IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

Impact Factor: 6.252

Volume 2, Issue 6, April 2022

# The Influence of Boron on Some Plant Nutrients in Sweet Sorghum (*Sorghum bicolor* L.)

**Jadhav Sujeet S.**

S. B. R. College, Mhaswad, Man, Satara, Maharashtra, India

**Abstract**: *Boron is one of the important micronutrients which plays important role in plant growth. The supply of boron to the plants plays 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 important crop used as food, fodder, fuel and fertilizer. It can produce sugar juice from the stem that is useful to produce ethanol, jaggery and syrup along with grains. The sweet Sorghum c. v. Madhura and RSSV-9 were selected for the present investigation. The seeds of these varieties were sown in the earth pots having 2x3x2 feet in size and depth. An average of 25 kg of black soil was used with average 2 kg of organic farm manures per pot. The selected soil was analysed for its original boron concentration. The soil is having 0.0339 ppm boron in it with p H 6.7. After 15 days, 40 days and 70 days of sowing, the pots were treated with different boron concentrations like 10 ppm, 50 ppm and 100 ppm along with control having distilled water only. Five fresh leaf samples were collected randomly on the 5 th day of last boron treatment and washed with distilled water for further analysis. In the present investigation an attempt has been made to study the behaviour of inorganic contents like magnesium and manganese in sweet sorghum cultivars Madhura and RSSV-9 after treating with different boron concentrations. The results are showing consistent decrease in magnesium content due to all the boron treatments in both the cultivars but significant decrease in Mg content reported with 100 ppm boron in c. v. Madhura. The manganese activity is increased due to 10 ppm boron treatment in both the varieties. As boron treatment is increased the Mn level is decreased as compare to control plants in both cultivars under investigation.*

**Keywords**:Boron, Magnesium, Sorghum, etc.

## I. Introduction

Magnesium is a structural component of chlorophyll and ribosome which captures sunlight energy and turns it in to chemical energy. Uptake and transformation of phosphorus is mediated by Mg. Amino acids synthesis and cell proteins are also synthesized by Mg. The transformation of sugar and starch in the plants was mediated by Mg. Being a key component of chlorophyll and ribosomes, it is involved in the photosynthesis, protein synthesis, photorespiration, generation of reactive oxygen species and photo oxidation in leaf tissues. Magnesium ($Mg^{2+}$) is an essential macronutrient of living cells and is the second most prevalent free divalent cation in plants. $Mg^{2+}$ plays a role in several physiological processes that support plant growth and development (Chaudhry et al., 2021). In plants, Manganese (Mn) is an important micronutrient for plant growth and development and sustains metabolic roles within different plant cell compartments. it is involved in the structure of photosynthesis and as an enzyme activator playing vital role in oxidation-reduction processes, respiration and nitrogen metabolism. The metal is an essential cofactor for the oxygen-evolving complex (OEC) of the photosynthetic machinery, catalyzing the water-splitting reaction in photosystem II (PSII) (Alejandro et al., 2020).

Boron is one of the microelements required for healthy crop growth and development of reproductive tissues. It is required in a very small amount. However, the deficiency and excess use of boron may affect crop growth. Boron is important micronutrient which plays role in improving yield and enhance its availability for sustainable development of the plants (Shireen et al., 2018). The work done by Atique-ur-Rehman et al. (2020) states that soil applied boron improves growth and yield of cotton grown on calcareous saline soil.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Impact Factor: 6.252
Volume 2, Issue 6, April 2022

As boron is important micronutrient required for plant growth and yield (Soomro *et al.,* 2011) which play vital functions in cell wall formation, nitrogen fixation, nucleic acid, membrane stability, sugar transport, carbohydrate and Indole Acetic Acid metabolism. Due to all these roles, boron leads to an increase in plant height and production (Ali *et al*., 2012). The application of B (fertilizers) in different rice-based systems helps to increase crop productivity by reducing yield losses, enhancing milling return, and improving cooking quality (Atique-ur-Rehman *et al.*2018). Together with the knowledge of the physiology and genetics of boron, should result in the development of efficient and tolerant varieties that may represent a long-term sustainable solution for the problem of inadequate or excess boron supply (Brdar-Jokanovic *et al*., 2020).

