Effect of comparative response of different sources and levels of sulphur in maize

- A REVIEW

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Abstract

Maize (Zea mays L.) may be a widely cultivated major cereal crop, and a model for a monocotyledonous C4 plant with a considerable physiological and anatomical information base. After nitrogen, phosphorus and potassium, the fourth leading plant nutrient which is incresingly being accepted is sulphur. It is ranked along with nitrogen and phosphorus and also is a key element in the formation of proteins.In sulphur, the dry weight basis of plants increases in order gramineae sp. < leguminoceae < crucifera and the demand for optimal growth varies between 0.1 and 0.5% .Sulphur play crucial role in oil synthesis and chlorophyll formation. Under sulphur lacking conditions the economics of the fertilizer applied and the ratio of applied NPK fertilizer. Therefore, higher crop yields may not be sustained.Varietal variation in uptake characteristics has been reported and should represent a possible for breeding improved sulfur use efficiency. Responses to sulfur-limitation which occur at several levels in overlapping succession are described. These include changes in organic phenomenon focussed on cellular processes like uptake through to wholesale changes in root: shoot biomass allocation and influences on necrobiosis programming and therefore the formation of aerenchyma. These provide mechanisms to maximise uptake, enhance utilization efficiency and moderate, although ultimately cannot prevent, an enhanced susceptibility to abiotic and biotic stresses.

INTRODUCTION

India is one among the highest ten maize producers within the world; it approval around 2-3% of the entire maize produced worldwide and is one among the highest five maize trade good within the world contributive almost 14% of the entire maize exported to varied countries round the world. Maize is third most essential field crop in India. Maize has three thriving seasons in India, namely Spring Kharif, Rabi. Kharif is that the most all-important season covering approximately 80% of the entire area of maize in India. Maize is being utilized in assorted sectors and activities in India.

The biggest user of maize in India is that the poultry manufacture with 47% of the share followed by direct consumption at 20%. Other usages include cattle feed (14%) and starch (14%) followed by the food and beverage industry with a 7% share. Maize goes about as a source within the assembling of starch, syrup, dextrose, oil, gelatin, lactic corrosive sleuth. Corn flour is employed as a thickening specialist within the readiness of various edibles like soups, sauces and custard powder. Yellow maize is that the most extravagant wellsprings of Vitamin-A. Maize has more riboflavin than wheat or rice and is wealthy in phosphorous and potash. Maize contains 1.2 to 5.7 % eatable oil. Maize contains 60 to 68% starch and seven to fifteen protein and contains a high level of basic amino acids. Sulfur positions alongside nitrogen and phosphorus in significance within the development of proteins. It not just impacts yield yet additionally improves crop quality inferable from its impact on protein digestion and oil synthesis. it's included within the blend of the elemental amino acids, like cysteine, cystine and methionine aside from it's a constituent of vitamins thiamine and biotin, sulfur glycosides and co-catalyst. It improves crop the executives through its positive impacts on natural stress, obstruction against bug and diseases. The expanded utilization of sulfur free high investigation composts like diammonium phosphate (DAP) rather than single super phosphate (SSP) and absence of expansion of natural fertilizers throughout the years caused development of S deficiency. Therefore this investigation was planned to seek out the acceptable dose and source of sulphur for maize crop.

Sulfur (S) fertilization has become a problem thanks to reduced industrial emissions of S to the atmosphere and therefore the consequent decreased deposition of S onto agricultural land in many areas of the planet (McGrath et al. 1996). Sulfur nutrition plays a crucial role within the growth and development of upper plants, and sulfur limitation leads to decreased yields and quality parameters of crops (Hawkesford 2000). Adequate sulfur nutrition is additionally required for plant health and resistance to pathogens (Rausch and Wachter 2005)

In all plant species studied so far , a series of specific responses aimed toward optimizing acquisition and utilization are induced by sulfur limitation (Hawkesford 2000, Hawkesford and De Kok 2006). Arabidopsis has proved a useful model for basic molecular studies including the elucidation of the genes involved in these responses. The molecular knowledge from this model has been applied to many crop species, notably cereals (wheat, barley, rice) and Brassicas in reference to sulfur use efficiency during a physiological context. This review focuses specifically on sulfur nutrition in maize (Zea mays L.), a monocotyledonous species of the Poaceae family and a typical C4 plant, and on responses of maize to limiting sulfur availability.

