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Research Article

INFLUENCE OF BORON APPLICATION ON THE GROWTH AND PRODUCTIVITY OF RICE

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Abstract: Rice is grown globally feeding billions and is affected by various stresses, one of which is nutrient deficiency including boron. About 33% of Indian soils are recorded to be deficient in Boron. Its deficiency in rice is also considered to be spreading in most rice growing soils. Boron maybe micro in amount but its indispensable role cannot be avoided. Its many functions are cell wall stability, flowering, pollination, sugar transport, carbohydrate metabolism. With its deficiency pollen tube and anthers fail to develop which leads to panicle sterility, a limiting factor for rice yield. To keep up with the population pace, rice yield has to be increased and so management of B should be addressed. Deficiency of B can be treated by boron application either as foliar or soil applied. However, range between deficient and toxic is very thin therefore care has to be taken in applying the exact quantity of B fertilizer. Several studies have reported the effect of boron application on rice attributes to increased number of productive tillers, grain weight, panicle, reduce in panicle sterility and thereby, increase in yield over control.

Keywords: *Boron, deficiency, rice, panicle sterility and yield*

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Introduction

The essentiality of boron has been given more than 90 years back but it has not got as much attention as macronutrients. The importance of B needs to be addressed because boron deficiency has become a global issue. Boron deficiency has been reported in over 80 countries affecting 132 crops globally [1]. In India, it is the second most deficient among all micronutrients constituting about 33 percent [2]. It also stands in sixth position among essential nutrients deficient next to N, P, K, S and Zn. Though less interest has been given, one cannot deny the fact that boron has the potential to improve growth and crop yield has been claimed recently to be the most critical micronutrient for crop production. Boron deficiency is widely reported to affect the productivity of a wide range of crop including rice [3]. Correction of B deficiency has the potential to improve crop production

Why interest in Boron?

Boron deficiencies occur over a wide range of soils and crops. Its role and deficiency in cole crops and oilseeds is known widely. Toria, an important oilseed reported to be adversely affected by B deficiency is now made mandatory to apply B in Toria cropping areas along with NPK. Rice though considered as less sensitive to B deficiency compared to other crops, substantial reduction in yield has been reported [4]. Panicle sterility in rice is a major constraint threatening global production of rice [5]. One of the major contribution of B deficiency to causing panicle sterility evolve as a result of failure of pollen to germinate and improper development of another [6]. This evokes a keen interest in the study of B nutrition of rice such that deficiency is corrected and yield is increased. Correction of B deficiency has the potential to improve rice production. Focus is therefore on B.

Functions of B in plants

Boron is neither a constituent of enzymes nor directly involved in enzymatic activities. However, boron plays a crucial role in performing the following activities-

Flowering and seed production
Pollination
Cell wall strength
Carbohydrate metabolism
Nucleic acid metabolism
Sugar transport
Cell division
Root elongation

Boron in flowering is very important because rice crop is more sensitive to B deficiency during reproductive stage than vegetative stage [7]. Due to its role in flowering and pollination, there had been reduction in sterile panicle as reported by researchers. Translocation of sugar is another important function through which sugar gets transported to the grain part where it helps in grain filling by enhancing starch content in grain. Also, 90 percent of cellular boron is found localized in the cell wall [8]. Carbohydrate metabolism and nucleic acid metabolism are essential central to pollen tube growth.

Factors affecting boron availability

There is list of dominant factors which influence the availability of boron. These include soil pH, presence of organic matter, parent material, microbial activity, soil texture and interaction with other elements [9].

Deficiency symptoms of boron in rice

The deficiency of boron is commonly observed in soils which are inherently poor owing to kind of parent materials, light textured soil, alkaline and calcareous soils. Boron is immobile in plants so its deficiency symptoms develop firstly on young leaves. Its deficiency results in reduced plant height and tips of the emerging leaves become white and rolled.

Severe deficiency results in death of growing points. Rice also fails to produce panicle if they are affected at panicle initiation stage. Stems also become thin and brittle comparing to healthy plants. Short and fewer tillers also a deficiency symptom of boron deficiency [10].

Toxicity symptoms in rice

Toxicity symptoms of boron in rice first appear as chlorosis of the tips and margin of older leaves. As the days progresses, later after two to four weeks, dark brown elliptical spots appear on these discolored areas, which then turn brown and withers. Necrotic spots are most prominent at panicle initiation. Necrotic spot owing to B toxicity looks similar to symptoms of brown spot disease of rice. The symptoms can be differentiated by the extent of area covered. In case of B toxicity, the brown patches appear along the leaf margin. Whereas in brown spot disease, the necrotic spots cover the entire leaf area.

