basis of deficiency symptom can be misleading as each symptom can be due to more than one factor, deficiency of one nutrient can be due to excess of the other, disease and pest damage can be confusing with nutrient deficiency and these symptoms occur very late for remedial measures to be taken (Romheld, 2012). The micronutrients are required in the lesser quantity in the plants and a slight increase in their quantity can lead to their toxicity. Micronutrients deficiencies are difficult to diagnose and consequently the problem is termed 'hidden hunger' (Stein *et al.* 2008). Therefore, the management of micronutrient deficiency requires micro level and localized approach.

Uptake of micronutrient by plants is an important component of their nutrition in the plants. The nutrient transport first occurs into the apoplasm of the roots through mass flow and diffusion which act as transient storage of nutrients, thereafter, transport across the plasma membrane occurs either as active transporters *i.e*. primary one where transport is coupled directly at the expense of ATP or pyrophosphate; secondary where the electrochemical gradient of H^+ is harnessed either in the same (symport) or opposite (antiport) direction or as passive transporters catalyzing movement along the electrochemical gradient (White, 2012). Due to the negative charge of cytoplasm, cations are transported along the gradient whereas the anions transport via active mechanism involving H^+ symport and the uncharged molecules have high membrane permeability and thus, doesn't require transportes (Reid, 2001). Iron uptake occurs through two mechanisms, strategy I for dicots and non graminaceous monocots, in which plant roots induce the reduction of Fe^{3+} in rhizosphere through electron transport to rhizosphere, its acidification, increased release of phenolic acids and accumulation of citric acid in plants and strategy II for graminaceous monocots, where phytosiderophores are released into the rhizosphere and the Fe^{3+}-siderophores are transported across plasma membrane through H^+ symporters (Yang and Romheld, 1999).

The chemical composition of the soil parent material determines the deficiency or toxicity of the particular micronutrient. Thus, soil testing for the inherent micronutrient content is the first step of management. The knowledge of micronutrient content of the particular region is helpful for both industry and Government to develop the micronutrient fertilizer for specific region and implementation of the various programmes, respectively. The major breakthrough in the field of micronutrient estimation is extraction through the chelating agent EDTA and DTPA useful for Zn, Cu, Fe, Mn and Ni wheras hot water and ammonium oxalate are used as extractant for the estimation of molybdenum and boron, respectively (Datta *et al.* 2018).

Though the soil may be rich in the particular micronutrient, it is not necessary that it will be available to the crops. It depends on the pH, texture, soil water regimes and lime content. Therefore, determining these characteristics are equally important for available micronutrient management in the soils. pH influences the micronutrient availability to a greater extent. At low pH, micronutrients exist in the available form and may show the toxicity. At higher pH and calcareous soils, the availability of micronutrient decreases. There are inter related problem in acidic soils, where there is toxicity of Al, Mn and Fe and there is deficiency of P, Mg, Ca, K and micronutrients such as Mb and B (Schroth *et al.* 2003). Thus, soil pH should be maintained around 6.0 for sufficient availability to plants (Deb *et al*. 2012). The higher pH will lead to the deficiency of almost all the micronutrients except Molybdenum and boron is excess at pH that of the sodic soils. pH stabilization can be done with the application of lime in acidic soils and gypsum and other amendments in the alkaline and sodic soils. Similarly, soil texture has influence on micronutrient availability. Clay soils are relatively richer in micronutrients when compared to coarse textured soils owing to their higher water holding capacity (Kumar *et al.* 2016). Similarly, acid leached soils are deficient in micronutrients due to deficient parent material and leaching also removes the large amount of it (Kumar *et al.* 2016).

Soil organic matter content is an important determinant of the available micronutrient status in the soil. It acts as storehouse of micronutrients *e.g*. Fe, Mn, Zn and Cu. It has solubilizing action on the availability through formation of chelates. Rutkowska *et al.* (2014) under long term fertilization experiment revealed that concentration of Zinc, Boron and iron increases under FYM application. Soil organic matter increases the micronutrient availability to the plant as it promotes the reduced conditions in the soil, converting adsorbed form of micronutrient to plant available through chelation and forming stable complexes with micronutrients. (Dhaliwal *et al.* 2019). Saha *et al.* (2019) under long term experiment reported that FYM as organic amendment under integrated nutrient management are superior to rice straw or green manure in improving micronutrient availability. The regular addition of organic matter to the soil makes it less prone to micronutrient deficiency. The incorporation of green manure can prove effective as it not only adds organic matter but also recycle the deep lying nutrients to the root zone of the crops. Better crop productivity along with maintaining soil factors can be obtained with integrated nutrient management (Aulakh and Grant, 2008).

Cropping system followed in particular region determines the micronutrient status of the soil. The intensive cropping system along with the higher application of primary nutrients makes the soil susceptible to micronutrient deficiency, if it is not replenished with external source. In Indo-Gangetic plains, intensive cultivation with inadequate agricultural practices has led to the micronutrient deficiency especially of Zinc, Boron and Manganese (Nayyar, 2003). Rice-wheat systems are prone to deficiencies of zinc, boron, manganese, iron, molybdenum and copper (Rashid, 2005).

Crop diversity can enhance the heterogeneity of the chemical nutrients in soil (Yang *et al.* 2020).

The micronutrient availability can be enhanced with the development of cultivars which are efficient in utilization of soil micronutrients. This is important from the sustainability point of view as we are witnessing the after effects of heavy fertilizer use post green revolution era. This emerging field of utilizing the plant genomics for enhancing the nutrient use efficiency of the crop plants is termed as plant nutromics. The micronutrients use efficiency at molecular and physiological level are still at initial stage (Khoshgoftarmanesh *et al.* 2010). Genotypic variation exists in the micro-nutrient use efficiency either these change the rhizospheric chemical and microbiological properties or increase the nutrient utilization in plant tissues *e.g*. of zinc (Rengel, 2001). Genotypes of plant differ widely in their adaptation to micronutrient deficiency stress in soil (Yang and Romheld, 1999).