*Sorghum bicolor* is an important dry land annual cereal crop grown in India. It is the fifth most important cereal grain after maize, rice, wheat and barley in the world (FAOSTAT 2021). It is a main staple food in arid and semi-arid areas. In semi-arid tropics when other plants fail to survive, sweet sorghum can grow successfully. In tropical, subtropical, temperate, semiarid region and in poor quality soil, it can be easily grown. It can be cultivated in kharif, ruby and summer seasons. Sweet sorghum is said to be valued for 4-F's. These 4-Fs are food, feed, fuel and fertilizer. It can produce along with grains, a sugary juice that is useful to produce ethanol, jaggery, syrup and flour. As sweet sorghum produces food as well as fuel, it can help to meet the country's fuel needs without compromising our food supply. This plant can compete with sugarcane for ethanol production as sugarcane requires comparatively more water, fertilizers and has a long lifespan also. The purpose of selecting this crop for the study as this plant requires minimum water and fertilizers and can grow in semi-arid areas also.

The present study was carried out to establish the behavior of some nutrients like magnesium and manganese due to different boron concentrations in two sweet sorghum cultivars 'RSSV-9' and 'Madhura'. Magnesium is key component of chlorophyll and several other physiological processes that support plant growth and development. As well as manganese is also a important in photosynthesis and oxidation-reduction processes, respiration and nitrogen metabolism. Thus, the objective of this study is to know the proper dose of boron in sweet sorghum which ultimately beneficial for the sustainable behavior of nutrients like magnesium and manganese.

.

## II. Materials And Methods

The sweet sorghum varieties RSSV-9 and Madhura were 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. The pot culture technique was used for the experiment with three replications. The individual pot of the size 2x3 feet in size with two feet depth was used for experiment. Every pot was filled with 25 kg black soil approximately and two kg of organic manures were added to it. The soil selected was analyzed. The soil having pH 6.7 and 0.0339 ppm boron was naturally present in it. There were three treatments of boron with different concentrations along with one control pot without any treatment. One pot is used for each treatment and the seedlings were thinned. Five plants were kept in every pot for further growth. At maturity plants from each treatment and control were harvested and the randomly selected 5 leaves were used for the preparation of acid digest.

The method described by Toth et al. (1948) to digest the plant material has been used. For the estimation of inorganic constituents, an acid digest from the oven dried plant material is used. Manganese (Mn ++ ) and Magnesium (Mg ++ ) from the acid digest were detected by atomic absorption spectrometer (Perkin Elmer Model-3030) using acetylene air flame. Hollow cathode lamp was used as light source. The concentrations of Mn ++ and Mg ++ were react at 324.8nm, 248.3nm, 279.5nm and 285.2nm respectively.

## III. Result And Discussion

### a) MAGNESIUM (Mg):

The influence of boron treatments on magnesium content of two sweet sorghum cultivars Madhura and RSSV-9 is depicted in fig. 1. The results are showing consistent decrease in magnesium content due to all the boron treatments in both the cultivars under investigation. But significant decrease in Mg content reported with 100 ppm boron in c. v. Madhura..

