April - June 2012
Vol. 5 No. 1

IMMA NEWS

Indian Micro Fertilizers Manufacturers Association

Mo Deficiency on Citrus Leaves

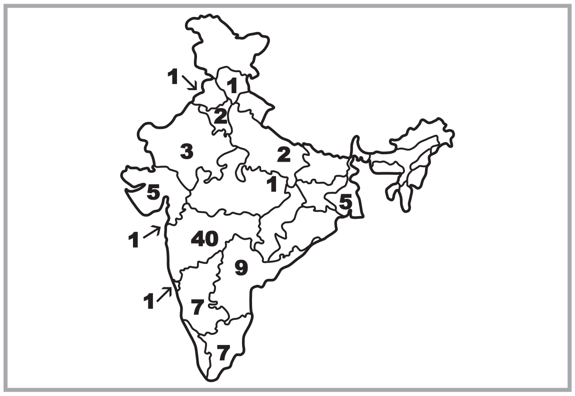
Mo Deficiency on Citrus Fruits

B Deficiency in Cauliflower

B Deficiency in Cauliflower - Brown Rot

Rs. 10/-

Indian Micro – Fertilizers Manufacturers Association



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from the editor's desk

Sulphur is an important constituent of two of the ten essential amino acids viz. Methionine and Cystine, which in turn act as the building blocks of proteins. Sulphur is involved in Carbohydrate metabolism and is well known for improving the quality of edible oils as well as milling and baking quality of cereals. Unlike Nitrogen deficiency, Sulphur deficiency is always associated with new leaves which often exhibit chlorotic symptoms. The roots and stem become abnormally long and brittle as they develop woodiness. Sulphur is usually provided in ample quantities, through Rain, Gypsum, Single Super Phosphate, Ammonium Sulphate, Magnesium Sulphate and Micronutrient Mixture Fertilizers, in readily available Sulphate (SO_4) form, for the plants.

Micronutrients are the important constituents of chlorophyll which is an essential part of the photosynthetic apparatus. Therefore balanced use of all micronutrients with other essential nutrients increases the rate of photosynthesis. It ultimately brings about faster growth and development of a crop. Since Micronutrients are the metalloenzymes, their use aids in increased uptake of the major nutrients. In other words, they increase the Nutrient Use Efficiency (NUE) of NPK fertilizers. They also impart better disease resistance in crops. They are known to take part in the production of secondary metabolites in crops which further reduce the pest population on a crop.

Therefore, adequate supplementation of Micronutrient Mixture Fertilizers coupled with major and secondary fertilizers - much before arising their deficiency symptoms - leads to higher crop yields with better quality.

Invitation for Technical Data

We are publishing 'IMMA News' Bulletin every quarter with Technical Data on Fertilizers in general and Micronutrient Fertilizers in particular. We do forward the same as an complimentary to the Agriculture Scientists & officers, all over India.

We request all the readers to please send us Technical matter to be published in our 'IMMA News', which will assist the extension officers to disseminate your ideas to farmers, to increase crop yields.

Micronutrient feeding needs immediate attention
for sustainable agriculture

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Estimated population of India by 2020 is 130 corer. To meet the food grain demand for the ever expanding population, production need to be increased several fold. There is limited scope for expansion of area of cultivation and a huge chunk of arable land on the other side goes under industrial and urban use. Agricultural land is therefore shrinking and that under cultivation is degrading due to indiscriminate use of agricultural inputs. The era of green revolution witnessed intensive use of agro-chemicals (Straight fertilizers, fungicides, pesticides and herbicides) which un doughty transformed Indian agriculture by increasing food grain production many fold, but at the same time brought forth some very serious challenges which if not addressed timely and adequately will have very serious repercussions in the future. Era of green revolution is over now. Experts are contemplating an ever green revolution. Improved genotypes and integrated use of agricultural inputs will go together to make this dream come true. Right from the rapid adaptation of green revolution technology in general and cultivation of high biomass producing high yielding and hybrid varieties in particular has put tremendous pressure on soil nutrient reserves. This high input technology has led to great imbalance in nutrient pools in the soil. A large chunk of soils has been rendered deficient in micronutrient, which is one of the major reasons that crop varieties have stopped responding to high analysis fertilizers. Limited use of micronutrient chemical fertilizers and addition of inadequate quantities of organic manures will make the situation more complex. The need for micronutrients is greatest on very poor soils, were soil conditions such as light texture and high pH reduce their availability to crop plants, were intensive farming (with high yielding varieties and hybrids) is performed and on those soils were organic manures are not used at all. This article is intended to create awareness about the importance of micronutrient feeding in agriculture, which I think is immensely important in view of the current agricultural scenario.

