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Role of Boron in Crop Production and Its Management

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Boron is non-metal essential micronutrient, most deficient after Zinc in Indian soils. It is responsible for cell wall formation and stabilization, pollen germination and pollen tube growth, imparts drought tolerance to plants. B deficiency cause brown head and hallow stem in cauliflower. Foliar spray is more prominent than the soil application.

Introduction

Boron is a non-metal, essential micro nutrient and it belongs to the third periodic group. B is unique among the essential elements because it is the only element that normally occurs in soil solution as a non-ionised molecular H_3BO_3. Boron is neither an enzyme constituent nor is there convincing evidence that it directly affects enzyme activities, but has utmost role in lignifications, RNA metabolism. Boron deficiency occurs in many countries worldwide with coarse textured soils in humid regions. In Indian soils Boron is most deficient micronutrient after Zinc.

Status of Available Boron in Indian Soils

Total boron in Indian soils varies between 7 and 630 mg Kg^{-1}. The range of available boron in different states of India is traces to 12.2 mg Kg^{-1}.

Name of the state	Soil group	Samples analysed	Available soil B (mg/ Kg)	% Soil deficient
Assam	Acid soil	320	0.05-0.72	43
Bihar	Calcareous soil	1201	0.06-8.00	48
Madhya Pradesh	Red & yellow	544	0.5	49
Meghalaya	Alfisols	20	0.10-0.50	50
Orissa	Red & Laterite	882	0.10-2.20	69
Punjab	Ustochrept	116	0.30-2.00	43
Uttar Pradesh	Saline-Alkali	45	0.20-4.10	23
West Bengal	Red & Laterite	2544	0.02-3.30	64
	Terai-Tista alluvial	633	0.05-0.76	84

Source: Shrotriya and Phillips (2002)

Functions of Boron in Plants

- Responsible for cell wall formation and stabilization, lignifications and xylem differentiation. Boron deficiency causes a remarkable decrease in the production of indole acetic acid (IAA) which induces Calcium deficiency.
- It imparts drought tolerance to the crops.
- Plays pivotal role in pollen germination and pollen tube growth in cereals and oilseeds.
- Regulates K/ Ca ratio and sugar translocation in tuber crops like potato, sugarbeet, etc.,
- Essential for cell division & protein synthesis.
- Facilitates the transport of Potassium in guard cells.
- Diseases viz. *Fusarium* and *Verticillium*, potato wart and club root of crucifers are reduced with the supply of Boron.

Deficiency Symptoms of Boron in Crops

B deficiency symptoms appear at first on the younger leaves or terminal shoots with an appearance of misshaped, wrinkled, brittle and sometime thickened with dark bluish color. Under Boron deficiency chlorosis occurs and in case of severe condition plants die. Death of terminal buds stimulates sprouting of lateral buds which may give plants a bushy and rosetting appearance. Deficiency symptoms mostly observed during reproductive stages with impaired fruit formation and with reduced numbers of seeds. There are some individual plants which impart some characteristic symptoms due to Boron deficiency which are given below:

Rice: White necrotic streaks and the youngest emerging leaves fail to unroll and remain enclosed within the subtending leaf.

Wheat: Chlorotic specks in older leaves with bright orange yellow color in the middle of lamina. Inflorescence and grain setting is restricted in ear producing tillers.

Barley: At about 7 week growth, older leaves of plants shows dark brown necrotic spots along the tips and margins. Internodes become short and often nodes appear enlarged.

Mustard: At pre-flowering stage, plants leave become thick, leathery with pale to brownish green colour, showed scorching symptoms at growing tips. Stunted growth and produce of unfilled grains also observed at maturity stage.

Cotton: Boron deficiency occurs after 4 weeks of growth, while visible symptoms appear about 45-50 days of crop growth with chlorotic patches of brittle young leaves. At the same time middle leaves show inward cupping.

Carrot: Formation of rough, small roots with a longitudinal crack and distinct white core.

Cauliflower: 'Brown-head', 'Hollow stem' and delayed curd formation occurs.

Tomato: Growing point of the stem having blackened appearance with stunted growth followed by curling and yellowing. Fruits may show corky patches and unevenly ripen.