Sulphur is attaining importance altogether regions of the planet due to frequent sulphur deficiencies in time and space .Several factors contributing to sulphur deficiencies were reported by many researchers includes, the increased use of sulphur free high analysis fertilizers and fewer use of sulphur containing pesticides along side multiple and high intensive cropping leaching and erosion restricted use of organic manures, and removal of crop residues for feed and fuel. The scenario of sulphur deficiency is more pronounced in alfisols compared to vertisols thanks to the low organic matter content. In sulphur deficient condition, the utilization efficiency of applied NPK fertilizers, the economics of their use could also be seriously affected, and high yields might not be sustained. Complete yield potential of a crop can't be obtained where soil is suffering with sulfur deficiency, even regardless of all the opposite nutrients application and under excellent management practices. Sulfur application at level of 5 tons ha-1results in higher maize yield

REVIEW OF LITERATURE

Dhananjaya (1998), reported a rise within the plant height of maize with increasing levels of sulphur application up to 45 kg S ha-1 . A two years field experiment was conducted by Choudhary et al. (2013), results revealed that maximum plant height (291cm) at harvest was attained with application of 40 kg S ha-1 over control.

Bhagyalakshmi et al.(2010) , at Bangalore reported that among the sulphur levels, application of 60 kg S ha-1 recorded the very best plant height (267 cm) on sandy clay loam soil having slightly alkaline in reaction. Sulphur application promotes the assembly of plant growth hormones for improving better growth of plants.

Gahlout et al.(2010) , reported that the very best plant height (171.33 cm) of maize was obtained with application of 45 kg S ha-1 at Allahabad (Uttar Pradesh). Total dry matter production of a plant often indicates its yield potential. it's going to vary through effect of weather change on photosynthetic system or length of season during which photosynthesis continues

Effect of S fertilization on yield attributes of maize

The plant requirement for sulphur is especially liable for nitrogen availability hence with the increasing rate of sulphur, the supply of nitrogen and it uptake increases. Bhagya Laxmi et al.(2010) , noted that application of 60 kg S ha-1 recorded highest cob length and 100 grain weight of maize. Application of 20 kg S ha-1 recorded highest cob length, cob weight and 100 grain weight107 . Gahlout et al.(2010) , revealed that application of 45 kg S ha-1 recorded significantly higher number of □grains per cob and 100 grain weight than preceding levels.

Bharati and Poongothai (2008) , concluded that the appliance of 45kg S ha-1 recorded better 100 grain weight. Khan et al. 51 , concluded that application of 60 kg S ha-1 recorded higher weight of 100 grains which was on par with 40 kg S ha-1 . the appliance of 60 kg S ha-1 recorded the upper yield attributes like cobs per plant, rows per cob, cob weight and grain weight per cob over the preceding levels69,110,113 . Application of 45 kg S ha-1 increases yield attributes over its lower levels68 .

Baktash (2004) , noted that best results were obtained with 60 kg S ha-1 for cob length, number of rows per cob and number of grains per cob. Mandal and sikder65, reported a rise in dry matter yield with 30 kg S ha1 .Dhananjaya24, revealed that number of cobs per plant increases with increasing levels of sulphur up to 45 kg S ha-1 .

Ojeniyi and Kayode (1993), reported that the appliance of 80 kg S ha-1 recorded the upper cob weight compared to the other treatments. Shivran et al.(2013) , reported that maximum number of cobs plant-1 was obtained with application of 60 kg S ha-1 (1.48) than 30 kg S ha-1 (1.46) and control (1.33).

A two years field experiment was conducted by Choudhary et al. (2013), at Udaipur region of Rajasthan and reported that application of 40 kg S ha-1 recorded the absolute best grain yield (4606 kg ha-1) and stover yield (7115 kg ha-1) than control. Sulphur application facilitates more number of larger size cobs which can have accommodated number of grains providing sufficient space for development of individual grain, leading to higher test weight with sulphur application resulting in higher grain weight cob-1 (Ahmed et al.