What are micronutrients?

Micronutrients are those essential elements which are required by plants in very small amounts, which include copper, manganese, zinc, iron, boron, molybdenum and chlorine. As these minerals are required in traces that is why they are also referred to as "trace elements". Although the requirement of micronutrients in plants is relatively very small but they are equally important and need to be supplied in adequate amounts for optimum plant growth.

Role in plant nutrition and deficiency symptoms :

Though there is great variation in specific role of micronutrients but they have a common role of participating in innumerable enzymatic reactions in plants. Recent analysis of soil samples from the different states of the India under AICRIP on micronutrients shows that zinc deficiency is very wide spread (Fig.1), followed by iron, copper and manganese. Soil of the country are generally adequate in copper. Deficiency of a single micronutrient adversely affect normal yield and severe deficiency may results in complete crop failure. Application of science and technology has greatly helped in diagnoses of micronutrients deficiency in the soil. Diagnoses through visual symptoms is an easy, cheap and widely adopted interim technique for timely correction of micronutrient deficiency. Some important functions and deficiency symptoms are given in below.

- **Zinc :** Being constituent of several enzymes (dehydrogenases, proteinases and peptidases), it regulating various metabolic reactions and auxin concentration as well, helps in the synthesis of proteins and carotenes, acts as a catalyst in chlorophyll formation, enhances heat and frost resistance in plants by way of regulating water relation in plants system and promotes starch formation and seed maturation. Zinc deficiency causes characteristic little leaf and clustering of leaves at the top (Rosetting). In rice Zn deficiency results in poor tillering and appearance of reddish brown spots on the older leaves, which later on turn whole leaf rusty. Stunted plant growth due to shortening of stalk internodes. Some commonly know zinc deficiency diseases are; khaira disease of rice, white bud of maize/sorghum, cotton little leaf, mottle leaf of citrus.

● **Iron :** Being a component of many enzymes (peroxidase, catalase and cytochrome-oxidase) and ferredoxin, it controls various metabolic functions such as N-fixation, photosynthesis and electron transport. Its deficiency causes Interveinal chlorosis of younger leaves, which under sever conditions turns the whole leaf first yellow and then finally white.

● **Copper :** It acts as electron carrier in enzymes associated with oxidation reduction reactions. It has indirect effect on root nodulation in legumes. Its deficiency causes chlorosis of young leaves, rolling and dieback. In advance stages death of tissues at leaf tips and margins takes place which may be confused with potassium deficiency.

● **Manganese :** It influences auxin level and is involved in oxygen evolving system of photosynthesis. Deficiency symptoms are similar to that of iron except at later stage necrosis develops instead of whitening of leaf.

● **Boron** : It is essential for development nad growth of new cells in the meristem and nodule formation in legumes. It is also associated with translocation of starch, sugar, nitrogen and phosphorous and calcium metabolism. Boron deficiency often causes cracking or rotting of fruits, tubers or roots. Thickening and curling of leaf and development of cracks in stem are other symptoms.

