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GUIDELINES FOR USE OF MICRONUTRIENTS IN RICE, WHEAT AND PULSES

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Introduction:

Indian soils have become deficient not only in major plant nutrients like nitrogen, phosphorus and in some cases, potash but also in secondary nutrients, like sulphur, calcium, and magnesium. Micronutrients such as zinc, boron and to a limited extent iron, manganese, copper and molybdenum have also been reported to be deficient. Deficiency of micronutrients during the last three decades has grown in both, magnitude and extent because of increased use of high analysis fertilizers, use of high yielding crop varieties and increase in cropping intensity. This has become a major constraint to production and productivity of rice, wheat and pulses. Thus, there is an urgent need for correction of individual nutrient deficiency and for arresting its further spread.

1) **Zinc (Zn):** Zinc deficiency is most widely spread in Indian soils followed by iron, boron andcopper. It is common in high pH, calcareous and low organic matter- content soils. (Sathiyamurthi and Dhanasekaran, 2014)

- **Role:** It is required in protein synthesis and for ensuring seed quality and uniform maturity.
- **Deficiency symptoms:**

Rice: Appearance of rusty-brown spots and discoloration of older leaves beginning 2-3 weeks after transplanting is noticed. Under acute conditions leaf margins of older leaves dry up. New leaves are smaller in size. Crop maturity is non-uniform and delayed.

Wheat: Plants become stunted and bushy. Interveinal chlorosis of new leaves is seen. In severe cases, leaves turn white and die.

Pulses: Stunted growth, development of light green, yellowish, bleached spots, little leaf condition, shortening of internodes and delayed reproductive phase are commonly noticed.

- **Sources:**
  1) Zinc –EDTA chelate ; Zn content -12 %
  2) Zinc sulphate monohydrate; Zn content-33 %
  3) Zinc sulphateheptahydrate; Zn content-21 %; included in the FCO, 1985.
- **Dose and Application method:**
  - Zinc sulphateheptahydrate (Zn-21%) is recommended for soil application at the rate prescribed by the State Agricultural Universities/Soil Testing Laboratories. The dose varies across the states from 25 to 60 kg/ha depending on soil type, cropping intensity and crop productivity levels, to be applied once in two years.

- It should not be mixed or applied with phosphate fertilizers, as water soluble zinc is transformed to relatively insoluble zinc phosphate.
- Drilling, band placement or broadcasting of zinc sulphate are popular application methods. Basal (soil) application is always preferred. However, in the absence of basala pplication, foliar spray of 0.5 % solution of zinc sulphatehepta hydrate 15 days after transplanting of rice and 30 days after planting of wheat should be practiced. The foliar application should be repeated after 15 days. About 500 l of solution will be adequate for one foliar spray of1 hectare cropped area.

- **Crop Response:**

Crop response to applied zinc varies depending on soil type, crop and its variety, available nutrient status etc. Average yield increases due to zinc (Zinc sulphate) application have been recorded as 550 kg/ha in Paddy and 360 kg/ha in wheat. Response of pulse crops to zinc sulphate application ranges from 160 to 200 kg/ha.

2) Boron (B): Boron deficiency is most common in Bihar, West Bengal, Orissa, Assam and Jharkhand. However, it has also been observed in Gujarat, Karnataka Madhya Pradesh, Chhattisgarh and Uttar Pradesh (Department of Agriculture, New Delhi)

- **Role:** Boron is required for cell division and extension. It is essential for pollen tube growth which affects seed/fruit set and hence yields.
- **Deficiency symptoms:**

Rice: Young leaves are deformed and growing points undergo drying and withering.

Wheat: Boron deficiency causes thickening of stems and leaves, shortened internodes and reduced flowering and seed formation.

Pluses: Stem thickens, growing points die, leaves become slightly chlorotic and mottled, seed setting is reduced.

- **Sources:**
  1) Borax (sodium tetraborate); contains 10.5 % boron.
  2) Boric acid; contains 17.0 % boron.
  3) Di-sodium octaboratetetra hydrate; contains 20 % boron.
- **Dose and application method:**
  - Boron should be applied to a deficient soil as borax @ 10 kg/ha through broadcasting at the time of planting rice, wheat or pulses.
  - It can also be applied through foliar spray as 0.5 % solution of borax 15 days after planting and at flower initiation stage.
  - The material used should conform to FCO/BIS specifications.
- **Crop Response:** Boron application to deficient soils leads to significant increase in crops yields. Average yield increases due to Boron application have been recorded as 310 kg/ha in rice, 370 kg/ha in wheat and 320 kg/ha in pulses.

3) Iron (Fe): Deficiency of iron has been observed in north Bihar, Andhra Pradesh, Gujarat,Rajasthan, Uttar Pradesh, Haryana, Karnataka, Maharashtra, Tamil Nadu, andPunjab. Iron deficiency is generally noticed in calcareous and alkaline soils.

- **Role:**Iron plays an important role in synthesis of chlorophyll which is essential for photosynthetic activity. It is also required for chemical reduction of nitrate and sulphate and in nitrogen assimilation.

- **Deficiency symptoms:**

Rice: Interveinal chlorosis in streaks is noticed. Drying of leaves starts from tips and margins. Under severe conditions, leaves become white and die.

Wheat: Deficiency of iron is manifested as interveinal chlorosis of upper most leaves. As deficiency intensifies, leaves turn almost white and die.