Stem of boron deficient cauliflower- frequently hollow

Fruit showing corky patches and uneven ripening in tomato

Vertical splitting exposing the central core of the root of carrot

Causes of Boron Deficiency in Soil

B deficiency particularly prevalent in light-textured, highly leached acid soils, calcarious soils, high clay soils, soils with low organic matter. Adoption of high yielding cultivars, intensive cropping with increased use of high analysis B-free fertilizers, drought condition also favors deficiency of B.

Amelioration of Boron Deficiency

The need to include boron in the fertilizer recommendation is determined by crop requirement and soil boron test level. High rate of boron may require for clay-type soils, soils with high water pH, calcium content, and/or organic matter content.

Sources of Boron Fertilizer

Boron requirement for various crops was found to be a natural prerequisite for efficient and rational use of boronated fertilizer. Many compounds have been recommended as source of B for soil and foliar application. A number of boron containing fertilizers are listed below.

Boron containing fertilizers:

Name	Chemical formula	B content (%)
Borax	$Na_2B_40_7 .10H_2O$	11 '
Sodium tetraborate (Fertilizer Borate-48, Agribol)	$Na_2B_40_7. 5H_20$	14-15
Fertilizer Borate-68	$Na_2B_40_7$	21
Boric acid	H_3B0_3	17
Solubor	$Na_2B_40_7.5H_20 + Na_2 B_{10}O_{16}. 10H_2O$	20-21
Colemanite (Portabor)	$Ca_2B_6O_{11}. 5H_2O$	10-16
Boron frits	Complex borosilicates	2-6

Method of application

Soil application: Basal soil application of B is superior and corrects its deficiency more efficiently than foliar sprays. Borax was found to be most widely used for soil application but rates should not exceed 1.5 lb/acre on soils with a pH less than 6.5 to avoid boron toxicity problems.

Foliar application: boric acid and sodium borate are effective for foliar spray. In case of hidden deficiency, sprays of 0.2% boric acid or borax at pre flowering or flower head formation stages enhance crop yields, but it should not exceed 0.3 lb/acre to avoid toxicity problems.

For all types of applications, extreme care must be taken to apply the correct amount and to apply it uniformly to avoid toxicity problems.

Foliar spray is more prominent than the soil application due to following reasons:

1. Uniform spread over the crop canopy
2. Require a lower rate than soil application
3. Crops respond immediately for rapid recovery.

Rate of application: The narrow concentration range between boron deficiency and toxicity requires special care in the application of boron fertilizers. The general recommended dose of

boron for soil application is at 0.50 to 2 kg ha^{-1} with or without mixing with major nutrient or as foliar spray at 0.2 to 0.5% (W: V). Usually the recommended dose for Borax is 10-15 Kg ha^{-1}, for Boric acid 5-7 and for solubor is 7-9 Kg ha^{-1} to the soil or applied through foliar spray.

Soil amelioration: To correct problem of B deficiency sometimes application of lime and organic matter is useful to increase the availability of B in acid soils. The beneficial effects of organic farming have been realized for sustainable agriculture production, restoration of soil fertility, production of quality foods, and avoidance of pollution of soil, water and air including low cost technology. The chief sources of micronutrients used by farmers' level are organic matters available in farmhouses. Green Manure contains 20.0 mg B Kg^{-1}, City compost 15 mg Kg^{-1}, Rural compost 10 mg Kg^{-1}, Sewage sludge 9 mg Kg^{-1}, FYM 4.6 mg Kg^{-1}, Pig Manure3.5 mg Kg^{-1}, Poultry Manure 5.0 mg Kg^{-1}.

Precautions

- Boron containing fertilizers should not come into contact with the seed at planting time.
- Borax and fertilizer borates are not suitable for compounding with $(NH_4)_2SO_4$ as their alkaline reaction may cause liberation of NH_3.

Conclusion

Prevention or correction of B deficiency in crops on B-deficient soils have a dramatic effect on yield and improve quality of many crops including fibers, cereals, pulses, oilseeds, vegetables, citrus fruits and alfalfa. Source, rate, formulation, time and method of B fertilizer application and proper balancing of B with other nutrients in soil affect crop yield on B-deficient soils. Both soil and foliar application methods of B are effective in improving crop yield, produce quality, concentration and uptake of B, and economic returns.

References

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