● **Molybdenum :** It is an essential component of enzymes nitrate reductase (associated with nitrogen assimilation) and nitrogenase (associated with nitrogen fixation in legumes). Due to its deficiency young leaves become mottled pale in appearance. Bleaching and withering of leaves are other symptoms of molybdenum deficiency.

● **Chlorine :** It is important for photosynthesis, activator of enzyme associated with splitting of water and associated with osmo-regulation of plants growing in saline soils.

Taking in to consideration the fact that deficiency of some micronutrients, zinc deficiency for instance may depress crop yield without the plants producing any visual symptoms and confusion with pest damage and environmental stress this method is not truly scientific. Application of advance soil and plant analysis techniques is therefore essential for nutrient budgeting. This also is important to avoid toxicity of micronutrients, which may occur by applying micronutrients haphazardly. Scientists have worked out the normal range of micronutrient concentration in plant tissues by using water culture and sand culture technique (Table1).

Causes of micronutrient deficiency and their amelioration : Earlier zinc received greater attention in view its widespread deficiency all over the country. But recently deficiencies of some more micronutrients have surfaced. There are various reasons for it but important factors responsible for micronutrient availability are briefly discussed under.

Heavy input agriculture : Development and adaptation of the hybrid and high yielding varieties, use of increased doses of high analysis nitrogen, phosphorous and potassium fertilizers and improved water, weed and pest management practices has resulted into higher crop yields. This in turn results into continuous removal of micronutrients, which exhausts their supply in certain soils. Such soils if not fertilized with micronutrients may develop their respective deficiencies.

Soil pH : Soil pH is a major determinant of the fractions in which a particular micronutrient is likely to occur in soil. Unproductiveness of acidic and alkaline soils is very often due to micronutrient unavailability owing to adverse soil reaction. Highly acidic conditions some time make concentration of metals like Al, Fe and Mn so high that it becomes toxic to plants. Higher pH on the other hand decreases availability of most of the micronutrient, sometimes to starvation levels. Neutral soil reaction is most conducive condition for availability of micronutrients and better crop growth as well. Correction of soil reaction by applying suitable soil amendment (Table 2) is therefore an essential step to ameliorate micronutrient deficiencies.

Nutrient antagonism : Higher levels of a nutrient availability may induce deficiency of other nutrient in several crops. This emphasizes the need for balanced nutrient application based on scientific principles. Some important examples of antagonism are given in table 2.

Organic matter content of the soil : Additions of organic manures in adequate quantities is important to improve soil fertility as they are recognized as nutrient reservoir. They are also important source of some of the micronutrients (table 3). It brings improvement in soil colloidal complex which in turn increases soil nutrient retention capacity. It also has chelating effect which also contributes in nutrient availability by way of preventing certain harmful reactions of the respective nutrients in the soil solution. Some organic fraction may hinder the availability of micronutrients. Substances like lignin, for instance, immobilize zinc and therefore reduce its availability to the plants.

Soil texture : Coarser soil fractions (sand) inherently posse's lower nutrient retention capacity. It is because of this reason that light textured soils are generally deficient in micronutrients. Clay mineral and micronutrient interaction is of two types. Firstly, they may be involved in cation exchange reaction with silicate clays. Secondly, they may get fixed to certain silicate clays. Zinc, manganese and iron are found in the crystal structure of silicate clays, which may get released or vice versa, depending on the condition in the soil.

Soil moisture : Soil water management can influence the availability of micronutrients. Drainage in acid soils is particularly important as it results into the formation of oxidized forms of iron and manganese, which are less soluble and less problematic than reduced forms. In the recent years Zinc deficiency of wetland rice has received much attention than any other minor element problem. It is reported that under soil submergence conditions concentration of most element nutrients increases. However, the case is reverse with zinc availability. The concentration of water soluble zinc decreases and reaches values as low as 0.03ppm despite desorption from iron and Manganese oxide hydrates. This reduces availability of zinc for plant uptake. Due to poor water management and inherent low nutrient retention capacity leaching of micronutrients is a problem with light textured soils.