Pulses: Yellowing of interveinal areas of young leaves is commonly noticed in iron deficient plants. Severity leads to pale-white discoloration of leaves.

- **Sources:**

1) Ferrous sulphate (FeSO4. 7H2O); contains 20 % iron.

Fe-EDTA chelate; contains 12% iron.

- **Dose and application method:**
  - Ferrous sulphate is most commonly used source of iron. Soil application @ 50kg/ha to rice, wheat or pulses every 3 years or 15 kg/ha every year is recommended. However, it is more effective when applied as foliar spray of 1% solution, 2-3 times at weekly interval in rice, wheat or pulse crops.
- **Crop Response:** Crop responses to iron application are comparable to or higher than those to zinc. Average yield increases due to iron (Ferrous sulphate) application have been recorded as 450 kg/ha in chickpea, 780 kg/ha in wheat andupto 1500 kg in paddy.

4) Manganese (Mn): Manganese deficiency is prevalent in Assam, Karnataka, Tamil Nadu, Punjab,Haryana and Gujarat. (Inniyalakshimi *et al.*2016)

- **Role:**It is important for normal functioning of many enzymes, nitrogen metabolism and carbon dioxide assimilation.
- **Deficiency symptoms:**

Rice: Chlorotic patches between veins are first noticed on younger leaves.

Wheat: Leaves show interveinal chlorosis with grayish yellow to pinkish brown specks of variable size confined largely to lower portion. At later stage, specks coalesce forming streaks or bands in-between the veins which remain green. Acute deficiency may lead to drying of whole plant.

Pulses: Interveinalchlorosis and mottling in young leaves is noticed. Brown lesions in cotyledons are commonly noticed.

- **Sources:**
  1) Manganese sulphate; contains 30.5 % Mn.
  2) Mn-EDTA chelate; contains 5-12 % Mn.
  3) Manganese chloride; contains 17 % Mn.
- **Dose and application method:**
  - Foliar spray of 0.5 % manganese sulphate solution at tillering in rice and crown root initiation in wheat is recommended.
- **Crop Response:** Data base on crops response to manganese is very limited. Average yield increases in paddy and wheat recorded in Punjab are 360 kg/ha and 560 kg/ha, respectively. Inter-varietal differences in response of wheat crop to applied manganese have been observed.

5) **Molybdenum (Mo):** The states affected by Mo deficiency include Orissa, Jharkhand, and West Bengal Gujarat, Madhya Pradesh and Haryana.

- **Role:** Molybdenum is involved in symbiotic N-fixation and protein synthesis in crops.
- **Deficiency symptoms:**
  - Marginal scorching and rolling or cupping of leaves are indicative of Mo deficiency.
  - Acid and coarse textured soils with low organic matter content are usually deficient in molybdenum.
- **Sources:**
  1) Ammonium Molybdate; contains 52 % Mo.
  2) Sodium Molybdate; contains 39 % Mo.
- **Dose and application method:**
  - Apply 2-4 kg/ha sodium molybdate or 2-3 kg of ammonium molybdate at the time of planting or treat seed with 10-20 g sodium molybdate per 25 kg of seed.
  - Alternatively, 0.1- 0.3 % ammonium molybdate solution may be foliar sprayed2-3 times at 10 days interval.
- **Crop Response:** Wheat crop has shown significant increase in yield (440 kg/ha) due to foliar application of molybdenum. Green gram productivity improved by 40 % in laterite soils of Bhubaneshwar when seed was treated with @ 12g Mo / 25 kg seed.

6) **Copper(Cu):** The states of Gujarat and Kerala are worst affected by copper deficiency. However, Tamil Nadu, Karnataka and Jharkhand have also reported copper deficiency. Deficiency is usually noticed in strongly acidic, alkaline, poorly drained and low organic matter soils.

- **Role:** Copper is involved in chlorophyll formation and is a part of several enzymes. It's also required for symbiotic nitrogen fixation.
- **Deficiency symptoms:**
  - Leaves become light green and develop twisted tips. Panicles are poorly filled and may even remain empty if the deficiency is severe.
- **Sources:**
  1) Copper sulphatepentahydrate; contains 24 % copper.
  2) Copper sulphate monohydrate; contains 35 % copper.
- **Dose and application method:**
  - Foliar spray of 0.025 % solution of copper sulphate (pentahydrate) at appearance of symptoms or soaking of seeds in 0.25 % copper sulphate solution in case of rice or soil application of 1.5-2 kg copper sulphate / ha oncein 4-8 years is recommended.
- **Crop Response:** On an average, wheat yield improves by 380 kg/ha and paddy yield increase isabout 460 kg/ha.

General Precautions for application of micronutrients:

- Never mix zinc, iron or copper micronutrient fertilizers with phosphatic fertilizers as these elements are rendered less soluble.
- Avoid excessive use of phosphorous as it adversely affects utilization of zinc, iron and copper.

- Excess of iron adversely affects utilization of zinc and manganese; conversely excess of zinc, manganese and copper induces iron deficiency in crops. Thusmixing of iron containing fertilizers with zinc, manganese and copper fertilizers should be avoided. Further, over-use of micro-nutrients should also be avoided.
- Excess of sulphur and copper induces molybdenum deficiency in crops. Thus application of sulphur and copper should be within recommended doses.
- Excessive use of lime or liming material should be avoided as it induces zinc, iron, and manganese and boron deficiency.

Reference:

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