Available online at www.agrifarming.org

DOI: http://dx.doi.org/10.18782/2582-7146.146

ISSN: 2582 – 7146

Curr. Rese. Agri. Far. (2021) *2*(3), 45-50

Current Research in Agriculture and Farming

Peer-Reviewed, Refereed, Open Access Journal

Review Article

A Review on Effects of Varies Doses of Lime and Boron Application and There Interaction on Nutrient Availability and Acidity Parameters of Soil in Soybean

Rohitashv Nagar*, S. K. Trivedi, Rakesh Kumar Meena and Deepak Nagar

School of Agricultural Sciences, Career Point University, Kota, Rajasthan

*Corresponding Author E-mail: rnagar1900@gmail.com

Received: 27.03.2021 | Revised: 30.04.2021 | Accepted: 7.05.2021

ABSTRACT

Soybean is a grain legume has the ability to fix atmospheric nitrogen in the soil in association with Brady rhizobium rhizobia. Soybean crop fixes 61-337 Kg Nha^{-1}. Many of scientist reported that as macronutrient needs are met, it becomes possible that micronutrient requirements of the soybean plant could be limiting optimum production and although boron is termed a micronutrient, its role within the plant is widespread. The role of boron within the plant includes cell wall synthesis, sugar transport, cell division, differentiation, membrane functioning, root elongation, and regulation of plant hormone levels. The application of lime and boron were given in the plots as per their treatments prior to sowing. The significant increase in the soybean yield was mainly due to increasing does of lime and boron as well. However, the interaction of lime and boron were not fund significant. The maximum seed yield was increased by the application of lime @ 5 t/ha. However on the other hand, increase in the yield by the application of boron 1 kg/ha. When compared with absolute control. It showed that application of lime and boron separately give the positive effect on soybean grain yield whereas in combination with lime and boron could not play significant increase in crop yield.

Keywords: *Available Boron, Soybean, Lime, Acidity.*

INTRODUCTION

Soybean *Glycine max* L. Is an important oriental crop whose agronomic characteristics were apparently well known in China before 2200 BC. It belongs to a leguminaceae, under family of Fabaceae that is being grown successfully under tropical, sub-tropical and temperate climate. (CGIAR, 2005). Shorrocks (1997) reported that boron is one of the most commonly deficient micronutrient in agriculture, with reports of deficiencies in 132 crops and in 80 countries. The legumes and pulses are highly sensitive to B deficiency, creates low productivity in NEH region. B is an essential micronutrient for plant growth and development in which some plants are more sensitive than others are to the B deficiency and toxicity.

Cite this article: Nagar, R., Trivedi, S. K., Meena, R. K., & Nagar, D. (2021). A Review on Effects of Varies Doses of Lime and Boron Application and There Interaction on Nutrient Availability and Acidity Parameters of Soil in Soybean, *Curr. Rese. Agri. Far. 2*(3), 45-50. doi: http://dx.doi.org/10.18782/2582-7146.146

B absorption depends on many factors, such as soil, clays mineralogy, organic matters, temperature, and moisture content and so on. The excessive application of lime can creates B deficiency in plants. (Arzani et al., 2010).

1. **Effect of lime on growth, yield and quality of soybean**

Liming "sweetens" the soil thereby improving its chemical and biological condition and promoting the uptake of nutrients, which are essential for both plants and animals. Amelioration of acid soil by different liming materials can raise soil pH benefiting soil properties and plant growth and liming is widely practiced for improving the acid soils productivity (Edmeades & Ridley, 2003; & Conyers, 2006). There are plenty of liming materials that can be used to neutralize soil acidity, but majority of then comes from ground limestone such as calcite (CaCO3) and dolomite (CaCO3, MgCO3). Ranjit et al. (2007) reported that lime was important for soybean because it increased the soil pH and decreased the toxicity of Al and Mn as well as increased the P, K, and Ca uptake. Bhat et al. (2007) results showed that application of lime caused a significant increase in grain and straw yield at wheat 13.5 and 40.6 % increased grain and stover yield respectively was obtained over the control with LR 1/10th and LR 1/5th levels of lime respectively. The corresponding values of stover yields were 10.0 and 26.1 %.

