



# INFLUENCE OF BORON ON THE PERFORMANCE OF MACRONUTRIENTS IN SWEET SORGHUM CULTIVAR MADHURA

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## Abstract:

Macronutrients are essential for the growth and good overall stage of the plants. They play a very important role in the plant growth and development. Moreover these elements must be present in the proper proportion. Their function ranges from being structural units to redox sensitive agents.

The supply of boron to the plants play key role in behaviour of other macro and micro nutrients in the plant. The response of plants to boron varies with soil type, environmental conditions and plant species also. So the excess or deficiency of boron may affect the uptake and availability of other plant nutrients. The sweet Sorghum is a semi-arid crop grown as main staple food of many areas. It is also used as fodder, fuel and fertilizer. The sweet Sorghum c. v. Madhura was selected for the present investigation. In the present investigation the effect of different boron concentrations like 0 ppm (Control), 10 ppm, 50 ppm and 100 ppm on sweet Sorghum var. Madhura has been studied. The pot culture technique was used for this investigation. The objective was to identify the correct dose of boron to improve behaviour of some macronutrients in sweet Sorghum. The data was collected after the fifth day of last treatment of boron.

In the present investigation, an attempt was made to study the influence of boron on the behaviour of macronutrients like N, P, K, in the sweet Sorghum cultivar Madhura. Our results clears that boron increases nitrogen in plants benefitted to nitrogen metabolism under boron stress conditions through nitrogen metabolism for the improvement of crop. The induced nitrogen content might enhance uptake of mineral elements such as P, K, Ca, Mg, Zn, Mn as indicated by Moussa (2000). The increase of P under increasing boron concentration suggests a promoted remobilization of P in Sorghum. The adaptive nature of accumulation of  $K^+$  due to boron treatments reported in c. v. Madhura, which correlates, with many earlier reports and it might be helpful to regulate metabolic activities in the c. v. Madura.

**Key Words: Influence, Boron, Nitrogen, Potassium, Phosphorus.**

## **Introduction:**

Sweet Sorghum produces food as well as fuel so it can help to meet the countries fuel needs without compromising our food supply. Sweet Sorghum is said to be valued for 4-F's. These 4-F's are Food, Feed, Fuel and Fertilizer. It can produce along with grains, a sugary juice which is useful to produce ethanol, jaggery, syrup and flour. Sweet Sorghum is merely 23% more profitable than grain Sorghum. The use of sweet Sorghum may be back to 150 years to produce syrup, forage, and silage for animal feed (Schaffert, 1988), and it is still grown mainly for syrup, forage, and grain (Gnansounou *et al.*, 2005). Sugarcane is also used for ethanol production on large scale but cost of cultivation of sugarcane is three times more than Sweet Sorghum (Dayakar Rao *et al.*, 2004) as well as sweet Sorghum has more total reducing sugars and poor sugars contents as compare to sugarcane (Huligol *et al.*, 2004), so it makes sweet Sorghum, the best and chief alternative for ethanol production.

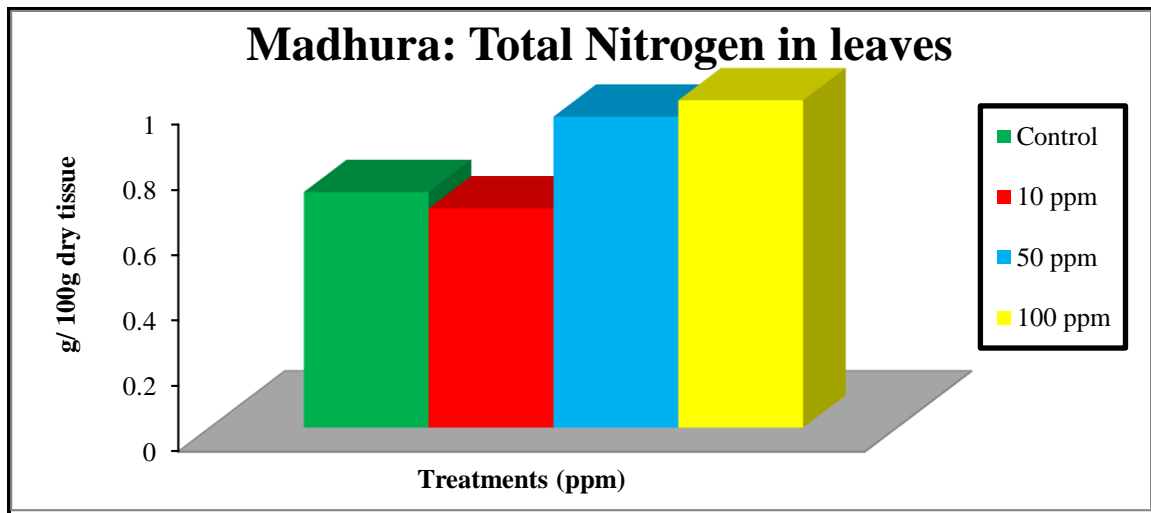
Boron is microelement that has been known longer, essential for both plants and animals. In recent years, research on boron is progressed on exact role of boron in plants physiology. Various workers demonstrated that although boron is essential element in plant growth but its requirement is very less and it may cause toxic effects on plant at excess level. The range of boron requirement and excess is very narrow in plants (Moore, 2004; Hassan, 2007). Boron can be leached to lower surface of soils in arid and semi-arid areas where low rainfall occurs and high rainfall may decrease boron availability in to the soil. Thus soils with low rain fall have high content of boron and shows toxic effects in the fields (Cartwright *et al.*, 1984). Effect of boron on plant is studied by various investigators however the required range of boron needed by plant is very narrow with less concentration causes deficiency while higher concentration may cause toxicity (Moore, 2004; Hassan, 2007), so boron requires special attention as requirement of boron to overcome deficiency and toxicity is very narrow. The amount of boron requirement to crop growth is different in species to species. Generally monocotyledons require less boron than di-cotyledons.