Choice of fertilizer : The most common management practice to overcome the nutrient deficiency is the application of commercial fertilizers. Choice of fertilizers is therefore important factor which can influence the availability of micronutrients. Since micronutrients availability if greatly dependent on the soil pH, selection of fertilizer suitable to soil reaction is therefore important. Application of acid producing fertilizers, neutral and alkaline fertilizers in soils with high, neutral and low pH value respectively should be the practice of our farming community. Micronutrients fertilizers (Table 3) should also be used based on soil/plant analysis report.

Mode of fertilizer application : Micronutrient are commonly applied to the soil, but in the recent years foliar sprays and seed treatments have been used. In general soil application is advocated for agricultural crops and foliar application for horticulture and vegetable crops. Even in agricultural crops foliar spray produces better results over soil application were adverse soil reaction renders micronutrients unavailable to plants. For soil application basal application has been found superior over top dressing; however in standing crops visual deficiency could be effectively controlled through top dressing. Recent research shows that molybdenum application through seed treatment and foliar spray is economic.

Summary

Adaptation of green revolution technology has increased the removal of micronutrients from soil. That is why micronutrient application is becoming increasingly important. Application of scientific tools has greatly helped us to know that micronutrient deficiency is limiting crop production over large area in the country. Rational use of fertilizers supplying trace elements along with adaptation of management practices like application of organic manures, use of soil amendments to correct soil reaction, crop rotation, water management etc. needs to be assured for sustainability in yields. In view of the current day agriculture in the country, use of micronutrient fertilizers is rapidly going to increase in future. This indeed is required to prevent soils from getting exhausted.

Table 1:
Range of micronutrient concentration required for normal plant growth as reported by Pilli (1996).

Micronutrient	Concentration (ppm)	Micronutrient	Concentration (ppm)
Zinc (Zn)	0.02 to 0.2	Manganese (Mn)	0.01 to 0.05
Iron (Fe)	0.5 to 5.0	Boron (B)	0.1 to 1
Copper (Cu)	0.01 to 0.05	Molybdenum (Mo)	0.01 to 0.05