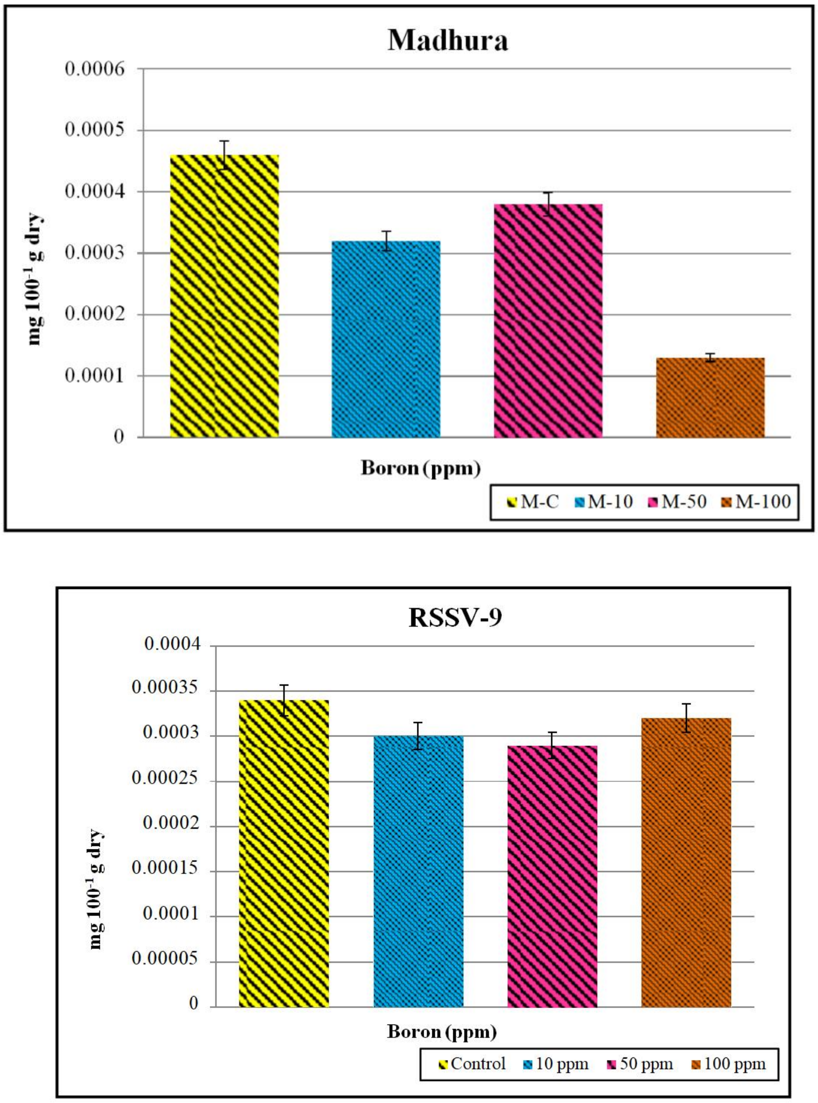



**Figure 1:** The effect of boron on magnesium content of the leaves of sweet sorghum cultivars.

Magnesium is a divalent, strongly electropositive, small, mobile element of plants. Being a key component of chlorophyll and ribosomes, it is involved in the photosynthesis, protein synthesis, photorespiration, generation of reactive oxygen species and photo oxidation in leaf tissues.

The involvement of boron on the analogues of Mg content in plants was reported in previous studies. The supply of boron to crops either by fertilization of soil or by addition of nutrients resulted in decreased Mg content (Joret and Henri, 1937). Downton and Hawker (1980) were of the opinion that Mg was decreased due to addition of boron concentration in nutrient solution. The leaves applied with boron shows decreased metal ions like Mg 2+ . This decreased Mg 2+ can be related to chlorophyll loss (Power and Woods, 1997). Lopez-Lefebre et al. (2002) reported competition between cations like Mg at root level results in decreased Mg due to high boron in leaves, stem, burs and seeds of cotton.

The adverse effect on Mg content due to increased boron concentration was observed by Datta et al. (2001) in wheat. In cotton plant, Ahmad et al. (2008) was found significantly low Mg concentration due to excess boron. Ahmad et al. (2011) reported decreased Mg with boron rates in different plant parts. According to Bowen (1981), Ahmad et al. (2008) high boron reduces Mg concentration due to antagonistic activity. The decrease in Mg content due to boron application is recorded in our study. Such a reduction is noticeable in c. v. Madhura than RSSV-9.

