Review Article

ENHANCING GROUNDNUT PRODUCTIVITY THROUGH INTEGRATED NUTRIENT MANAGEMENT AND LIMING - A REVIEW

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ABSTRACT

Majority of soils Tripura are strongly acidic having a pH range of 5.1-5.5. Groundnut, an oilseed crop, can grow well in coarse-textured soils which facilitate the better growth and development of groundnut pods. The low soil pH is associated with a number of soil chemical and biological properties that manifest themselves as the components of the acid soil syndrome. There are some specific problems which are associated with acid soils e.g., aluminum, iron and manganese toxicity; molybdenum deficiency; failures in legume nodulation; increase in plant disease, and calcium and magnesium deficiency. These conditions may adversely affect groundnut growth. Liming is an important proposition to combat soil acidity, however, everywhere this approach does not prove economical and most of the time it is out of the reach of resource poor farmers. Thus, judicious application of lime and integrated nutrient management (combinations of bio-fertilizer, greeen manuring, organic manure and chemical fertilizer) can be practiced to formulate an integrated programme for acid soil management which will be eco-friendly and economically feasible tool to conquer productivity barrier and to attain sustainable groundnut production in acid soils of Tripura.

INTRODUCTION

Soil acidity is a major factor that restricts crop growth in a large part of the world (Shainberg *et al*., 1989). In general, fertility status and growth and yield of plant of acid soils are very poor (Kundu, 2017; Bhat *et al.*, 2017). Acid soils occupy ~3.95 billion hectare (ha) and account 30 percent of the world's ice-free land area (Vonuexküll and Mutert, 1995). Out of the 328 million ha in India, nearly 145 million ha is cultivated. A rough estimate indicates ~48 million ha of this soils are acidic, of which 25 million ha has pH less than 5.5 and ~23 million ha has pH between 5.6 and 6.5 (Sharma and Sarkar, 2005). Plant and other living (macro- and micro-) organisms in soils can be affected by both low and high pH (Brady and Weil, 2008). Because, soils with low pH have deficiency of many essential nutrients e.g., calcium (Ca^{2+}), magnesium (Mg^{2+}) and phosphorus (P). Soil pH below 5.0 inhibits availability of phosphorus and activity of cation exchange capacity (Baumann *et al.*, 1998). Iron (Fe^{3+}) can reach toxic levels for plants when pH falls below 4.0, and hydrogen (H^{+}) ion can damage root membranes at pH between 4.0 and 4.5 (Brady and Weil, 2008). In a very acidic soil (pH 4.5-5.5), aluminium (Al^{3+}) toxicity affects plant metabolism, where roots containing Al become shortened, thickened, and unable to adequately take up water and nutrients, particularly phosphate (Rowell, 1994). Like aluminium, manganese can be very soluble as and when pH drops, but its toxicity level in soils increases when it reaches at 5.6 (Brady and Weil, 2008). To alleviate the problem, integrated nutrient management (INM) is pertinent to utilizes available organic and inorganic nutrients to build ecologically sound and economically viable farming systems. In this approach all the possible sources of plant nutrients are applied through organic source based on economic consideration and the balance required for the crop is supplemented with chemical fertilizers. The combined use of organic and inorganic sources of plant nutrient not only pushes the production and profitability of field crops, but also helps in improving the fertility status of the soil (Kannan *et al*., 2013).