2. **Effect of boron on growth, yield and quality of soybean**

Boron is a micronutrient required by plants in a very small quantity (Abd-El-Wahab, 2008) and its availability in soil and irrigation water is an important determinant of agricultural production (Tanaka & Fujiwara, 2007). Ross et al. (2006) suggested that application of 0.28 -1.12 kg B ha-1 during early vegetative or reproductive growth were found to be sufficient to produce near maximal yields. Crak et al. (2006) also reported that increasing B rate applied either as soil or as foliar improved first pod height (17 %). Hari Ram et al. (2014) reported that boron treatments significantly influenced the plant height, pods per plant and seed yield. Seed per pod, 100 seed weight, Stover yield and harvest index were not significantly influenced by boron treatments. The Stover yield and harvest index were not significantly influenced by any of the treatments. The maximum harvest index was obtained in B1.0 that was 2.17% higher than B0.5. The highest yield response with application of B was recorded in B1.5 that was 4.7-18.1% higher than lower level of B.

Mandal et al. (2006) conducted experiments on farmer's field on three places of B deficient soils (alluvial soil of West Bengal and Orissa and red and laterites soil of Jharkhand), which indicated that application of boronated NPK (0.3% B) increased yield of the crops to the tune of 4.3 to 66.7%, 6.0 to 22.9%, 1.9%, 9.4%, 2.4% to 27.2%, 4.8%, 5.4%, 15.1% and 5.0 to 16.2% for mustards, wheat, lentil, coriander, potato, tomato, chilli, groundnut and cauliflower, respectively, over NPK alone.

Boron application increased the rate of fruiting of grain, decreased the incidence of bare ears in maize, and decreased empty pods of soybean and empty grain in rice (Li & Liong, 1997). Besides, yield reduction by 10 to 20% was estimated in rice tolerant varieties irrigated with the excess boron during rainless dry seasons (Koonkan et al., 2008). Ayfer et al. (2006) reported that the total amount of boron in wheat shoots showed a highly significant negative correlation with decreases in shoot dry weight under boron depressed fresh and dry weights and reduced the yield (Eraslan et al., 2007a; & Kaya et al., 2009).

Soybean is very sensitive to boron (B) deficiency (Liu et al., 2005). It requires an adequate supply of B, especially during flowering and seed development. B is required for maintaining the integrity of cell wall, root nodule formation, regulating carbohydrate metabolism and seed setting. Its deficiency may cause restriction of water absorption and even sterility i.e. less pods and less seeds pod-1 resulting in lower seed yield (Marschner, 1995). Both negative and positive effects of liming on the availability of nutrients in acid soils and subsequent uptake by crops have been reported (Quaggio et al., 2004; & Kovacevic et al., 2006). However, information on the interactive effects of lime and B on soybean is lacking for the acidic soils of northeast India, which necessities and investigation in this line to evolve an effective strategy of lime and B application to improve soybean productivity in the region.

Gupta (2007) reported that deficiency of boron can cause reductions in crop yield scan impair crop quality or have both effects. Boron deficiency disorders appear to be physiological in nature and occur even when boron is in ample supply. Boron-deficient soybean (Glycine max (L.) Merrill) showed low acetylene reduction activities and damage to the root nodules. In boron-deficient pea (Pisum sativum L.) leaves although, the concentration of sugars and starch increased, there was a negative effect on bean seeds quality and productivity.

3. Boron in soil

Saleem et al. (2011) reported that total soil B content can range from around 10 to 100 mg kg-1; however only a small fraction of this amount that is about 3 to 5 % is available to the crop. A large amount of the boron is present as a component of insoluble mineral tourmaline. Hou et al. (1994) reported that Boron available forms for plants include inorganic borate complexes of Ca, Mg, and Na, and various organic compounds formed from plant and microbial decomposition. Saleem et al. (2011) showed that the pH is the most important factor affecting B adsorption in soils, with increasing soil solution pH, B fixation also increases and maximum adsorption is near pH 8 to 9, further increase in solution pH decreases the adsorption.

Dey et al. (2014) reported that in acid soils soluble B occurs as non- ionized boric acid [B (OH) 3], whereas formation of borate anion [B (OH) 4] take place with a rise in soil pH. Thus leaching of B primarily as B (OH) 3 under high precipitation regimes and adsorption of solution B on Al and Fe oxides (Goldberg & Glaubig, 1985) are the major causes of B deficiency in acid soil.

Liming

Application of lime increases the soil pH and this may cause B deficiency because pH has negative correlation with B availability (Evans & Sparks, 1983). Due to liming of acid soils, soluble B combines with Ca ions and forms the highly insoluble Ca-metaborate, which reduces the availability of B (Goldberg & Chuming, 2007).