IJARSCT

ISSN (Online) 2581-9429

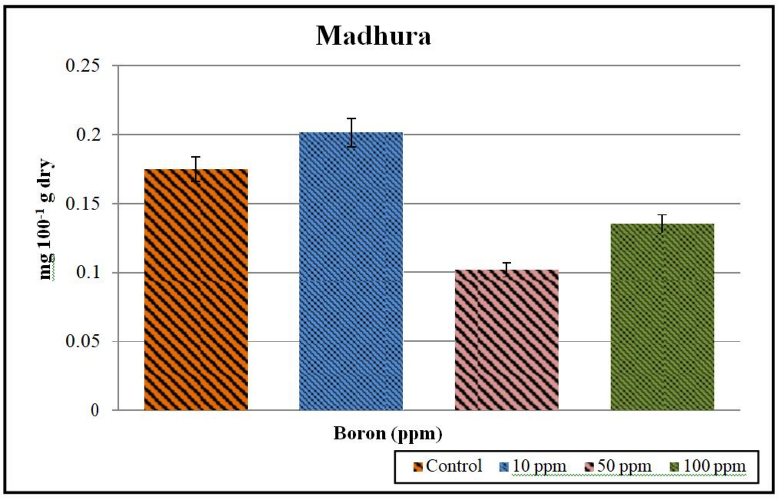
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

Impact Factor: 6.252

Volume 2, Issue 6, April 2022

**b) MANGANESE(Mn):**

The different boron concentrations have impact on manganese content of sweet Sorghum cultivars are depicted in fig. 2. It is clear from the results that 10 ppm boron treatment increases manganese activity in both the varieties under investigations. But as boron treatment is increased the Mn level is decreased as compare to control plants in both cultivars under investigation.



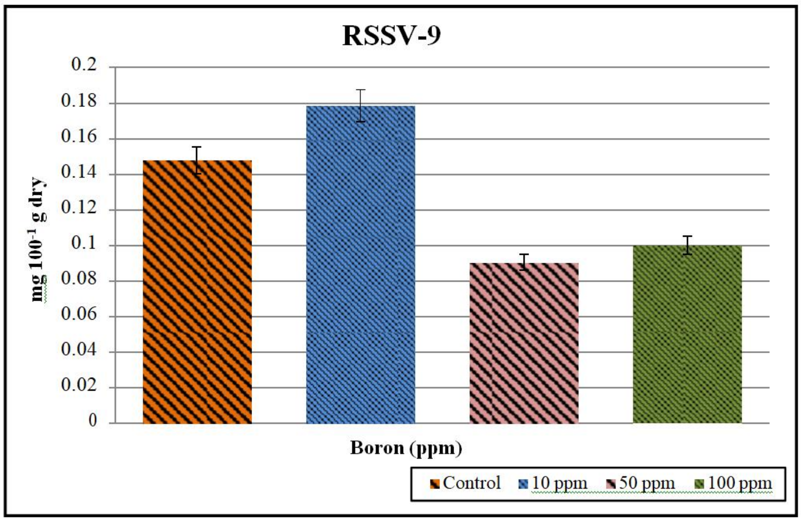




**Figure 2:**The effect of boron on manganese content of the leaves of sweet sorghum cultivars.

Manganese is an essential microelement in most organisms. In plants, it is involved in the structure of photosynthesis and as an enzyme activator playing vital role in oxidation-reduction processes, respiration and nitrogen metabolism. It has also useful in synthesis of polyamines, which play important role in plant growth and development and in detoxification of active oxygen species (Evans and Malmberg, 1989).

The different boron concentrations have different effects on manganese content of plants was studied by different workers. Boron at 10 ppm and 20 ppm concentration may increase Mn content in seedlings of Toxodium distichum as reported by Mazher et al. (2006). In mulberry plants Tewari et al. (2010) reported that boron deficit conditions increased Mn content. Castagnara et al. (2012) found increased Mn content due to increased boron application on white oat plants. Ali et al. (2013) studied maize plant and were of the opinion that foliar application of boric acid increased Mn content in the leaves.