It is important to study the nutrient interactions for managing the micronutrient availability of crops. There are four type of interactions *i.e*. Synergism where yield from the combined application of two nutrients is more than their individual application; antagonism where yield from combined application is less than their individual application; zero interaction where yield obtained from combined application is similar to individual application and Liebig synergism where if one nutrient is limiting crop production, the addition of another nutrient will have no effect on yield, however the combined application will increase the yield (Rietra *et al.* 2017). Excess of iron adversely impacts the utilization of Zinc and manganese. Similarly, excess of sulphur and copper leads to molybdenum deficiency in the crops. Zinc and phosphorous is an important example of antagonistic interaction. This is due to reduced Zn mobility due to lesser root growth and VAM colonization of roots, dilution of Zn due to higher grain yield, reduced solubility and mobility of Zn in plants under higher P availability as well as Zn deficiency enhances root permeability to P and its higher uptake by roots and also reduces phloem loading of P (Broadley *et al.* 2012). If the phosphorous concentration is increased, zinc task is impaired at specific position in the cell (Mousavi, 2011). Rietra *et al.* (2017) in a review study have found total 117 interactions involving both macro and micro nutrients of which 23 interactions were synergistic, 20 have shown Liebig synergism, 17 were antagonistic and 35 had shown zero interaction.

The regions where the soil test shows the micronutrient deficiency or the crops show the deficiency symptoms, it is essential to replenish the soil with external source of micronutrient. It depends on the soil type, cropping system being practiced and severity of deficiency symptoms observed. The application of micro nutrients can be done both as soil application or foliar application. The source of micronutrients is either in inorganic salt form *e.g*. Zinc sulfate heptahydrate, ammonium molybdate etc or in their chelate form *e.g.* Zn-EDTA which are easily available to plants and specially designed glass frit forms.

Out of the several Zn sources evaluated for their efficacy under different soil-crop situations, $ZnSO_4{\cdot}7H_2O$ proved better or equal with other sources in correcting the Zn deficiency (Shukla *et al.* 2019). However, in some studies, chelated Zn proved more effective than $ZnSO_4{\cdot}7H_2O$ for maize and rice (Shukla *et al.* 2019). Iron deficiency in majority of the crops can be corrected with soil application of 50-150 kg $FeSO_4$ / ha or it can applied as foliar application @ 10-12 kg $FeSO_4$ / ha (Takkar *et al.* 1989). Application of 1.5 kg B/ha gave optimum yields of *rabi* (winter) crops such as mustard, maize, sunflower, onion and lentil and the rates were higher 2.0-2.5 kg B/ ha for *kharif* (summer) crops: groundnut, maize, onion, yam, bean and black gram (Sakal and Singh, 1995). Arabhanvi *et al.* (2015) in a review study concluded that foliar application of micronutrients is more beneficial than soil in oilseed crops.

One of the aims of application and management of micronutrients in soil is to have sufficient concentration in the final product of the crop in terms of seed and grains, as it will have direct impact on human health and nutrition. Today, most agricultural systems in the developing world do not provide enough nutrients. Many fall short of supplying enough micronutrients (14 trace elements and 13 vitamins) to meet human needs; even though the production of energy and protein *via* cereal crops appears to be adequate to feed the world (Shukla *et al.* 2014). Biofortification involves both agronomic and genetic approaches where, former relies on the foliar application of micronutrients *e.g.* for iron or soil application *e.g*. for zinc, however, combination of foliar and soil application prove more efficient *e.g.* 3 fold increase in the zinc concentration in grains with foliar and soil application (Shukla and Mishra, 2018); similar result were observed in wheat with soil and foliar application of zinc when compared to seed or soil or foliar application alone (Nissar *et al.* 2019). Zinc coated urea as $ZnSO_4$ recorded highest uptake of zinc whereas higher concentration of Zinc was reported with foliar fertilization @ 0.2 per cent $ZnSO_4$ (Pooniya and Shivay, 2013, 2015). Nitrogen fertilization along with zinc fertilization increases the zinc concentration in grain due to altered pH around root zone leading to its better uptake, translocation and deposition in grains (Nissar *et al.* 2019). Genetic approaches to biofortification involves both conventional breeding and biotechnological approaches, former involves screening and utilizing the germplasm variation for micronutrient densities and latter allows to introduce new traits into commercially important plant from unrelated species; some of the micronutrient biofortified varieties for different crops are CR Dhan 310 and DRR Dhan 45 for rice; WB 02 and HPBW 1 for wheat; HHB 299 and AHB 1200 for pearlmillet; ICSR 14001 for sorghum; Pusa Ageti Masoor for Lentil; Solapur lal for pomegranate (Shukla and Mishra, 2018).

CONCLUSION

By 2050, world population is expected to reach 10 billion (Khoshgoftarmanesh *et al.* 2010). This emerging challenge will become multidimensional adding the lesser nutritional security especially among the marginalized sections of our society. This will call for an intervention in form of second green revolution. However, it has to be kept in mind that this revolution should also encompass the sustainability factor as the resource constraint is increasing with each day. The focus on micronutrient should not only be in the perspective of scientific research but it also requires the policy interventions which encourage its use and discourage the N P K consumption. Nutrient based subsidy and soil health card has been such interventions in the past which has encouraged rationalized nutrient use. Micronutrient management is important for crop, livestock and human equally.

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