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SPATIAL DISTRIBUTION OF AVAILABLE BORON IN SOILS OF SAURASHTRA REGION OF GUJARAT: A REVIEW

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ABSTRACT

Boron (B) is a crucial micronutrient essential for plant growth and development. Understanding its spatial distribution in Indian soils is pivotal for effective agricultural management. This review synthesizes existing literature on the spatial distribution of available boron in soils of Saurashtra region of Gujarat state, highlighting methodologies, spatial patterns, relationship with various soil properties and implications for agriculture. The accurate estimation of spatial distribution of soil properties is important in precision agriculture and is one of the bases for decision and policy makers to make plans and strategies. Here in case of one important micronutrient boron (B) is under the estimated area. Hence, it is necessary to evaluate their status of the soil and promote the recommendations of soil test for balanced implications to maintain soil health. Under the study clearly showed the exide limit of boron found under the concentrated salt patches of coastal belt of Saurashtra, while in point of calcareous soils the availability was decreases due to bind with calcium ions.

Key words : ArC GIS, Available boron, EC, pH, Saurashtra region, Spatial variability.

Introduction

Boron is indispensable for various physiological processes in plants, is immobile in plants and release of boron in mineral soils, is usually quite slow. Soil organic matter holds much of the available boron rather tightly. Boron deficiencies are generally related to high rainfall areas with acid soil environment. Under acid soil conditions, boron is more water soluble and can therefore be leached below the root-zone of plants by rainfall or irrigation water particularly accentuated by light texture soils. It has also been shown that symptoms of boron deficiency are associated with high soil pH values (alkaline conditions). Reduced boron solubility under alkaline soil conditions can result in less plant uptake and increased the potential for boron deficiencies. It's availability in soils varies geographically. In India, where agriculture sustains a significant population, assessing boron distribution is vital. This review aims to consolidate studies on spatial boron assessment in Indian soils, crucial for informed soil management.

In Indian soils, spatial variability in micronutrient availability is presumed to be high due to small farms and varied management. Such variation decreases the effectiveness of uniformity applied soil management practices thus reducing the productive potential of a given area. Majority of soil maps are prepared by conventional methods and very little work has been done so far to use the modern spatial prediction techniques in this regard (Saha *et al*., 2012; Pal *et al*., 2014; Behera and Shukla, 2015; Tripathi *et al*., 2015; Bhunia *et al*., 2016).

Saurashtra is one, major region of Gujarat, situated at western part of state, including major 10 districts with 75 Tehsils (Talukas). With total area of 6.43 mha (32.74% area of Guj. State). From total area received up to 3.70 mha (61% of total area) included under cropping and farming. Major crops of Saurashtra region like Groundnut,

Cotton, Sesame, Soybean, Garlic, Onion, Chickpea, Castor *etc*. Major of oilseed and pulses grown in area of state are included into Saurashtra region that are facing many of micro-nutrient deficiencies and also from that nutrient Boron is common because of soils are majorly in calcareous in nature leads to create deficiency of these nutrient so need to evaluate these kinds of spots from the region by random sampling.

We take one example that groundnut productivity in Saurashtra exhibited stagnant trend during last three decade, this may be partly because of nutritional disorder caused due to continuous mono cropping of groundnut. Boron is one of them as the soils are calcareous, which restricts the boron availability. Boron is unique among the essential mineral micronutrients because it is the only element that is normally present in soil solution as a non - ionized molecule over the pH range suitable for plant growth. Boron is involved in the transformation of sugar and starch formation. It also influences cell development and elongation. Boron affects carbohydrate metabolisms and starch formation and synthesis of proteins. Addition of boron (2 ppm) in groundnut increased the yield by 18 per cent (Golakiya and Patel, 1986) and improved the quality (Golakiya, 1988) through suitable changes in yield attributes of groundnut (Sutaria and Golakiya, 1990). Similarly various study was taken at JAU, Junagadh. The yield of groundnut (26 %), mungbean (16.40 %) as influenced by boron application. So, for greater the quality and yield reduce their deficiency by identifying the areas of Saurashtra with status and deficiency of available boron that spatial distribution and survey is much useful.

Methodologies for spatial assessment

Studies employ diverse methodologies, including soil sampling, laboratory analyses and geospatial techniques. Sampling schemes like grid or random sampling capture spatial variability. Laboratory analyses, utilizing methods such as hot water extraction or DTPA extraction, quantify available boron. Geospatial techniques, including GIS and remote sensing, aid in regional mapping.

The data were generated by analysis of soil samples using standard methods of analysis delineated with using Arc GIS software using GPS based mapping boundaries and IDW and Kriging as interpolation tools. Delineated map was divided with six tier colored contrast with help of standard dividing format with different shadow color. Particular color in the map show the particular range of the given data with their status.