4. lime and boron interaction on nutrient availability and acidity parameters in soil

Among the essential micronutrients required in crop production, boron (B) is the second most deficient element in Indian soil (33% deficiency) and its deficiency is even more severe in high-rainfall acid-soil region of northeast India. It has a close relationship with calcium both in soil and in plant. Calcium (Ca) increases the B requirement of plants due to similarity in function (Golakya & Patel, 1986).
Availability of B is generally low in acid soils or high rainfall areas because of leaching of B and adsorption by aluminium (Al) and iron (Fe) oxide minerals (Matula, 2009). Barman et al. (2014) reported that soil pH is one of the most important factors which govern the availability of plant nutrient in soil the effect of application of lime on soil pH (H2O) was studied. Application of lime at 0 (control), 1/3 rd, 2/3 rd and 1 LR increased the soil pH (H2O) from 5.66 to 7.11, 7.25 and 7.36, respectively. Effect of Lime and B application on the nutrient contents in soil is presented. Application of lime at 1/3 and 2/3 LR significantly increased the mineral N content in soil from 56.7 mg kg-1 in control to 59.5 and 62.3 mg kg-1, respectively. Application of lime at 2/3 and 1 LR increased Bray P-1 extractable P in soil from 4.67 (control) to 7.38 and 6.70 mg kg-1, respectively. There was a marginal but significant increase (from 30.5 to 31.8 mg kg-1) in ammonium acetate extractable potassium (K) in soil as a result of addition of lime at 2/3 LR. Application of lime at 2/3 and 1 LR increased the ammonium acetate extractable Ca in soil from 333 mg kg-1 in control to 647 and 867 mg kg-1, respectively. Influence of both of these levels of lime application was significant in increasing extractable Ca content in soil. Lime application at 1/3, 2/3 and 1 LR significantly

increased the extractable Mg content in soil from 94.4 mg kg-1 (control) to 277, 229 and 292 mg kg-1, respectively. The increase in extractable S content in soil from 14.6 mg kg-1, in control to 23.6, 25.9 and 20.4 mg kg-1, respectively at 1/3, 2/3 and 1 LR was recorded. Applied lime at 1/3, 2/3 and 1 LR increased the DTPA-extractable Zn content in soil from 0.44 mg kg-1 (control) to 0.56, 0.60 and 0.58 mg kg-1, respectively. Significant decrease in extractable Cu content in soil from 1.48 mg kg-1 in control to 1.29 and 1.38 mg kg-1 was recorded at 2/3 and 1 LR, respectively. There was a significant decrease in DTPA-extractable Fe content with increasing levels of lime application from 6.75 mg kg-1 in control to 4.46, 3.88 and 3.94 mg kg-1, respectively at 1/3, 2/3 and 1 LR. The significant decrease in extractable Mn content in soil from 6.97 mg kg-1 (control) to 4.92, 3.12 and 2.59 mg kg-1 was recorded at 1/3, 2/3 and 1 LR, respectively. There was no effect of B application on the status of available N, P, K, Ca, Mg, S, Zn, Cu, Fe, and Mn in soil.

The effect of both lime and B application on the extractable B content in soil indicate that, on an average, hot calcium chloride extractable B in soil was decreased from 0.39 (control) to 0.24 and 0.23 mg kg-1 under 2/3 and 1 LR, respectively. As expected, there was a concomitant increase in extractable B in soil with the increasing level of applied B, was i.e., from 0 to 2 mg kg-1. The liming was ineffective in reducing the salicylic acid extractable B content in soil, except that at the highest level of applied lime. Like hot calcium chloride, salicylic acid extractable B was consistently increased with increasing levels of applied B. Results on interactive effect of lime and applied B in soil increasing with increasing rate of B application, with the increase being relatively less in limed soil as compared to that in control.

The application of lime enhanced the available nitrogen (N), phosphorus (P), calcium (Ca), magnesium (Mg), sulphur (S), and zinc (Zn) content in soil and availability of copper (Cu), iron (Fe) and manganese (Mn) in soil was reduce due to liming. (Barman et al., 2014). Zsigrai and Ora (2006) observed in the sixth year after the liming. The contents of calcium and magnesium, as expected, remarkably Increased with increasing liming rates. Especially high amount of calcium (4736 mg ca kg-1) was found at the highest rate, suggesting some nutrients disorders could appear. We presume that the antagonistic effects of calcium and magnesium could be responsible for potassium decreasing in the soil adsorption complex.