Effect of S fertilization on Maize Yield

Bhagya Laxmi et al.(2010) , stated that application of sulphur through bentonite at 60 kg ha-1 recorded higher grain and stover yield. Gahlout et al.34 , obtained highest grain yield with the appliance of 45 kg S ha-1 . Shrinivasrao et al.107 , revealed that application of 20 kg S ha-1 increases grain yield by 0.59 t ha-1 over control. Application of 60 kg Sha-1 significantly increased the grain and stover yield111. Addition of 30 kg S ha-1 increased the grain yield of maize significantly.

Bharathi and Poongothai (2008) , recorded 16.85% increase in yield with application of sulphur at 30 kg ha-1 compared to regulate . Khan et al.51 , obtained highest stover yield with application of 60 kg S ha-1 . Application of 60 kg sulphur through gypsum @ 60 kg ha-1 recorded highest grain and stover yield over lower levels in Rajasthan conditions . Biswas et al. (2004) ,found that optimum S rate varied between 30 and 45 kg ha-1 in most of the agroclimatic zones of the India and maize yields increase from 11 to 93% thanks to application of sulphur.

Maurya et al.(2005) , reported increase in grain and stover yield with increase in sulphur application up to 150 kg S ha-1 . Ram et al.96 , recorded significantly higher yield by application of 20 kg S ha-1 .

Majumdar et al. (2002) , recorded significantly higher yield by application of 20 kg S ha-1 . Patel et al.86 , reported an higher yield with application of S level of 40 kg ha-1 . Application of 40 kg S ha-1 enhanced the typical grain yield of maize by 0.99 t ha-1 103.Toatia et al.123 , reported highest stover yield in treatments receiving 80 kg S ha-1 .

Fontanetto et al.(2000) , noted significant increase in stover yield with application of 24 kg S ha-1 . Application of 45 kg S ha-1 recorded higher grain and stover yield24. Haq et al. 40, found a 20.5% increase within the grain yield with 72 kg S ha-1 .

Addition of twenty-two .4 kg S ha-1 within the sort of ammonium sulphate increased the yield of maize up to 43.4% compared with the control109. Das et al. (1973), reported that on an soil with 10 ppm available sulphur, the appliance of 30 kg S ha-1 increased maize grain yield by 4.7 q ha-1 , this increase being 9%. Pasricha et al. (1993). , and Dev et al.(1982) , found that S application up to 25 ppm was useful to supply optimum yields of maize in an soil . Rahul94, found that application of 90 kg S ha-1 significantly raised the yield of maize in S deficient soils of Rajasthan.

Effect on S uptake by Maize

The depth of the novel and seminal roots, amount of residue cover and therefore the drainage of water through the profile are the key factors influencing S uptake in maize. it's reported that the uptake of sulphur is about 3 to 4 kg by cereals118 .

Srinivasa rao et al.107 , recorded higher uptake of S with application of 20 kg S ha-1 . Bharati and Poongothai (2003) , noted that uptake of sulphur by grain and stalk increased significantly with increasing levels of sulphur.

Mehta et al.(2005) , concluded that highest sulphur uptake by grain and stover recorded with application of 60 kg S ha-1 . Patel et al. 87 , recorded 8 kg S ha-1 uptake by maize. Dwivedi et al. 27, reported that application of sulphur significantly increased the sulphur uptake by grain, stover and total sulphur uptake from 4.11 to 5.85, 1.85 to 3.53 and 6.91 to 9.34 kg ha-1 , respectively.

Pandey et al.(2002) , reported a better uptake of S with application of 20 mg/kg of soil which is like application of 40 kg S ha-1 .

Majumdar et al. (2002) , reported a rise in S uptake with increasing levels of sulphur. Total S uptake progressively increased from 2.58 to 9.44 kg ha-1 in treatment receiving 60 kg S ha-1 than preceding levels103, the very best value of S concentration (0.44%) was recorded in where P and S were applied at the speed of 90 kg ha-1 P + 75 kg ha-1 S and lowest S (0.09%) concentration was recorded on top of things plot, during a study by Irfan et al.44 .