Results and Discussion

Spatial Distribution Patterns

Indian soils exhibit diverse boron distribution patterns influenced by soil type, parent material, land use, and anthropogenic activities. Alkaline soils often display boron deficiency, while acidic soils may face toxicity. Human activities, like excessive fertilizer use, exacerbate boron imbalances. Most General used form of boron among the boron fractions in the soil was hot water soluble boron (available boron) that was commonly denoted that the index of boron availability in soils. Here, for the Saurashtra region soils were analyzed with standard procedure of available boron estimation with using 0.01 M $CaCl_2$ in MP-AES instrument. Overall, it was varying ranged from 0.03 to 3.09 mg kg^{-1} with a mean value of 0.41 mg kg^{-1} (Gorasiya *et al.*, 2024).

Relationship between Boron and different Soil Properties

Boron concentrations in soil vary from 2 to 200 mg B per kg, but generally less than 5-10% is in a form available to plants (Diana, 2006). Boron concentration and its bioavailability in soils is affected by several factors including parent material, texture, nature of clay minerals, pH, liming, organic matter content, sources of irrigation, interrelationship with other elements, and environmental conditions like moderate to heavy rainfall, dry weather and high and light intensity (Moraghan and Mascagni, 1991). Therefore, knowledge of these factors affecting B availability and its crop uptake was essential for the assessment of B deficiency and toxicity under different conditions.

Soil pH

Boron availability decreases with increasing soil pH. Liming acid soils can cause a temporary B deficiency in susceptible plants with the severity depending on crop, soil moisture status and time elapsed after liming. Heavy liming of soils high in organic matter may encourage organic matter decomposition and release of boron, thus increasing boron uptake. At low pH, most of the B compounds are soluble and thus B remains available to plants as boric acid. In sandy soils having low pH, B is lost down the profile by leaching if rainfall is high. In fine-textured soils, however, B leaching is not a major problem if the soil is not very low in pH.

Soil EC

In soils of arid regions, the available boron exists as sodium or potassium salts which are highly soluble. Under conditions, which favour the formation of saline-alkaline soils, boron moves up along with other salts and is deposited at the surface. Gandhi and Maheta (1958) reported that saline soils of Gujarat and Saurashtra contain much higher water-soluble boron than non-saline soils of the same area. Kanwar and Singh (1961) observed the

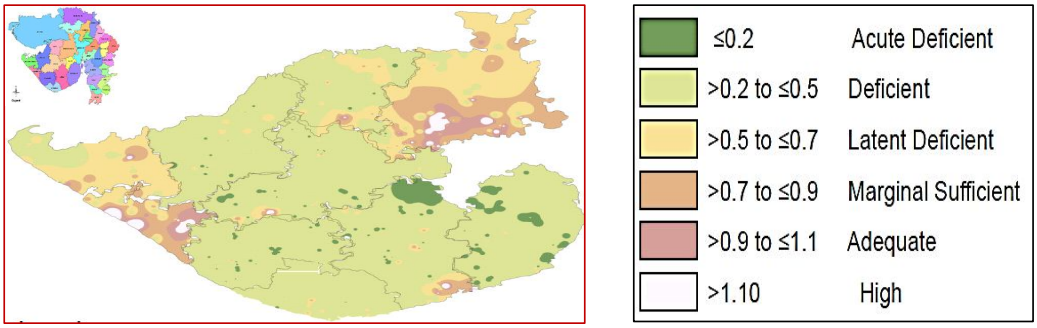

Fig. 1 : Map of available boron (mg kg^{-1}) status in soils of entire Saurashtra region.

highly significant positive relationship between water soluble boron and electrical conductivity of the saturation extract of soil.

Implications for Agricultural Management

Understanding boron spatial distribution informs targeted soil management. Soil amendments, tailored to boron levels, mitigate deficiencies or excesses. Precision agriculture enabled by geospatial technologies optimizes nutrient application, enhancing crop yield and environmental sustainability.

- ❖ Spatial variability of any particular nutrients can be identify with using GPS based surveying it can predict or estimate the potentials and limitations of soils for many specific uses.
- ❖ Based on mapping the specific area isolate the patches of deficient as well as sufficient or high to toxic levels of nutrients to particular part of region that is used to make workable summaries for nutrient applications and recommendations.
- ❖ Information gain from soil survey and soil mapping can be used for site specific nutrient management and further can be benefited for sustainable nutrient management.

Conclusion

Spatial assessment of available boron in soils is essential for sustainable agricultural practices. By leveraging diverse methodologies and technologies, researchers can develop informed soil management strategies, ensuring optimal nutrient availability for crop growth while minimizing environmental impacts. Among, different districts of Saurashtra region, districts like Porbandar and Surendranagar were found in sufficient marginal, whereas the remaining districts like, Rajkot, Junagadh, Bhavnagar, Amreli, Gir-somnath, Jamnagar, Morbi and Devbhumi Dwarka were acute to latent deficient in range in respect of available boron. The results gained from research area potentially practicable used for determining site specific nutrient management practices, that considerably would help in improving fertilizer use efficiency, reducing cost for cultivation and prevent environmental pollution.

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