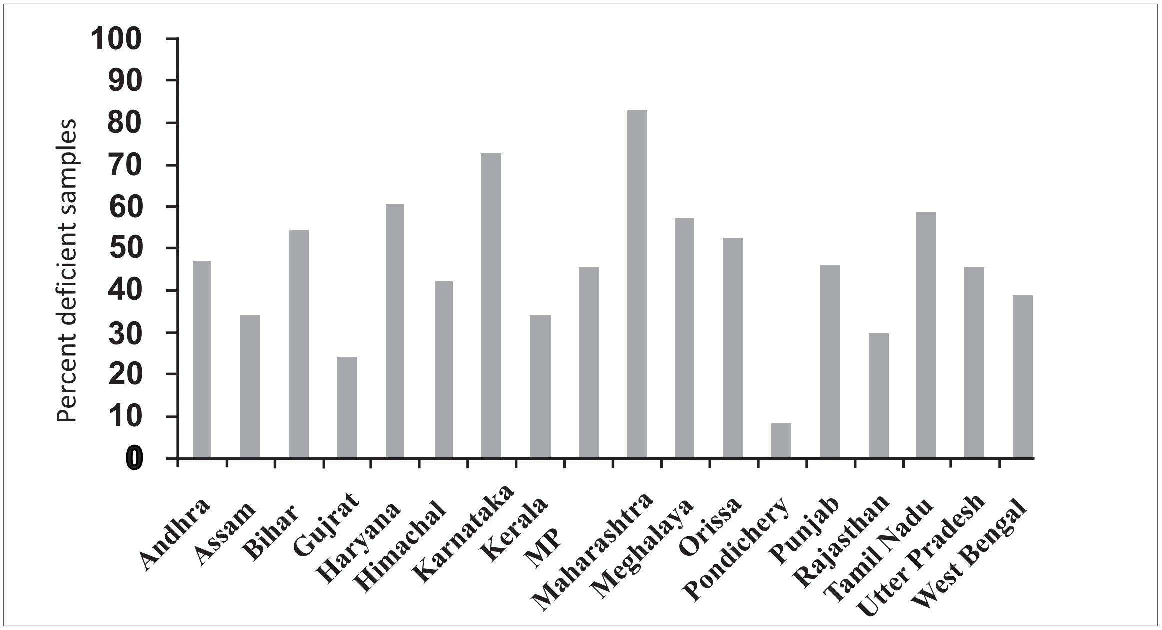

Table 2 : Different soil amendments used for correction of soil reaction

Soil amendment	Chemical composition	Suitability
Lime stone/calcium carbonate	$CaCO_3$	Acidic and saline (pH <8 soils
Burnt/quick lime/calcium oxide	CaO	Acidic soils
Slaked/hydrated lime/ Calcium hydroxide	$Ca(OH)_2$	Acidic soils
Dolomite	$CaMg(CO_3)_2$	Acidic Soils
Gypsum	$CaSO_4$	Alkaline and Saline-alkali soils with pH up to 9
Sulphur	S	Alkaline and Saline-alkali soils with pH up to 9
Iron sulphate	$FeSO_4$	Alkaline and Saline-alkali soils with pH up to 9
Pyrites	FeS_2	Sodic soils

Fig 1: Extent of zinc deficiency in soils of India.

Table 3 : Forms available to plants, antagonists and sources of different micronutrients.

Micronutrient	Forms available to plants	Antagonist	Source of micronutrient with per cent nutrient Content	
Zinc	Zn++	Nitrogen, Phosphorous, Calcium and Magnesium.	Zinc sulphate monohydrate ($ZnSO_4.H_2O$)	33%
			Zinc sulphate heptahydrate ($ZnSO_4.7H_2O$)	21%
			Chelated Zinc (Zn-EDTA)	12%
			Zinc incorporated in urea (Zincated urea)	2%
Iron	Fe++	Phosphorous, Zinc, Copper & Molybdenum	Ferrous sulphate	19%
			Iron chelates	12%
Copper	Cu+ Cu++	Nitrogen & Phosphorous	Copper sulphate	24%
Boron	Bo_3= $HB_4O_7^-$	Lime	Borax	10.5%
			Boric acid	17%
Manganese	Mn++ Mn+++	Sodium, Potassium, Iron, Copper & Zinc	Manganese sulphate	30.5%
Molybdenum	$HMoM_4^-$	Copper & Sulphur	Ammonnium Molybdate	52%
			Sodium Molybdate	39%

Table 4 : Micronutrient Composition of different organic manures

Organic Manure	**Micronutrient (ppm)**			
	Zn	Cu	Fe	Mn
Farmyard manure	40.0	2.8	1465.0	69.0
Poultry manure	50.0	6.9	1075.0	190.0
Piggy manure	198.0	12.8	1600.0	168

Source: Randhawa and Thakkar (1975).

Sulphur Recommendation and Guidelines For 's' Management

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Sulphur is one of the major secondary plant nutrients. An average crop absorbs as much sulphur as P from the soil. In a view of wide spread 'S' deficiencies in many soils and crops, best returns from investments in other nutrients cannot taken for granted if the 'S' deficiency is not corrected. A field is most likely to be 'S' deficient if it's texture is course, its organic matter is low when it is intensively cropped, largely using 'S' free high analysis fertilizer, when it receives little or no organic manures.

Crops raised on 'S' deficient soils are small and spindly with short and slender stalks. Their growth is slow, yield is low and quality is inferior. Seeds of oil crops have fewer oils in them, nitrogen fixation in legumes reduced; forage quality is inferior which overall fetches fewer prices in market.

