Indian Farmer
Volume 10, Issue 01, 2023, Pp. 10-14.
Available online at: www.indianfarmer.net
ISSN: 2394-1227 (Online)

ORIGINAL PAPER

The use of gypsum to improve soil properties and reduce soil erosion

Daniel Prakash Kushwaha* and Anil Kumar

G. B. Pant University of Agriculture and Technology, Pantnagar – 263145 (U. S. Nagar), Uttarakhand, India

Corresponding Author: danielprakash1991@gmail.com

Article Received: 14 January 2023 *Published Date: 18 January 2023*

ABSTRACT

Agricultural productivity is supported by good soil, which in turn promotes plant and animal growth. A healthy plant gives good yield and helps in socio-economic growth. Soil degradation in terms of salinity, alkalinity, acidification, and erosion cause reduction in productivity and as a result affect the human life. Use of soil amendment is one of the soil conservation measures in which soil physico-chemical properties are enhanced in shorter period and lesser cost in comparison to other measures. Gypsum is an inorganic soil amendment, which is used to reclaim alkaline soils, enhance soil physico-chemical properties, and reduce soil erosion and runoff. The basic advantage of gypsum is that it meets the other needs of former in terms of affordability and accessibility. Optimum application rate of gypsum and its blending with other soil amendments such as biochar, lime, rice straw etc. can enhance its properties to reduce soil degradation and improve vegetation growth.

Keywords: Soil degradation; Soil productivity; Gypsum; Application rate; Cost.

INTRODUCTION

Soil erosion and quality declination are the most severe environmental issue on the planet (Anh et al., 2023; Kushwaha and Kumar, 2016, 2017a, b). Out of India's total 328 Mha of land, 147 Mha are thought to have degraded soil, and 16.4 t/ha of soil is thought to be lost to erosion per year (Bhattacharyya et al., 2015). To improve the physico-chemical characteristics of soil and lessen soil erosion, a number of agronomic and engineering measures are in use (Groffman, 1997; Mal, 1994; Sanders, 1986; Singh at al., 2020). To boost agricultural output, which is greatly impacted by the physico-

chemical qualities of the soil, people implement all soil conservation methods on agricultural fields.

Various types of soil amendments have been considered during the last few decades to improve the physico-chemical characteristics of soil and prevent runoff and soil erosion (Filho et al., 2020; Kumar and Saha, 2011; Kushwaha and Kumar; 2021). To enhance and sustain the qualities of the soil, a soil amendment is added, which will subsequently lead to greater plant development and yield (Lal, 2008; Waddington, 1992). In general, there are two types of soil amendments i.e. organic and inorganic. Inorganic soil amendments have a less impact on soil physical characteristics than on soil chemical characteristics.

Gypsum is a well-known inorganic soil amendment for restoring alkaline soils and meeting other needs of researchers, such as affordability and accessibility. Effect of gypsum on preventing soil erosion and runoff are particularly important, especially on sloping land (Filho et al., 2020; Kim et al., 2017; Kumar and Saha, 2011). The value of gypsum in the soil was demonstrated in a number of literatures. By utilizing gypsum, polyacrylamide (PAM), or a mixture of the two, Kumar and Saha (2011) increased the soil quality by lowering its erodibility on steep slopes. Gypsum use, as opposed to polyacrylamide, significantly reduced soil erosion, runoff, and nutrient losses, according to Kumar and Saha (2011) research. In addition to this, Kumar and Saha (2011) showed that gypsum was a cost-effective soil supplement and recommended using it in conjunction with PAM to reduce runoff, soil erosion, and losses of available nitrogen, phosphorus, and potassium. To study the impact of lime and gypsum on a sandy clay loam soil, Filho et al. (2017) conducted a long-term field trial using no-tillage farming. According to Filho et al. (2017), applying phospho-gypsum increased the stability of macro-aggregates in sub-soil layers. Improved soil particle arrangement, increased porosity, and a decrease in soil bulk density were all results of increased aggregate stability.