Comparative effect of soil and foliar application study on sulphur on maize by Sarfaraz et al. (2014), revealed that foliar application of sulphur at 20 kg ha-1 at knee heigh stage and silking stage gave maximum N, P, K uptake (44.7 kg ha-1 , 20.3 kg ha-1 , 99.5 kg ha-1) than soil application. Imran et al. , during spring season maize revealed that Phosphorus and sulphur uptake by dry matter and grain significantly increased by the addition of S @ 50 kg ha-1 along side NPK fertilizer.

In crop production, sometimes sulfur is taken into account to be forgotten secondary nutrient. However it's most essential for activity of proteolytic enzymes and synthesis of amino acids. If adequate supply sulfur is ensured within the field it improves yield and quality of crops. the particular importance of sulfur has been noticed in
the recent overdue to exhaustive farming with high yielding varieties and therefore the use of complex fertilizers, which
led to sulfur deficiency during a lot of soils. In Tamil Nadu maize is one among the important commercial crops used as a
constituent in poultry and cattle fee-d. Maize crop responds well to sulfur fertilization and it removes about 30-
70 kg S ha-1. Several workers have reported that uptake of major nutrients is additionally positively influenced by sulfur
(Bharathi and Poongothai, 2008).
About 98% of total soil sulfur could also be found in organic forms and is said with a various mixture of plant, animal residues and soil micro-organisms (Bloem, 1998). With depth the organic sulfur concentration is
usually on the pattern of organic matter concentration in soils (Probert, 1980). Soil organic sulfur is separated in two main groups: i.e, sulfur atoms with reduced and oxidized states. About 1 to three of the soil organic sulfur are often assumed the a part of microbiological biomass (Stevenson, 1986), while from present study of Banerjee et al. (1993) soil microbial biomass sulfur is usually 1.5 -5% of total soil organic sulfur. In microbial cells amino acids and proteins are the foremost important sort of sulfur (Banerjee and Chapman, 1996). Inorganic sulfur is usually greatly in fewer amounts in most of the agricultural soils than organic sulfur (Bohn et a/., 1986). The mainly ordinary appearance of inorganic sulfur is sulfate and should be subdivided into mineral sulfur, SO4 2- in soil and adsorbed SO4 2- (Barber, 1995). Sulfur possibly precipitates with calcium, magnesium or sodium to make their sulfates. Great quantities of sulphide metals like pyrite accumulated in tidal marshlands. Once draining these areas, the sulfur holding complexes are oxidized to SO4 2- attended by a drop off in pH. If adsorbed SO4 2- isn't willingly available to crop, every management causing a decline in retention and a resultant addition of SO4 2- in soil solution must increase SO4 2- availability to plants (Elkins and Ensminger. 1971). Mehlich (1964) originated that discharge of adsorbed SO4 2- was associated with the count of succeeding rise of Ca (OH)2, that's believed the effect of increased pH. Therefore, small SO4 2- adsorption is probable in upper soils which are sufficiently limed (Evans, 1986) and thus the combined application of limestone and gypsum consequences in an improved availability of SO4 2- (Serrano et al, 1999). Keeping in sight the importance of sulfur within the production

of maize, current work was designed to assess the likelihood of sustaining high crop yield through the appliance of soil and foliar sulfur with these objectives: to review the effect of sulfur on NPK uptake by maize. to seek out out effect of sulfur on yield and yield components of maize

Conclusion

Use of high analysis fertilizers containing little or no sulphur including intensive cropping system has caused wide spread sulphur deficiencies in plants. Efficiency of applied N, P2O5 and K2O and therefore the economics of their use is seriously affected under sulphur deficient conditions.It is concluded that maize hybrids responded positively to higher rates of N in term of biological yield, grain yield, harvest index, benefit cost ratio whereas application of sulfur at either level had not substantial improvement in yield and yield related traits except S content in soil and in tissue. Nitrogen level of 350 kg ha-1 substantially increased maize yield with the very best values of BCR as compared with other N levels. The combine application of N and S at rate of 350 kg ha-1 with 40 kg ha-1 was found more economical as compared to other levels.To get maximum yield of maize 60 kg ha-1 sulfur should be added to sulfur deficit soils along side NPK fertilizers. Foliar application of sulfur may attain yield comparable soil application if it should applied in three or four splits rather than two. The experiment could also be repeated to verify these results of soil Vs foliar application of sulfur on maize.