Ensuring adequate sulphur for crop

Inadequate sulphur in the soil or in the plant is very simple to correct. The major crop of sulphur deficiency status that is not able to furnish adequate sulphur for crop use. In all such cases, soil sulphur supply can be raised using a suitable 'S' containing fertilizer before planting the crop. Most of these fertilizers are already known to farmers and contain 'S' in the sulphate form which can be readily absorbed by plant roots. Once adequate 'S' supply is ensured by the farmer, crop can maximize their yield potential.

'S' containing fertilizer

Farmers can add 'S' to their soils and crops through any of well known 'S' fertilizer and minerals that are listed below.

Name of fertilizer	S content. (%)
Mono Ammonium sulphate	24
Ammonium phosphate sulphate	15
Single super phosphate	11
Elemental sulphur	85
Mineral gypsum	13-18
Potassium sulphate	18
Zinc sulphate	15
Iron pyrites	18-22

All of the above sources, except elemental 'S' and pyrite contain 'S' in the water soluble, readily available sulphate ($SO_4^{=}$) forms. This is the form in which plants absorb 'S'. The S taken up by plant is used to from amino-acid, protein and oils.

Importance of S in crop nutrition

No doubt, 'S' is essential for growth and development of all crops, like other essential plant nutrients. The plants, which are deficient in 'S', become small and short at internodes. Pale yellow colorations of younger leaves, delaying in maturity of 'S' deficient fruit crops, less N: S ratio in forage crops, poor nodulation in legumes, slender stalks in cereals, long maturity period are some common deficiency symptoms in crops. Therefore, 'S' application through 'S' contain fertilizer is important for higher crop yields.

Rates of 'S' application

Precise recommendation for 'S' application for gradually becoming available in the feature. Such recommendation received an attention because a fair amount of 'S' added through ammonium sulphate, SSP, ammonium phosphate sulphate, gypsum etc,. The optimum dose of 'S' application are shown below

Crops	Kg 'S'/ha
Cereals	24-40
Pulses	10-40
Oilseeds	20-50
Tubers	25-60
Tea	40-50
coffee	12-26
Fodders	25-50

Time and method of 'S' application

Sulphur application is usually suggested as a part of basal dressing before planting, along with P, K and some N. However, when a deficiency is noticed in a growing crop, a top dressing with ammonium sulphate can be useful. It not only provides readily soluble 'S' but also provides usually practical top dressing of N to the crop elemental 'S' and pyrite should be surface broadcast 3-4 weeks before planting. Keeping the soil moist but not flooded so that the change from elemental to sulphate form can occur.

Conclusion

To obtain sustained and adequate yield there is need to know the value and improved crop quality obtained by correcting S deficiencies in soils and crop management. For this the extension workers, soil testing laboratories and training centers will play important roles. In addition to other nutrients, S also play important role in increasing crop production and securing higher prizes in market.

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Amelioration technology for correcting Zn, B, Mo and S deficiencies

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Deficiency of a micronutrient can be corrected through addition of chemical fertilizers (off farm inputs), organic manures/residues (on-farm inputs) and by cultivation of tolerant plants. Several inorganic salts, synthetic chelates, natural organic complexes, mixtures are notified by the Government of India under FCO, 1985 as micronutrient fertilizers which vary considerably in their nutrient content, ameliorative efficiency, residual effect and for economic effectiveness for different soil cropping systems. Apart from the specifications of single micronutrients, some major nutrient fertilizers fortified with micronutrients have also been notified under FCO, 1985 such as boronated single super phosphate and zincated urea. The fortified fertilizers, which have one or two major nutrients like N or N and P with a specific micronutrient may have special advantage in areas of wide spread deficiencies in soils. Zinc phosphate is also notified based its better performance to seed treatment.