The contradictory reports of Leece (1978) were shown that boron high levels depressed the Mn concentration in maize cops. In bean plants boron deficient conditions were markedly reduce the Mn adsorption (Dave and Kannan, 1981).

According to Singh et al. (1990) in wheat plants increasing boron though soil application may decrease uptake of Mn. The high boron level may reduce Mn concentration in radish plant was reported by Tariq and Mott (2006). The response of Mn to different boron concentrations is similar in both the cultivars studied here.

## IV. Conclusion

The decrease in Mg content due to boron application is recorded in our study. Such a reduction is noticeable in c. v. Madhura than RSSV-9, but even though the reduction in Mg content may not affect the photosynthesis activity largely in sorghum is a matter of further investigation. In the present investigation response of the Mn content to boron treatment is uniform in both cultivars of sorghum. The initial increment in Mn content due to low boron treatment may to partial replacement of Mg as it decreased due to boron treatment reported earlier in both cultivars under investigation.

## References

**[1]** Ahmad N, Muhammad A, Fiaz A, Ullah MA, Javaid Q, AliMA.Impactof boron fertilization on dry matter production and mineral constitution of irrigatedcotton.Pak. J. Bot., 2011. 43(6):2903-2910.

**[2]** Ahmad P, Serwat M, Sharma S. Reactive oxygen species, antioxidants andsignallingin plants. J. PlantPhysiol., 2008.51(3):167-173.

**[3]** Alejandro S, Holler S, Meier B, Peiter E. Manganese in Plants: From Acquisition to Sub cellular Allocation. Front Plant Sci. 2020. 11:300. doi:https://doi.org/10.3389/fpls.2020.00300

**[4]** Ali A, Sarwar MA, Ahmad W, Shafi J, Qaisrani SA, Ahmad A,Ehsanullah, Akbar N, Masood N, Atta BM, Javeed HMR. Physiological andbiochemical responses of maize (Zea mays L.) to exogenic application of boron underdrought stress.Intr. J. Adv.Rea., 2013. 1(10):6-16.

**[5]** Ali EA. Effect of iron nutrient care sprayed on foliage at different physiological stages on yield and quality of some durum wheat (Triticum durum L.) varieties in sandy soil. Asian Journal of Crop Science, 2012. 4(4): 139-149.

**[6]** Atique-ur-Rehman, Farooq M, Rashid A, Nadeem F, Stuerz S, Asch F, Bell RW, Siddique KHM. Boron nutrition of rice in different production systems. A review. Agron. Sustain. Dev. 2018. 38 (25).https://doi.org/10.1007/s13593-018-0504-8

**[7]** Atique-ur-Rehman, Qamar R, Hussain A, Sardar H, Sarwar N, Javeed HMR. Soil applied boron (B) improves growth, yield and fiber quality traits of cotton grown on calcareous saline soil. PLoS ONE 2020. 15(8): e0231805.https://doi.org/10.1371/journal.pone.0231805

**[8]** Brdar-Jokanovic, Milka. Boron Toxicity and Deficiency in Agricultural Plants. International Journal of Molecular Sciences, 2020. 21 (4): 1424. https://doi.org/10.3390/ijms21041424

**[9]** Bowen JE. Micro- element nutrition of sugarcane. I. Interaction in microelementsaccumulation.Trop. Agric. 1981. 58:215-220.

**[10]** Castagnara, DD, Krutzmann A, Zoz T, Steiner F, Maria A, Castro CE, Neres MA, De Oliveira PSR.Effect of boron and zinc fertilization on white oatsgrown in soil with average content of these nutrients. R. Bras. Zootec., 2012. 41(7): 1598-1607.