By using gypsum and rice straw compost, Kim et al. (2017) restored the quality of the soil in coastal tidelands and demonstrated how it reduces soil bulk density by enhancing soil porosity. Gypsum and cow dung manure were employed by Filho et al. (2020) to restore saline-sodic soil. The problem of saline-sodic soils, which reduced agricultural productivity and damaged farm machinery, cannot be solved by using expensive pesticides and fertilisers. To observe how amendments affected the soil, they employed a percolation column. Kebede et al. (2020) applied PAM in blended form with gypsum and lime to reduce soil erosion and to improve soil productivity in acidic soil.

PROPERTIES

Gypsum used in agriculture has the molecular formula calcium sulphate dihydrate ($CaSO_4.2H_2O$). Gypsum is an inorganic soil improvement that works to bond the soil particles on the surface (Kumar and Saha, 2011). Gypsum was discovered to lower soil pH and boost electrical conductivity. Gypsum is primarily a calcium supplier for the soil;

hence it has a variety of specialized agronomic purposes. In sodic soils, it serves as a soil conditioner. Gypsum and biochar together increase the physico-chemical characteristics of the soil. Combining gypsum and biochar improves ability of biochar to break down organic matter, lower soil pH, and raise soil moisture content.

Gypsum also lessens soil erosion, runoff, and nutrient and carbon losses significantly. Additionally, it has been discovered that the behaviour of gypsum with PAM is particularly effective at regulating soil pH, electrical conductivity (EC), soil erosion, runoff, and fertility loss. Gypsum and PAM together were discovered to be superior to their solo applications. Additionally, it was found that applying gypsum to the soil surface rather than blending it with soil in is preferable (Kumar and Saha, 2011). Impact of gypsum on biomass has not yet been found to be particularly noteworthy. However, its blended form with other amendments, such as biochar, PAM etc. can promote the increase of biomass.

APPLICATION RATE AND COST

Before using powdery gypsum in the field, it is crucial to determine the ideal dose. Random dosage application might have negative effects in the fields. According to a scientific perspective, choosing the right dose of the amendment can benefit from a thorough and current evaluation of earlier studies. According to Kumar and Saha (2011) and Kushwaha et al (2021) reports, powdery gypsum should be applied at a rate of 2.5 t/ha and 5 t/ha, respectively. According to other earlier studies, the application arte of gypsum should be in the range of 2.5 to 5 t/ha. Gypsum should normally be applied to bare soil surface rather than being mixed in with the soil (Kumar and Saha, 2011; Kushwaha et al., 2021). Fig. 1 showed the surface application of gypsum in an experimental plot. Cost of recommended doses of gypsum is given in Table 1.

Fig. 1 Surface applications of gypsum

Table 1 Total cost of recommended doses of gypsum

Application rate (t/ha)	Cost of gypsum (Rs./kg)	Total cost (Rs./ha)
2.5	8/-	20000/-
5.0	8/-	40000/-

CONCLUSIONS

For the restoration of alkaline soils and to satisfy the financial needs of farmers, gypsum is a highly recommended soil amendment. Gypsum should be applied on the surface rather than being mixed into the soil. Ability of gypsum ability to bind soil particles on the surface and lower runoff, erosion, nutrient loss, and soil pH is dependable and effective. Gypsum has not been found to have a substantial impact on biomass growth to date, but when combined with other amendments such biochar, PAM, manure, rice straw, lime, etc., it can increase biomass growth and improve the physico-chemical characteristics of degraded soil.