Groundnut (*Aarchis hypogaea* L.) is a premier oilseed crop of India and contributed ~40 per cent of the total oilseed production. But it has low productivity (900 kg ha^{-1}) (Bandopadhya *et al.*, 2000). Improper nutrient management is important for low productivity. Being a legume-oilseed crop, it requires more P, sulphur (S) and Ca than those by cereals. Kanwar *et al*. (1983) while studying the nutrient and fertilizer response of groundnut concluded that with balance use of fertilizer for groundnut production can be increased considerably. However, a wide inconsistency in response of groundnut to fertilizer application is noticed (Reddy, 1988) and the conclusive evidences on balance nutrition of groundnut are still meagre and fragmentary in coverage. According to Mandal (1997) around one-third of total cultivable land of India is suffered from soil acidity. Again, Sharma and Singh (2002) reported that most of the acid soil area falls under North-Eastern region of India where around 65% area have soil pH below 5.5. Productivity of soil and crop is restricted by toxicities of Fe and Al, deficiency of phosphorus, calcium, magnesium, boron etc, reduced microbial activity and other soil acidity-induced constraints (Patiram, 1991; Kumar *et al*., 2012). The magnitude of the negative impacts of soil acidity on productivity of both soil and crop is further increased because of variation in climate (Kumar *et al.*, 2012). Efficient management of such acid soil is very important for increasing crop productivity as well as for increasing food security on regional as well as global basis. To increase the productivity of crops grown under such extreme acid soil liming as well as INM (Integrated Nutrient Management) is to be followed by the farmers of Tripura (Dey *et al.*, 2015). Inoculation of Rhizobium + PSM in-combination with lime 500 kg per ha FYM 10 ton per ha + 50% Nitrogen. Phosphorus and Potassium brought significant improvement in yield, residual fertility and more remuneration. This combination may be adopted for cultivation of groundnut in acid alfisols under mid hill altitude conditions of the North East India (Singh *et al.,* 2003). Legumes are usually lime loving (Mandal *et al.,* 1997) and a little information pertaining to the effect of liming on legumes is available in Tripura. However, it was reported that cowpea and mung yielded 80.0 and 93.0 per cent more over respective control after the application of 10 quintal (q) lime ha^{-1}. Lime requirement of the soils even with similar acidity (pH) levels may vary widely based on the differences in their organic matter contents, and therefore, lime application should not be advocated merely on the basis of existing soil pH. Rather, proper testing of lime requirement is needed for the best results in terms of soil acidity amelioration and crop productivity improvement. Palm *et al.* (1997) highlighted that organic source of nutrients influence nutrient availability by the total nutrients added by controlling the net mineralization-immobilization patterns. Several researchers (Bakayoko *et al*., 2009) have shown that application of organic manures in combination with lime significantly improved the soil quality due to an increase in soil organic matter content. Further, INM is one of the most effective ways to improve soil fertility in tropical soils of India (Kumar *et al*., 2012). A combined application of organic manure with lime increased exchangeable Ca and Mg and improved soil pH (Rahman *et al*., 2002). The increase can be attributed to the release of Ca2+ ions in lime through its dissociation (Chimdi *et al.,* 2012) and to mineralization of manure with released nutrients (Shen and Shen, 2001). Further, a judicious use of FYM and biofertilizers along with 75% recommended NPK increased the organic carbon content and application of lime and FYM along with 100% recommended NPK increased P content (Ramesh *et al.,* 2014). The management of acid soils should aim at improving the production potential by addition of amendment to correct the acidity and manipulate the agricultural practices so as to obtain optimum crop yields under acid condition.

LIMING AS A SOIL ACIDITY MANAGEMENT STRATEGY

Liming in adequate amount in acid soil have some favourable effects in increasing nutrient availability, microbial population and their activity and ultimately in increasing crop productivity (Bhat *et al.*, 2010; Bhat *et al.*, 2017). Liming eliminates soil acidity and toxicity of aluminum, iron, manganese, and H^+ ions; improves soil structure (aeration); improves availabilities of calcium, magnesium, phosphorus, molybdenum and magnesium, and N-fixation; and reduces the availabilities of manganese, zinc, copper and iron and leaching loss of cations. For several crops, liming results in some chemical changes in the soil such as, increase in pH, effective cation exchange capacity (ECEC), and exchangeable Ca, decrease in toxic elements for example Al^{3+} and Mn^{2+} and changes in the proportion of basic cations in CEC sites (Ezekiel, 2006).Soil nitrogen availability is also increased by liming because of increased organic matter decomposition. (Donald, 2011). These liming materials include limestone (both calcitic and dolomitic), burnt lime, slaked lime, marl, and by-products of steel industries like basic slag (Bhat *et al.,* 2017), by-products of sugar factory like pressmud which are of low cost. Over-liming, however, can significantly reduce the bioavailability of micronutrients (Zn, Cu, Fe, Mn and B), which decrease with increasing pH (Fageria *et al.,* 2002). This can produce plant nutrient deficiencies, particularly that of Fe which is made available at medium acidic conditions.

EFFECT OF FARMYARD MANURE APPLICATION ON SOIL ACIDITY

Organic matter has been found to increase the soil's ability to hold and make available essential plant nutrients and to resist the natural tendency of soils to become acidic (Reis and Rodella, 2002). Application of manure to acid soils not only supplies the nutrients and organic colloids for plant growth but it also reduces soil acidity, improves phosphorus availability and reduces aluminium toxicity. Proton exchange between the soil and manure which contains some phenolic, humic-like material makes it capable of raising soil pH (Tang *et al.*, 2007). The soil pH is increased due to addition of farmyard manure as organic acid and humic substances produced due to decomposition of organic matter are adsorbed on the surfaces of hydrous oxides of Fe and Al by exchange with the corresponding release of OH^- (Hue *et al.*, 1986).Returning organic amendments in form of livestock manures and crop residues to soil could be important in supplying crop nutrients as well as improving soil moisture conditions and increasing availability of P by stimulating microorganisms that solubilize soil P (Fankem *et al*., 2008).