What boron deficiency does to rice plant?

Boron is responsible for better pollination, seed setting and grain formation in different rice varieties. Its deficiency therefore results in this major consequence- failure of pollen germination, poor another development, deteriorate of kernel and root growth ceased. All this leads to reduction in rice yield. One of the major reasons of panicle sterility in rice plant occurs during micro sporogenesis where even a short-term B deficiency leads to failure in another development and affects pollen viability [11]. Pollen grains are considered to be naturally low in boron content and therefore considering the importance of B in pollen tube germination and growth, a continuous supply of boron is required for pollen tube growth [12]. It is proposed that the capture of secreted pollen proteins for membrane and cell wall building proceeds only in the presence of boron through borate complexes with sugar residues [13]. The possible role of B in increasing translocation and availability of sugar favors the development of pollen by increased enzymatic activity. Deficient of B thus alters the whole reproductive processes leading to unfertilized panicle and ultimately reduction in yield because of less number of filled grains.

Response of rice to soil and foliar application of boron

Boron plays a vital role in activities like cell division, cell wall formation, leaf and flower bud initiation. A study on response of rice to boron application by Hussain, *et al*., (2012) [14] reported that 1000-grain weight showed an increase with boron application over control. The highest response was found with foliar application at tillering increase by 10 percent followed by soil application at grain formation. The effect of boron application by applying @ 1 kg ha^{-1} using three varieties of rice as test crop *viz*., Super Basmati, Basmati-385 and KS-282. Yield was significantly increased in boron applies treatment over control [15]. Super Basmati increased by 21%, Basmati-385 increased by 20% and KS-282 by 13%. The substantial yield increases were primarily the consequence of reduced panicle sterility and increased productive tillers. The data also suggest that maximum yield of rice is obtained at boron application of 1 kg. Boron has been found to play a key role in pollen germination and pollen tube growth. B stimulates the plasma membrane, another development, floret fertility and seed development [16, 17]. Influence of B application on rice cultivar Khushboo-95 study carried out by Shah, *et al*. 2011 with three different treatments of boron applies as soil showed that the panicle as well as number of grains per panicle increased with B application at 1 kg/ha [18]. Rehman, *et al*., (2014) [19] experimented on two rice cultivars. In the end result the plant height is found highest when B is applied at 1 kg in both the varieties while concentration beyond that decreased. Panicle sterility also drastically reduced over control which could be the reason for increase in plant height. Rice crop supplemented with B source is found to be more beneficial and yield better results than those without boron fertilizer. The grain yield and economic returns was recorded maximum with application of boron as basal at 0.5 kg ha^{-1} and 2% as foliar spray after 45 days of transplanting [20]. It substantially increased panicle length, number of tillers per m^2, number of grains per panicle, straw yield and grain yield. Boron fertilization improves not enhances not only the growth but also brings in more net income. Positive response was observed when rice was fertilized with B as foliar in different rates. Similar to other investigations, several growth attributes were significantly increased, maximum recorded when B was applied @ 20 mg l^{-1} beyond which a decline in quality of rice was found [21]. This is due to the fact that the range between boron deficiency and toxicity is very narrow and therefore care has to be taken in recommending the exact dose of B fertilizer. The application of boron on rice crop have positive outcomes influencing various growth parameters in terms of number of tillers, panicle initiation, plant height, number of grains, grain yield and much more.

Conclusion

Boron deficiencies have been recorded worldwide and is coming into limelight because of its many consequences in its absence. Rice serves as a staple food for more than half of the global population and therefore any problem responsible for reduction in yield has to be removed such that every mouth meets its nutritional requirement. The importance of B in increasing rice productivity is well known. As such should not be neglected but look upon with great interest.

Application of research: Various studies have time and again proven that B application to rice can enhance its growth and thereby yield and economic returns. This is important because rice is one of the major crops and there are several factors that contribute in reducing its potential yield, and so boron should not be overlooked even though it is a micronutrient.

Research category: Soil fertility and Crop production

Abbreviations: B- boron, NPK- nitrogen, phosphorus, potassium, S- sulphur, Zn- zinc, ha- hectare, @- at the rate, kg- kilogram, l- litre

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