REFERENCES

1. Anh, D.T., Tanim, A.H., Kushwaha, D.P., Pham, Q.B., & Bui, V.H. (2023). Deep learning long short-term memory combined with discrete element method for porosity prediction in gravel-bed rivers. *International Journal of Sediment Research* 38(1): 128–140. https://doi.org/10.1016/j.ijsrc.2022.08.001.
2. Bhattacharyya, R., Ghosh, B.N., Mishra, P.L., Mandal, B., Rao, C.S., Sarkar, D., Das, K., Anil, K.S., Lalitha, M., Hati, K.M., & Franzluebbers, A.J. (2015). Soil degradation in India: Challenges and potential solutions. *Sustainability* 7: 3528-3570. https://doi.org/10.3390/su7043528.
3. Filho, A.C.A.C., Penn, C.J.,Crusciol, C.A.C., & Calonego, J.C. (2017). Lime and phosphogypsum impacts on soil organic matter pools in a tropical Oxisol under long-term no-till conditions. *Agriculture, Ecosystems & Environment* 241(1): Pages 11-23.
4. Filho, F.G., Dias, N.S. Suddarth, S.R.P., Ferreira, J.F.S., Anderson, R.G., Fernandes, C.S. Lira, R.B., Neto, M.F., & Cosme, C.R. (2020). Reclaiming tropical saline-sodic soils with gypsum and cow manure. *Water* 12(1): 57. https://doi.org/10.3390/w12010057.
5. Groffman, P.M. (1997). Ecological constraints on the ability of precision agriculture to improve the environmental performance of agricultural production systems. *Ciba Foundation Symposium.* 210: 52-67.
6. Kebede, B., Tsunekawa, A., Haregeweyn, N., Mamedov, A.I., Tsubo, M., Fenta, A.A., Meshesha, D.T., Masunaga, T., Adgo, E., Abebe, G., & Berihun, M.L. (2020). Effectiveness of polyacrylamide in reducing runoff and soil loss under consecutive rainfall storms. *Sustainability* 12: 1597. https://doi.org/10.3390/su12041597.
7. Kim, Y.J., Choo, B.K., & Cho, J.Y. (2017). Effect of gypsum and rice straw compost application on improvements of soil quality during desalination of reclaimed coastal tideland soils: Ten years of long-term experiments. *Catena* 156: 131-138.

8. Kumar, A., & Saha, A. (2011). Effect of polyacrylamide and gypsum on surface runoff, sediment yield and nutrient losses from steep slopes. *Agricultural Water Management* 98(6): 999-1004.
9. Kushwaha, D.P., & Kumar, A. (2021). Modeling of sediment yield and nutrient loss after application of pre-determined dose of top soil amendments. *The Pharma Innovation Journal* 10(4): 1199–1206. https://www.thepharmajournal.com/archives/2021/vol10issue4/PartQ/10-6-23-477.pdf.
10. Kushwaha, D.P., Kumar, A. & Chaturvedi, S. (2021). Determining the effectiveness of carbon-based stabilizers blends in arresting soil erosion and elevating properties of Mollisols soils of North Western Himalayas. *Environmental Technology and Innovation* 23: 101768. https://doi.org/10.1016/j.eti.2021.101768.

11. Kushwaha, D.P., & Kumar, D. (2016). Suspended sediment yield modelling using artificial neural networks. Master's thesis, G.B. Pant University of Agriculture and Technology, Pantnagar - 263145 (Uttarakhand). http://krishikosh.egranth.ac.in/handle/1/5810043647.

12. Kushwaha, D.P., & Kumar, D., (2017a). Modeling suspended sediment concentration using multilayer feedforward artificial neural network at the outlet of the watershed. *International Journal of Agricultural Engineering* 10(2): 302–313. https://www.i-scholar.in/index.php/Ijae/article/view/167918.
13. Kushwaha, D.P., & Kumar, D. (2017b). Suspended Sediment Modeling with Continuously Lagging Input Variables Using Artificial Intelligence and Physics based Models. *International Journal of Current Microbiology and Applied Sciences* 6(10): 1386–1399. https://doi.org/10.20546/ijcmas.2017.610.164.
14. Lal, R. (2008). Crop residues as soil amendments and feedstock for bioethanol production. *Waste Management*. 28(4): 747–58. https://doi.org/10.1016/j.wasman.2007.09.023
15. Mal, B.C. (1994). Introduction to Soil and Water Conservation Engineering, *Kalyani Publishers*, New Delhi, India.
16. Sanders, D.W. (1986). Water erosion control. *Climatic Change*. 9: 187-194.
17. Singh, S.K., Kashyap, P.S., Kushwaha, D.P., & Tamta, S. (2020). Runoff and sediment reduction using hay mulch treatment at varying land slope and rainfall intensity under simulated rainfall condition. *International Archive of Applied Sciences and Technology* 11 (3): 144–155. https://soeagra.com/iaast/iaast_sept2020/21.pdf.
18. Waddington, D.V. (1992). Soils, Soil Mixtures, and Soil Amendments. *In*: Turfgrass, Monograph no. 32. pp. 331-383.