FERTILIZER MANAGEMENT IN ACID SOIL

Higher amount of N is recommended in high rainfall areas to compensate leaching losses. Split application of N with small dose is preferred to single heavy dose to avoid such losses (Sanchez and Salinas, 1981). Liebig *et al*. (2006) reported decrease in soil pH level due to acidifying the nitrogen fertilizer in highly fertilized soil. Acid forming fertilizers such as ammonium chloride, ammonium sulphate, ammonium phosphate, urea, ammonium nitrate etc. should be avoided in acidic soils. Dolomitic lime stone used as a filler in the fertilizer mixture can reduce soil acidity beside supplementing Ca and Mg nutrition of the soil. High phosphate fixing capacity creates the deficiency of phosphorous in acid soil. Use of judicious quantity of rock phosphate well ahead of liming is a cheap means for P supplementation in such type of problematic soil. Somani *et al.* (1990) reported that arbascular mycorrhizae (AM) forms symbiotic association with roots of several plants and facilitates increased P uptake in low P soils. Here the fungal hyphae of AM act as an extension of plant root system, which increases the surface area for tapping P from larger soil volume.

SUMMARY AND CONCLUSION

Lands with pH value less than 5.5 are critically degraded with very poor physical, chemical and biological characteristics. The soils suffer due to deficiencies of phosphorus, calcium, magnesium, molybdenum and boron and toxicities of aluminium and iron. The productivity of Groundnut is, therefore, low in acidic soils due to poor soil health. The addition of lime to these soils neutralizes soil acidity and creates favourable environment for microbial activity, nutrient release and their availability to plants. The conjunctive use of lime and adequate fertilizers, therefore, holds key for higher productivity of these soils. Liming and integrated use of organic and inorganic fertilizers and bio-fertilizers can be adopted for increasing the yield of groundnut as well as for improving fertility status of the soil and reducing different forms of acidity in the acidic soils.

REFERENCES

Bakayoko, S., D. Soro, C. Nindjin, D. Dao, A. Tschannen, O. Girardin, A. Assa. 2009. Effects of cattle and poultry manures on organic matter content and adsorption complex of a sandy soil under cassava cultivation (Manihot esculenta, Crantz). *African Journal of Environmental Science and Technology,* 3(8): 190-197

Bandopadhyay, A., P.K. Ghosh and R.K. Mathur. 2000. Groundnut situation in India. The present scenerio and future strategies. *Indian Farming*, 50: 13-20.

Baumann, J., G. Werner and W. Moll. 1998. *Compaction and surface sealing*, **1**: 573**.** Brady, N.C. and R.R. Weil. 2008. The nature and properties of soils.Pub. Pearson Education, New Jersey, USA.

Bhat, J. A. M.C. Kundu, B. Mandal and G. C. Hazra. 2017. Nature of Acidity in Alfisols, Entisols and Inceptisols in Relation to Soil Properties. *Communications in Soil Science and Plant Analysis*, 48 (4): 395-404.

Bhat, J.A. M.C. Kundu, G.C. Hazra and Biswapati Mandal. 2010. Rehabilitating acid soils for increasing crop productivity through low-cost liming material. *Science of the Total Environment*, 408: 4346-4353.

Brady, N. C., and R. R. Weil. 2008. The nature and properties of soils, 14th ed., 980. Upper Saddle River, NJ: PearsonEducation, Prentice- Hall Inc.

Chimdi, A., V. Gebrekidan, K. Kibret, A. Tadesse. 2012. Effects of liming on acidity-related chemical properties of soils of different land use systems in Western Oromia, Ethiopia. *World Journal of Agricultural Science,* **8**(6): 560- 567**.**

Dey, D. and D. Nath. 2015. Assessment of effect of liming and integrated nutrient management on groundnut under acidic soil condition of West Tripura. *Asian Journal of Soil Science*, **10**(1): 149-153**.**

Donald, B. 2011. Soil pH: What it means. State University of New York College of Environmental Science and Forestry.

Ezekiel, A.A. 2006. Strategies for Improving Crops Use-Efficiencies of Fertilizer Nutrients in Sustainable Agricultural Systems. *Pakistan Journal of Nutrition*, **5**: 85- 193.

Fageria, N.K., V. Baligar, and R.B. Clark. 2002. Micronutrients in Crop Production. Advances in Agronomy. 77: 185-268.

Fankem, H., Ngo, N., Deubel, A., Quinn, J., Merbach, W., Etoa, F. and Nwaga, D. 2008. Solubilization of inorganic phosphates and plant growth promotion by stains of Psoudomonas fluorescens isolated from acidic soils of Cameroon. *African Journal of Microbiology Research***, 2**: 171-178**.**

Hue, N. V., G. R. Craddock, and F. Adams. 1986. Effect of organic acids on aluminium toxicity insubsoils. Soil Society of America Journal. 50: 28–34.