6. REFFERENCE

1. Ahmad, R., Dawar, K., Iqbal, K. and Wahab, S., Effect of sulphur on nitrogen use efficiency and yield of maize crop. Adv. Environmental Biol., 10(11): 85-90.

2. Aukineedu, G., Rao, J. V. and Reddy, B. N., Fertil. New, 28(9): 76-90, 105 (1983).

3. Aulakh, M. S., Pasricha, N. S. and Dev, G., Fertil. News, 9: 529-531 (1977).

4. Baktash, F. Y., Bulletin of Faculty of Agriculture, University of Cairo., 51(2):123-137 (2000).

5. Banerjee, M. R. and S. J. Chapman. 1996. The significance of microbial biomass sulfur in soil. Biological Fertile Soils. 22: 116- 123

6. Beaton, J. D, Burs, G. R. and Platou, J., Determination of sulphur in soils and plant materials, Tech. Bull. No. 14, The Sulphur Institute, Washington, D.C., USA (1968).

7. Bhagyalakshmi, T., Prakash, H. C and Sudhir, K. Effect of different sources and levels of sulphur on the

performance of rice and maize and properties of soils. Mysore J. Agric. Sci., 44(1): 79-88 (2010).

8. Bharati, C. and Poongothai, S., Res. J. Agric. Biol. Sci., 4(5) : 368- 372 (2008).

9. Biswas, B. C., Narayanaswamy, C. and Ravi, R., Fertil. News, 49(10):13-18, 21- 28, 31-33 (2004).

10. Blake Kalff, M., Harrison, K., Hawkesford, M., Zhao, J. and McGrath, S., Plant Physiology, 118:1337–1344 (1998).

11. Bloem, E. M. and S. B. Von. 1998. Agrarokosystemen unter besonderer Beruksichtigung hydrologischer and bodenphysikalischer Standorteigenschaften. Vol. 192, p-156

12. Bohn, H. L., N. J. Barrow, S. S. Rajan and R. L. Parfitt. 1986. Reactions of inorganic sulfur in soils. In:Tabatabai, MA. (Ed.). Sulfur in Agriculture, Agron. Monogr, vol.27. ASA, CSSA, and ISSSA, Madison, WI, p.233-249

13. Brunold, C., Regulatory interaction between sulphate and nitrate assimilation. In "Sulphur nutrition and assimilation in higher plants" (L. J. De Kok, I. Stulen, H. Rennenberg, C. Brunold, and W.E Rauser, Eds), 61-75 (1993).

14. Bullock, D. G. and Goodroad, L. L., Communication in Soil Sci. and Plant Analysis, 20(11 &12): 1209-1217 (1990).

15. Cassman, K. G., Doberman, A. R. and Walter, D. T., Agroecosystems, nitrogenuse efficiency, and nitrogen management. Agronomy & Horticulture -- Faculty Publications, p. 356.

16. Castellano, S. D. and Dick, R. P., Soil analytical study. Soil Sci. Soc. Am. J., 54:114-121 (1990).

17. Cate, R. B. Jr. and Nelson, L. A., A rapid method for correlation of soil test analysis with plant response data. North Carolina Agricultural Experimental Station International Soil Testing Series Technical Bulletin No.1, Raleig, NC (1965).

18. Chaubey, A. K., Dwivedi, K. N. and Yadav, R. S., Effect of NPKS on linseed. J. Indian Soc. Soil 40: 758 (1992).

19. Cheema, H. S. and Arora, C. L., Sulphur status of soil. Fertil. News, 29 (3): 28-31 (1984)

20. Choudhary, R., Singh, D., Singh, P., Dadarwal, R. S and Chaudhari, R., Impact of nitrogen and sulphur fertilization on yield, quality and uptake of nutrient by maize in southern Rajasthan. Annals of Plant and Soil Research. 15(2): 118-121 (2013).