## **Material and Methods:**

The sweet Sorghum variety Madhura is grown in individual pots which were treated with 10 ppm, 50 ppm and 100 ppm boron along with one pot untreated i.e. 0 ppm named as control. These treatments were given at 15 days old seedlings and the treatment was repeated at 40 days and 70 days old plant after sowing. Leaf samples were collected after fifth day of last treatment of boron, for further analysis.

According to method given by Hawk *et al.* (1948), total nitrogen was estimated from the leaves of treated and control plants of both the cultivars of Sweet Sorghum. Calorimetric estimation of phosphorus was done by following the method of Sekine *et al.* (1965). The method described by Toth *et al.* (1948) to digest the plant material. For the estimation of inorganic constituents, an acid digest from the oven dried plant material is used.

## Results and Discussion:



**Fig. 1: The effect of different concentrations of boron on total nitrogen content of sweet Sorghum cultivars.**

The influence of boron on total nitrogen content of sweet Sorghum cultivars is depicted in fig. no. 1. The nitrogen content is increased by boron treatments except due to 10 ppm boron treatment in c. v. Madhura. The enhancement in nitrogen content is observed due to 100 ppm boron.

Nitrogen is one of the most important primary plant nutrients, next to water. It is an essential component of all number of biomolecules including proteins, chlorophylls and vitamins. Nitrogen is needed in large quantities and must be in balance with other nutrients. Nitrogen occurs in all organisms, primarily in the amino acids which are the building blocks of proteins like porphyrin, cytochrome which are essential in respiration and photosynthesis respectively. Nitrogen is converted in to amino acids inside the plants and these amino acids then used in formation of protoplasm which is used in cell division. Similar amino acids are also used in producing necessary enzymes and structural parts of plants. Thus nitrogen can become part of stored proteins in the grains. Nitrogen is a part of chlorophyll, which is associated with production of simple sugars from solar energy. Nitrogen is present in the plants as a dark green color.

Sweet Sorghum requires less nitrogen as compare to other biofuel crops like sugarcane (Almodares and Hadi, 2009). Boron plays a pivotal role in nitrogen (N) metabolism as it enhances nitrate levels and reduces nitrate reductase activity under limited boron conditions (Shen *et al.* 1993). A study by Bolanos *et al.* (2004) has also highlighted the role of B in rhizobial N fixation, actinomycetes symbiosis, and cyanophyceae heterocyst formation in leguminous crops.