Table-2 Nutrient content of fertilizers approved under FCO

Sr. No.	Materials	Element/ Forms	Content (%)
1	Zinc Sulphate	Zn	21.0
2	Manganese Sulphate	Mn	30.5
3	Ammonium Molybdate	Mo	52.0
4	Borax (For soil application)	B	10.5
5	Solubor (Foliar spray)	B	20.0
6	Copper Sulphate	Cu	24.0
7	Ferrous Sulphate	Total Fe Ferrous & Ferric	19.5 19.0 & 0.50
8	Zinc Sulphate monohydrate	Zn	33.0
9	Zinc Phosphate Zn3(PO4)2.4H2O	Zn+P	19.5
10	Chelated Zn (EDTAform)	Zn	12.0
11	Chelated Fe (EDTAform	Fe	12.0
12	Boronated super phosphate	B+P2O5	0.18B+ 16.0P2O5
13	Zincated urea	Zn+N	2.0 Zn + 43.0 N

*Mean S% content in (i)$ZnSO_4.7H20$ -15% (ii) $MnSO_4.4H_2O$ - 17% (iii) $CuSO_4.5H_2O$ - 13% (iv) $FeSo_4.7H_2O$ - 19%

Zinc

● Among various inorganic sources, zinc sulphate heptahydrate (ZnSo4.7H2O) containing 21-22% Zn is found the most efficient, commonly available, economically cheapest zinc source for correcting Zn deficiency in most of the crops and diverse soils as compared to sparingly soluble zn sources, chelates and mixtures.

● Regular application of Farm yard manure (FYM) at 10-15 tonnes/ha helps in mitigating deficiencies of all the micronutrients. However, if Farm Yard manure is not applied annually, one should apply on alternate year to prevent emerging micronutrient deficiencies. When adequate FYM is not available, and 4-5 t/ha is added then one may reduce 50% of the recommended dose of $ZnSO_4$.

Rate of Zinc application

Amount of Zn required for alleviating Zn deficiency varied with severity of deficiency, soil types, nature of crops and cultivars. In majority of instances 5.5 Kg Zn/ha was found to be ideal dose. Zn deficiency can be best alleviate the use of 11 Kg Zn/ha to wheat, rice and maize, 5.5 kg Zn/ha to soybean, mustard, raya, sunflower and sugarcane and with 2.5 Kg Zn/ha to groundnut, ragi, gram, green gram, lentil etc.

● Soils testing very low, low and marginal needs 50, 25 and 12.5 Kg Zinc Sulphate/ha to get optimum yields. Initially higher doses of zinc application are useful but in subsequent crops only 12.5 kg Zn Sulphate/ha to each crop is enough to meet Zn requirements of crops.

Frequency of zinc application

● Zinc leaves marked residual effect so it is not necessary to apply Zn to every crop. The residual effect of 11 Kg Zn/ha added to soil persisted on four crops in calcareous and on six crops in non calcareous soils.

● The beneficial effect of FYM alone or in combination of zinc was higher compared to Zn application. Integrated nutrient management proved better than zinc alone.

Method of application

● Basal application of Zn to soil through broadcast and mixed or its band placement below the seed proved superior to top dressing , side dressing or band placement , foliar sprays or soaking or coating of seeds / seedling in Zn solution/ slurry as well as transplanting Zn enriched nursery because of later led delayed cure of Zn deficiency than basal use.

● Foliar feeding of crops with application of 0.5 % $ZnSO_{4.}7H_2O$ solution is the supplement of soil application but it is not a substitute. In field crops it proved inferior in case of Zn and B; however, in horticultural and plantation crops foliar feeding of crops with repeated foliar sprays of Zn or B generally excelled to their soil application.

Time of application

● Time of Zn application mainly depends upon its content in seed or severity of its deficiency. Best time of Zn addition is prior to sowing or transplanting of crops because maximum Zn absorption by plants takes place upto tillering or preflowering stages.

● Split application of Zinc sulfate in rice is recommended as 50 % at the time of sowing or transplanting and remaining 50 % before or upto tillering stage.