21. Das, S. K. and Datta, N. P., Fertilizer use in dryland problems and prospects. Fertil. New., 18 (9): 3-10 (1973).

22. Das, S. K., Chabbra, P., Chatterjee, S. R., Abrol, Y. D. and Deb, D. L., Influence of sulphur fertilizer on yield of maize. Fertil. News, 20: 30-32 (1975).

23. Dekok, L. J, Castro, A., Durenkamp, M., Stuiver, C. C., Westernmans, S., Young, L. and Stulen, I., Sulphur in plant physiology, Proceeding. No. 500. International Fertilizer Society, York, UK (2002). Sutar et al Int. J. Pure App. Biosci. 5 (6): 1582-1596 (2017)

24. Dekok, L. J. and Stulen, I., Sulphur nutrition and assimilation in higher plants. Academic publishing,The Hauge, The Netherland: 125-138 (1993).

25. Dev, G. and Kumar, V., Secondary Nutrients: IN Review of Soil Research in India, Part I, 342-360, 12th International Congress of Soil Science, New Delhi, India (1982).

26. Dev, G., Jaggi, R. C. and Aulakh, M.S., Study of nitrate-sulphate interaction on the growth and nutrient uptake by maize. J. Indian Soc. Soil. Sci., 27: 302-307 (1979).

27. Dhananjaya, B. C., Effect of fertilizer levels and foliar nutrition on yield, nutrient uptake and economic of maize (Zea mays L.). M.Sc. Thesis, UAS, Dharwad (1998).

28. Gahlout, B., Singh, R. and Lal, G. M., Effect of levels of nitrogen and sulphur on growth and yield of maize (Zea mays L.). J. Maharashtra Agric. Univ., 35(1): 149- 151 (2010).

29. Elkins, D. M. and L. E. Ensminger. 1971. Effect of soil pH on the availability of adsorbed sulfate. Soil Science Society of American Procduction. 35: 931-943

30. Imran, M., Parveen, S., Ali, A., Wahid, F., Arifullah and Ali, A., Influence of sulphur Sutar et al Int. J. Pure App. Biosci. 5 (6): 1582-1596 (2017) ISSN: 2320 – 7051 Copyright © Nov.-Dec., 2017; IJPAB 1592 rates on phosphorus and sulphur content of maize crop and its utilization in soil. Int. J. Farming Allied Sci., 3 (11): 1194-1200 (2014).

31. Majumdar, B., Nagaraj, M. and Trivedi, A., Sulphur nutrition in plants. J. Hill Research, 15(2): 63-70 (2002).

32. Maurya, K. L. Sharma, H. P. and Tripathi, H. P., Effect of nitrogen and sulphur application on yield attributes, yield and net returns of winter maize (Zea mays L.). Sher Singh Haryana J. Agron., 21 (2) : 115-116 (2005).

33. Mehta, Y. K. Shaktawat, M. S. and Singhi, S. M., Influence of sulphur, phosphorous and farmyard manure on yield attributes and yield of maize (Zea mays L.) in southern Rajasthan conditions. Indian J. Agron., 50(3) : 203-205 (2005).

34. Pandey, R. N. Girish, B. H. and Brajendra, Influence of sulphur application on dry matter yield and sulphur nutrition of maize (Zea mays L.) in major soil orders in India. Ann. of Agric. Res., 23(2): 263-270 (2002).

35. Parischa, N. S. and Fox, R. L., Plant nutrient sulfur in the tropics and subtropics. Advances in Agronomy, 50: 209-269 (1993).

36. Sarfaraz, Q., Perveen, S. and Shahab, Q., Comparative effect of soil and foliar application of sulfur on maize . Journal of Agriculture and Veterinary Science. 7 (4):32-37 (2014).

37. Shivran, R. K., Rakesh Kumar and Anupama Kumari, Influence of sulphur, phosphorus and farm yard manure on yield attributes and productivity of maize in humid south eastern plains of Rajasthan. Agriculture Science and Digest, 33 (1): 9- 14 (2013).