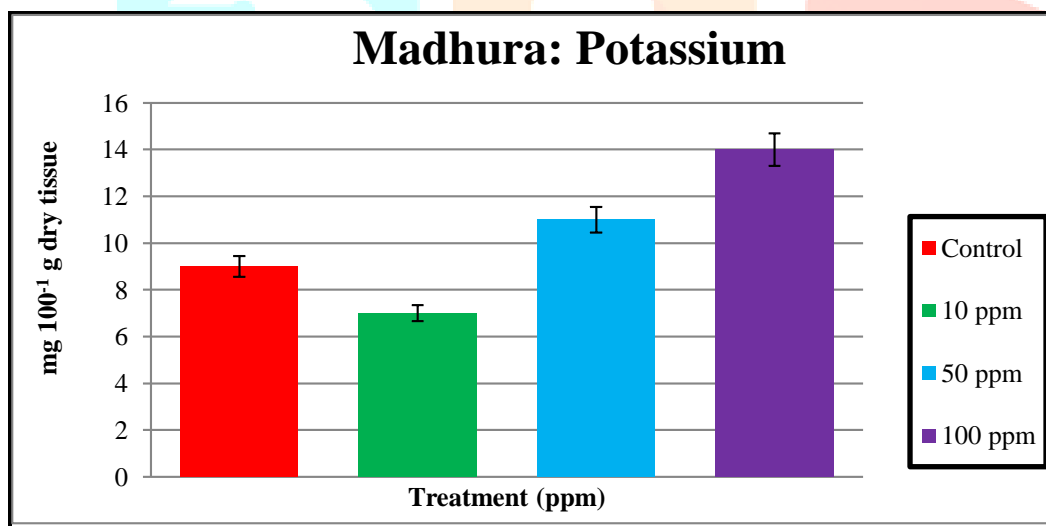
Boron is directly related to the growth of the aerial parts of plants, requiring the formation of chlorophyll and protein synthesis, of which N is a basic component. Thus, high levels of B affect these processes with consequences for the concentration of N (Epstein and Bloom, 2006). Several investigators also worked on boron essentially in nitrogen content in various plants. Robertson and Longhman (1974) found that nitrogen content

increased with increasing boron application. Singh and Singh (1984) were of the opinion that nitrogen concentration increases with increased boron.

Ahmad *et al.* (2011) have studied impact of boron on cotton and found that nitrogen concentration increases with increasing levels of boron. Ali *et al.* (2013) stated that in maize, application of boron under water stress conditions shows increased yield, grain oil, protein over control.

The work of El-Dissoky and Kadar (2013) on boron foliar application on potato increased nitrogen uptake up to 60 ppm boron concentration. This increased effect of limited use of boron to increase nitrogen is due to role of boron in synthesis of amino acids and proteins (Mengle and Kirkby, 1978). Similar opinion was also reported by El-Banna and El-Salam (2005); El-Mahdy (2007). The reports of El-Feky *et al.* (2012) showed decline in nitrogen due to high boron concentration.

Our results are in accordance with many references cited earlier which clear that boron increases nitrogen in plants which ultimately benefitted to nitrogen metabolism under boron stress conditions for the improvement of crop.



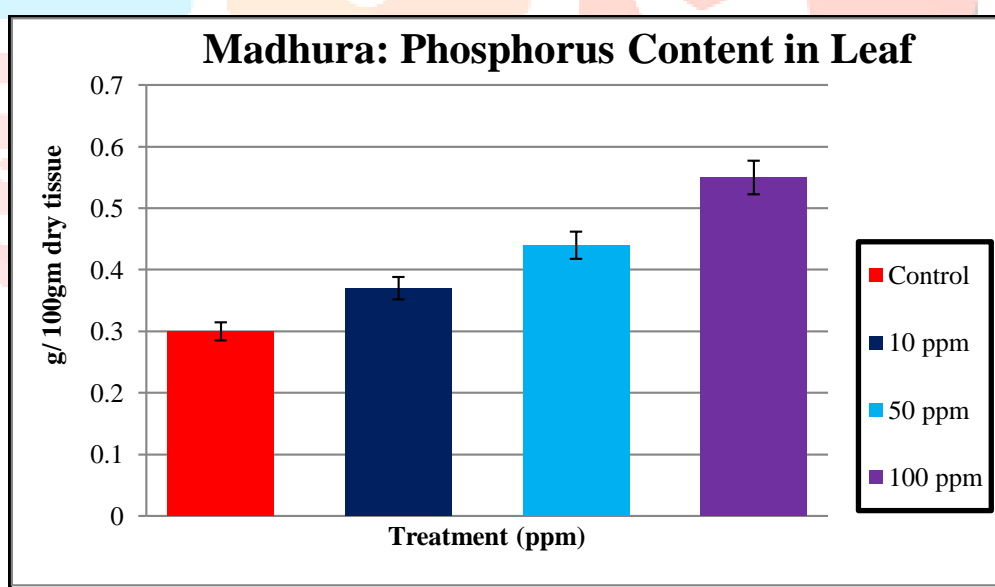
**Fig. 2: The effect of different concentrations of boron on potassium content of sweet Sorghum cultivar Madhura**

The effects of boron treatments on potassium content of sweet Sorghum cultivars Madhura and RSSV-9 is depicted in fig. no. 2. The results are showing, potassium content in c. v. Madura is slightly decreased with 10 ppm boron but then increasing as boron concentration is increased. The highest content of potassium is recorded with The 100 ppm boron treatment.