DISCUSSION

1. Effect of lime and boron fertilization and their interaction effect on soybean

Plant height showed no significant response to under lime and boron fertilization at p=0.05. However, studies have shown otherwise which might be due to appropriate dose of boron and because boron plays important role in various enzymatic and other biochemical reactions (Gitte et al., 2005). They reported that appropriate dose of boron increased plant height, and the high level of boron caused toxicity and created enzymatic problems so reduction of plant height occurred. Grain yield was significantly increased (36%) with the application of lime @ 5 t ha-1 as compared to its control. They reported that liming increased the soybean yield in Brazilian oxisols. The Grain yield increases due to increased uptake of macronutrient in shoot and grain with the increasing rate of liming. Fageria et al. (2006) reported that N and P improve number of pods per plant or per unit area in legumes in oxisols, which might have been responsible for greater variation in grain yield due to these nutrients.

REFERENCES

Abd El- Wahab, A. M., & Mohamed, A. (2008). Effect of same trace elements on growth, yield and chemical constituents of trachyspermumammi L. Plant under Sinai condition. *Res. J. Agric. Biol. Sci. 4*, 717-724.

Arzani, K., KhoshGhalb, H., Malekooti, M. J., & Bozorgmehr, M. (2010). The Effect of Ca, Zn and B application and harvest time on fruits polyphenol oxidase (PPO) activity in Two Asian pear cultivars during storage. *Pardis Aboureyhan J. Agric., 12*, 1-9.

Ayfer, A. T., Yazici, A., Erdem, H., & Cakmak, I. (2006). Genotypic variation in tolerance to boron toxicity in 70 durum wheat genolypes. *Turk J. Agric. For. 30*, 49-58.

Barman, M., Shukla, L. M., Datta, S. P., & Rattan, K. (2014). Effect of applied lime and boron on the availability of nutrirnts in an acid soil. *J. plant nutrition. 37*(3), 357-373.

Bhat, J. A., Mandal, B., & Hazra, G. C. (2007). Basic Slag as liming material to ameliorate soil acidity in alfisals of sub-tropical India. *American – Eurasian J. Agric. And Environ. Sci., 2*(4), 321-327.

CGIAR, (2005). CGIAR: Research and impact areas as research: Soybean. WWW.Cgiar.org/ Impact / research / soybean. Html (accessed 14/07/2010). Conyers, M. K. (2006). Liming and lime materials. In: Lal, R. (ed.) *Encyclopedia of Soil Science.* Abingdon, UKK, Taylor and Francis, pp: 1034-1036.

Crak, C., Odabas, M. S., Kevseroglu, K., Karaca, E., & Gulumser, A. (2006). Response of soybean (*Glycine max*) to soil and foliar applied boron at different rates. *Indian J. Agril. Sci., 76*, 603-06.

Dey, A., Brahma, S., Dwivedi, S., Datta, P., Mahesh, C., Meena & Binay, & Agarwal, K. (2014). Soil boron status: impact of lime and fertilizers in an Indian long-term field experiment on a typicpaleustalf. Acta Agriculturae Scandinavica, Section B- Soil and Plant Science, 2014.

Edmeades, D. C., & Ridley, A. M. (2003). Usinglime to ameliorate topsoil and subsoil acidity. In: Rengel, Z. (ed.), *Handbook of Soil Acidity.* Marcel Dekker, Inc., New York, Basel, pp: 297-336.

Eraslan, F., Inal, A., Gunes, A., & Alpaslan, M. (2007a). Boron toxicity alters nitrate reductase activity, proline accumulation, membrane permeability and mineral constituents of tomato and pepper plants. *Sci. Hort., 30*(60), 981-994.

Evans, C. M., & Sparks, D. L. (1983). on the chemistry and mineralogy of boron in pure and mixed systems: areview. *Comun. Soil Sci. and Plant Anal., 14*, 827-846.

Fageria, N. K., Baligar, V. C., & Clark, R. B. (2006). *Physiology of crop production.* New York: Haworth Press.

Gitte, A. N., Patil, S. R., & Tike, M. A. (2005). Influence of zinc and boron on biochemical and yield characteristics of sunflower. *Indian J. Plant Physiol., 10*, 400-403.