**[11]** Chaudhry AH, Nayab S, Hussain SB, Ali M, Pan Z. Current Understandings on Magnesium Deficiency and Future Outlooks for Sustainable Agriculture. Int J Mol Sci. 2021. 22(4):1819. https://doi.org/10.3390/ijms22041819

**[12]** DattaKS,Angrish R, Mola-Doila YAA, Kumari P. Physiologicalandbiochemicalchangesinborotoxicityundersalineconditionsanditsalleviationby calciuminwheat.Nationalseminaron"RoleofPlantPhysiol.forsustainingqualityandqualityof food productionin relationtoenvironment".Dharwad, 2001. PP.99.

**[13]** Dave IC,Kannan S. Influenceofborondeficiencyonmicronutrientsabsorption by Phaseolus vulgaris and protein contents in cotyledons. Acta Physiol.Plantarum., 1981. 3:27-32.

**[14]** Dowmton WJS and Hawker JS. Interaction of boron and chloroid on growthand mineral composition of Cabernet sauvignon vines. Ame. J. Enol. Vitic. 1980. 31: 277-282.

[15] Evans PT, Malmberg RL.Dopolyamineshavearoleinplantdevelopment? AnnualReviewsof PlantPhysiologyandPlantMolecularBiology, 1989. 40:235–269.

[16] FAO. Database of agricultural production. FAO Statistical Databases (FAOSTAT) 2021. http://faostat.fao.org/default.aspx.

[17] JoretGandHenri M.Actionofborononcereals.RecherchesFertilisationsta. Agron.Ministere Agr.(France)1937. 10: 138.

[18] Leece DR.Effectsofborononthephysiologicalactivityofzincinmaize.Aust.J.Agric.Res., 1978. 29: 739-749.

[19] Lopez -Lefebre LR, Rivero RM, Garcia PC, Sanchez E, Ruiz JM, Romero L. Boroneffect onmineral nutrientsof tobacco.J.Plant Nutr. 2002.25:509-522.

[20] Mazher AAM, Zaghloul SM, Yassen AA. Impact of boron fertilizer ongrowth and chemical constituents of Taxodium distichumgrown under water regime.W.J. Agric. Sci.,2006. 2(4):412-420.

[21] PowerPPandWoods WG.Thechemistryofboronanditsspeciationinplants. PlantandSoil, 1997.193:1-13.

[22] Shireen F, Nawaz, MA, Chen C, Zhang Q, Zheng Z, Sohail H, Sun J, Cao H, Huang Y, Bie Z. Boron: Functions and Approaches to Enhance Its Availability in Plants for Sustainable Agriculture. International Journal of Molecular Sciences, 2018. 19(7):1856.https://doi.org/10.3390/ijms19071856

[23] Singh JP, Dahiya DJ, Narwal RP. Boron uptake and toxicity in wheat inrelationto zincsupply. Fertil. Res., 1990. 24:105-110.

[24] Soomro ZH, Baloch PA, Gandhai AW. Comparative effects of foliar and soil applied boron on growth and fodder yield of maize, Pak. J. Agri., Engg. Vet. Sci., 2011. 27(1): 18-26.

[25] Tariq M, Mott CJB. Effect of boron supply on the uptake of micronutrientsbyradish(Raphanussativus L.)J.Argic. BiolSci., 2006.1 (2):1-8.

[26] Toth SJ, Prince AL, Wallace A, Mikkelsen DS. Rapid quantitative determination of 8 mineral elements in plant tissues by systematicprocedure involving use of a flame photometer. Soil Sci 1948; 66:456- 66

[27] TewariRK,KumarP, SharmaPN.Magnesiumdeficiencyinducedoxidativestressandanti-oxidant responsesinmulberryplants. Sci.Hort. 2006. 108:7-14.

[28] Toth SJ, Prince AL, Wallace A, Mikkelsen DS. Rapid quantitative determination of 8 mineral elements in plant tissues by systematic procedure involving use of a flame photometer. Soil Sci, 1948. 66:456- 466.