● Basal application of Zn to soil is found the best. However if it is missed Zn deficiency may be corrected by top dressing of Zn upto 45 days. Seed coating with ZnO and zinc phosphate slurry successfully corrected deficiency in marginally deficient soils.

● Foliar sprays of 0.5 % Zinc sulfate two to three times at 7-10 days interval just after appearance of its deficiency can control Zn deficiency more efficient and effectively. If deficiency persists than continue more sprays.

Amelioration of boron deficiency

Sources of boron

● Borax, granubor & Boric acid proved equally efficient in combating B deficiency in crops.

Method of application

● Basal soil application of B proved superior and corrected its deficiency more efficiently than to foliar sprays. Sprays controlled its deficiency in standing crops but less effectively.

● In case of hidden deficiency sprays of 0.2% boric acid or borax at pre flowering or flower head formation stage enhanced the crop yields.

● Boron helps in pollination and seed formation so foliar sprays are helpful in better pollination, seed setting and yield even in few soils tested adequate in soil available B.

Rate of application

● Boron deficiency in crops grown in calcareous or non calcareous (coarse textured) soils can be corrected by its soil application more efficiently.

● Optimum dose of Boron in Acid alluvial and lateritic soils are between 1.0-1.5 Kg B/ha. Rice, Maize, wheat, groundnut, sugarcane, cotton, sunflower, safflower and various vegetable crops showed high B requirements than soybean, green gram and mustard and oilseeds.

● Sensitive crops need two to three times more boron than tolerant crops in B deficient soils.

Frequency of application

● Boron leaves residual effect to the succeeding crops. Effect of 1.6 kg B/ha in acid alluvial soil persists on two to three crops in sequence.

● The optimum dose of B in lateritic soils ranged between 1.0-1.5 Kg B/ha for cereals and 1.5-2.0 Kg B/ha for pulses and oilseeds at an interval 3-4 crop.

● Application of more than 2.0 Kg B/ha caused toxicity to maize, grain and other crops even in calcareous alkaline soils.

Molybdenum deficiency

● Application of ammonium molybdate (54% Mo) and sodium molybdate (39%Mo) are common sources of molybdenum to rectify its deficiency in soils and crops.

● Vegetables, pulses, legume, oilseeds are more responsive to Mo than cereals.

● Crop need varied from 0.4-0.5 Kg Mo/ha in Mo deficient red acid soils. Wheat variety Somalia exhibited 38% grain yield response with application of 0.5 Kg sodium molybdate.

● Mixing of ammonium or sodium molybdate with phosphates fertilizers proved very effective to increase Mo use efficiency.

Sulphur deficiency in Indian soils and its amelioration

● Sulphur (S) deficiency is fast emerging in areas under oilseeds and pulses due to higher removal of S by crops. Survey of Indian soil under AICRP micronutrients revealed that on average, 41% of Indian soils are deficient in S and it is widespread in coarse textured alluvial, red and lateritic, leached acidic and hill soils and black clayey soils. The deficiency of S is emerging fast in areas where continuously sulphur free fertilizers like DAP, Urea etc are being used.

Amelioration of S deficiency

● Sulphur removal by one ton cereals, pulses and oil seeds grain is about 4, 8 and 12 kg. Oil seed show high response to S fertilization than cereals. Visible symptoms of S deficiency in most of the oil seeds and pulse crop appear on young foliage in the form of pale chloritic leaf, thin slender stem, stunted growth, poor branching and bushy appearance.

● Among different sources, SSP, Gypsum, pyrites, Ammonium Sulphate, Bentonite S found better for S Fertilization. Basal application of S was found beneficial but in oil seed its application can be made in at 25 – 30 days of crop growth.

Rate of application

● Chikpea, field pea, pigeon pea, soyabean, groundnut mustard require 40 kg S/ha

● Lentil, greengram, blackgram, cluster bean, sesame, linseed, niger needs 20 kg/ha

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