Kannan, R.L., M. Dhivya, D. Abinaya, R. Lekshmi Krishna and S. Krishnakumar. 2013. Effect of integrated nutrient management on soil fertility and productivity in maize. *Bulletin of Environment, Pharmacology and Life Sciences*, **2**(8): 61-67.

Kanwar, J.S., H.L. Nijhwan, and S.K. Raheja. 1983. Groundnut nutrition and fertilizer response in India. ICAR. New Delhi. **47**: 166-169.

Kumar, M., M.H. Khan, P. Singh, S.V. Ngachan, D.J. Rajkhowa, A. Kumar, and M.H. Devi, 2012. Variable lime requirement based on differences in organic matter content of iso-acidic soils. *Indian Journal of Hill Farming*, **25**(1): 26-30.

Kundu, M.C. 2017. Nature of acidity in some soils of red and lateritic belt of West Bengal. *Journal of Soils and Crops*, **27**(1): 39-44.

Liebig, A.A, J.R. Gross, S.L. Kronberg, J.D. Hanson, N.B. Frank and R.L. Phillips. 2006. Soil response to long term grazing in the Northern Great Plains of North America. *Agriculture,Ecosystem and Environment*, **115**: 270-276.

Mandal, L.N., and B. Mandal. 1997. Acid soils of West Bengal - Their characteristics and management. In: Acid soils ofIndia, eds. I. C. Mahapatra, S. C. Mandal, C. Misra, G. N. Mitra, and N. Panda, 261–63. New Delhi, India: IndianCouncil Agric. Res.

Palm, C.A., Myers, R.J.K., Nandwa, S. 1997. Combined use of organic and inorganic nutrient sources for soil fertility maintenance and replenishment. *American Society of Agronomy*, **51**: 193-217.

Patiram, 1991. Liming of acid soils and crop production in Sikkim. *Journal of Hill Research,* **4**: 6–12.

Rahman, M.A., Meisner, C.A., Duxbury, J.M., Lauren, J., Hossain, A.B.S. 2002. Yield response and change in soil nutrient availability by application of lime, fertilizer and micronutrients in an acidic soil in a rice-wheat cropping system. Paper presented in 17th WCSS, 14-21 August 2002, Thailand.

Ramesh, T., S. Hazarika, B.U. Choudhury, M. Kumar, B.C. Verma, K. Rajasekar, and S.V. Ngachan. 2014. Soil fertility changes under long-term integrated nutrient management practices on acid soils of Meghalaya.*Indian Journal of Hill Farming*, **27**(1):1-6.

Reddy, P.S. 1988. Genetics, breeding and varieties. In: Ground Nut. Ed. Reddy P. S., New Delhi: Indian Council of Agricultural Research; 200-316.

Reis, T. C. and Rodella, A. A. 2002. Dynamics of organic matter degradation and pH variation of soil under different temperatures. *Rev. Bras. Ciênc. Solo,* **26(3)**: 619–626.

Rowell, D. L.1994. Soil science: Methods and applications. Longman Group, Essex, UK.

Sanchez, A.P. and J.G. Salinas. 1981. Low input technology for managing Oxisols and Ultisols in tropical America. *Advances in Agronomy,* **34**: 279-405.

Shainberg, I., M.E. Sumner, W.P. Miller, M.P.W. Farina, M.A. Pavan and M.V. Fey. 1989. Use of gypsum on soils A review. *Advances in Soil Science*, **9**: 1-111.

Sharma, P.D. and A.K. Sarkar. 2005. Managing acid soils for enhancing productivity. Indian Council of Agricultural Research NRM Division, Krishi Anusandhan Bhavan-11 New Delhi.

Sharma, U. C., R.P. Singh. 2002. Acid soils of India: their distribution, management and future strategies for higher productivity. *Fertilizer News*, **47**: 45–52.

Shen, Q. R., Z. G. Shen. 2001. Effects of pig manure and wheat straw on growth of mung bean seedlings grown in aluminium toxicity soil. *Bio resource Technology*, **76**: 235- 240.

Singh, A.L., M.S. Basu, and N.B. Singh. 2003. Potential of Groundnut in North-eastern States of India. NationalResearch Centre for groundnut (ICAR), Junagadh,India. pp 75

Somani, L.L., S.C. Bhandari, S.N. Saxena and K.K. Vyas. 1990. Biofertilisers. Scientific publishers, Jodhpur.

Tang, Y., H. Zhang, J.L. Schroder, M.E. Payton and D. Zhou. 2007. Animal manure reduces aluminium toxicity in an acid soil. *Soil Science Society of American Journal*, **71**: 1699-1707.

Von Uexkull, H.R. and E. Mutert. 1995. Global extent, development and economic impact of acid soils. In: Date RA (ed) Plant-Soil interaction at Low pH: Principles and Management. Klüwer Academic Publishers, Dordrecht, pp 5-19.

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