Golakya, B. A., & Patel, M. S. (1986). Effect of Ca/B ratio on yield attributes and yields of groundnut. *J. Indian Soc. of Soil Sci., 36*, 287- 290.

Goldberg, S., & Chumings (2007). New advances in boron soil chemistry. Advances in plant and animal boron nutrition, *Springer Science + Business media B.V.* Netherlands. pp: 313-330.

Goldberg, S., & Glaubig, R. A. (1985). Boron adsorption on aluminium and iron oxide minerals. *Soil Sci. Soc. AM. J., 49*, 1374-1379.

Gupta, V. C. (2007). Boron in Allen, V., & Barker & David, J., Pilbeam Ed. Hand book of plant nutrition, CRC Taylor and Francis Group.

Ram, H., Guriqbal, S., & Navneet, A. (2014). Grain yield, nutrient uptake, quality and economics of soybean (*Glycine max*) under different sulphur and boron levels in Punjab. *Indian j. Agron., 59*(1), 101-105.

Hou, L. J., Evans, L. J., & Spiers, G. A. (1994). Boron fractionation in soils. *Comun. Soil Sci. and plant Anal., 25*, 1841-1853.

Kaya, C., Tuna, A. L., Dikilitas, M., Ashraf, M., Koskeroglu, S., & Guneri, M.

(2009). Supplementary phosphorus can alleviate boron toxicity in tomato. *Sci. Hort., 121*, 284-288.

Koonkan, H., Maftoun, M., & Emam, Y. (2008). Nitrogen and boron interactional effect on growth and shoot nitrogen and boron content in rice. *J. Crop Productivity Production*. *12*(44), 171-182.

Kovacevic, V., Banaj, D., Kovacevic, J., Lalic, A., Jurkovic, Z., & Krizmanic, M. (2006). Influence of liming on maize, sunflower and barley. *Cereal Res. Comun., 34*, 553-556.

Li, Y., & Liong, H. (1997). Soil boron content and the effect of boron application on yield of maize, soybean, rice, and sugarbeet in Heilongjiong province, China, P. R., In: Bell, R. W., & Rerkasem, B. (eds.) Boron in soils and plants. pp: 17-21.

Liu, P., Yang, Y. S, Xu, G. D., Fang, Y. H., Yang, Y. A., & Kalin, R. M. (2005). The effect of molybdenum and boron in soil on the growth and photosynthesis of three soybean varieties. *Plant Soil and Environ*., *51*(5), 197–205.

Mandal, B., Sarkar, A. K., Singh, S., Jena, D., Patra, D. P., & Phillips, M. (2006). Performance of Boronated NPK in B deficient soils. *Indian J. Fert., 1*(12), 57-59.

Marschner, H. (1995). Mineral nutrition of higher plants, 2ndedn. Academic press: New York.

Matula, J. (2009). Boron sorption in soils and its extractability by soil tests (Mehlich 3, ammonium acetate, and water extraction).*Plant Soil and Environ. 55*, 42–49.

Quaggio, J. A., Gallo, P. B., Gerroh, C. O., Abreu, M. F., & Cantarella, H. (2004). Peanut response to lime and molybdenum application in low pH soils. *Revista Brasilcirade Ciencia do Solo*, *28*, 659-664.

Ranjit, R., Dasog, G. S., & Patil, P. L. (2007). Effect of lime and phosphorus levels on nutrient uptake by groundnut genotypes in acid soils of coastal agro-eco-system of Karnataka. *Karnataka J. Agric. Sci., 20*(3), 631-633.

Ross, J. R., Slaton, N. A., Brye, K. R., & De Long, R. E. (2006). Boron fertilization on soybean yield, leaf, and seed boron concentration. *Agron. J., 98*, 198-05.

Saleem, M., Khanif, Y. M., FauziahIshak, Samsuri, A. W., & Hafeez, B. (2011). Importance of boron for Agriculture productivity: are view. *Int. Res. J. Agril. Sci. and Soil Sci., 1*(8), 293-300.

Shorrocks, V. M. (1997). The occurrence and correction of boron deficiency. *Plant and Soil*. *193*, 121-148.

Tanaka, M., & Fujiwara, T. (2007). Physiological roles and transport mechanisms of boron perspectives from plants. *Eur. J. Physiol. 456*(4), 671-677.

Zsigrai, G. Y., & Ora, N. (2006). Effect of long-term artificial fertilisation and reading available element content of a meadow chernozem soil. *Cereal Res. Comun., 34*(1), 721-724.