Potassium (K) is most abundant cation in plants. It is most essential nutrient in plants after phosphorus and nitrogen. It is commonly referred as the regulator as it is involved in more than 60 enzyme system in plants. Potassium plays vital role in enzyme activation, photosynthesis, protein synthesis, stomatal movement, phloem transport, cation- anion balance, osmoregulation, and formation of sugars, starch and most importantly stress

resistance (Marschner, 2012). In the cytoplasm  $K^+$  concentration found between 100- 200 mM (Shabala and Pottosin, 2010), while that of apoplastic  $K^+$  concentration varies in the range of 10 to 200 or may reach up to 500 mM (White and Karley, 2010). The appropriate ionic environment for various metabolic processes in the cytosol is provided by potassium which leads to function as a regulator of different processes including growth regulation (Oerke, 2006).

Previously different workers reported the increasing  $K^+$  concentration due to boron application in tomato (Francois, 1984), in barseem (Pal *et al.*, 1989). Mazher *et al.* (2006), Asad and Rafique (2000) found application of boron increased concentration of  $K^+$  ions in plants as boron may promote absorption of cations. In the saline – sodic soil, the  $K^+$  and  $Na^+$  ratio in the shoot of rice cultivars was reported to be improved due to application of boron (Mehmood *et al.*, 2009). Hellal *et al.* (2009) had reported in sugar-beet plant that boron application increased  $K^+$  concentration in root and shoot. Accumulation of  $K^+$  in barley roots and shoots due to application at 3 mg  $lit^{-1}$  boron was reported by El-Feky *et al.* (2012). The effect of boron on potato cultivars was studied by El-Dissoky and Abdel-Hader (2013) and reported that boron application at 60 ppm concentration increased total K-uptake which may be related to synergism relationship between K and Boron at sugar and carbohydrate transport (Mengle and Kirkby, 1978). But Simon *et al.* (2013) were of the opinion that  $K^+$  concentration increased due to excess boron application.



**Fig. 3: The effect of different concentrations of boron on phosphorus of sweet Sorghum cultivar Madhura**

The influence of different boron treatments on phosphorus content of sweet Sorghum cultivars Madhura and RSSV-9 is depicted in fig. no. 3. The results showing increase in phosphorus content with an increase in the boron concentrations. The c. v. Madhura shows accumulation of highest phosphorus content due to 100 ppm boron.

Phosphorus is second important macronutrient for plant growth. Phosphorus is one of the 17 essential element required for plant growth and development (Bai *et al.*, 2006). It is a component of key molecules including nucleic acids (DNA and RNA), phospholipids, ATP, nucleotides, sugar phosphates and coenzymes (Merschner,

2002). Plant cannot grow without considerable supply of phosphorus as it is involved in controlling key enzyme reactions and in the regulation of metabolic pathways (Theodorou and Plaxton, 1993). The conversion of other nutrients into usable building blocks for the plant growth is mainly followed by phosphorus. It is involved in several key plant functions like energy transfer, photosynthesis, sugar and starch transformation, nutrient movement in plants and genetic character transfer from one gene to another.

Khalifa *et al.* (2011) reported that low concentration of boron, increases P uptake in Iris plant. Macro and micro nutrient content of leaves and flowers increased when boron concentration is increased in boron deficit condition. Phosphorus assimilation was enhanced with boron supply. In cotton plant Ahmad *et al.* (2011) demonstrated positive and significant correlation between application of boron and P-uptake in leaves, burs, seeds and lint. A significant increase in P-uptake due to foliar application of boron when applied at 100 ppm concentration in the leaves of maize plant (Ali *et al.*, 2013).

Our results are in accordance with previous reports. The increase of P under increasing boron concentration suggests a promoted remobilization of P in plants (El-Feky *et al.*, 2012).

### Conclusion:

The adaptive nature of accumulation of  $K^+$  due to boron treatments reported in c. v. Madhura which correlates with many references referred earlier as it might be helpful to regulate metabolic activities in the c. v. Madura.

In the present investigation as boron concentration is increased uptake and assimilation of phosphorus increases. It indicates that P turnover is adversely affected by boron treatment.

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