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Farmyard Manure and Gypsum Effects on Soil pH and EC in a Semi-Arid Region of Kandahar, Afghanistan

Karamatullah Fazil[1], Wakil Ahmad Seerat[2], Hekmatullah Nimgarri[3] and Mohmmad Hanif Haqmal[4]

[1,2]Department of Agronomy, Faculty of Plant Protection, Afghanistan National Agricultural Sciences & Technology University (ANASTU), Kandahar, Afghanistan
[3]Department of Plant Protection, Faculty of Plant Protection, ANASTU, Kandahar, Afghanistan
[4]Graduate Student of ANASTU, Kandahar, Afghanistan
Email: Karamat.fazil@anastu.edu.af (corresponding author)

ABSTRACT

Soil alkalinity and salinity are the two main problems in Kandahar province, which cause poor crop growth and yield losses. FYM and gypsum can reduce soil alkalinity and salinity and gradually fix the mentioned problems. The application effects of these amendments have not been investigated before in this area. Therefore, a field experiment was conducted in the old city of Kandahar province in 2023 to assess the impacts of FYM and gypsum on soil pH and EC in the common bean field. The study utilized a split-plot design, with three main plots varying FYM application rates (0, 5, and 10 t ha^{-1}) and three subplots representing different gypsum levels (0, 2, and 4 t ha^{-1}). Results indicated that soil pH and EC were significantly decreased with the increasing addition of FYM and gypsum at all crop growth stages. The significantly lowest pH and EC values were recorded at the harvest stage with the addition of 10-ton FYM and 4.0-ton gypsum per hectare. Except for soil EC at 30 DAS, other interaction effects between FYM and gypsum on soil pH and EC were significant at all crop growth stages. The best treatment was a combination of 10 t ha^{-1} FYM and 4.0 t ha^{-1} gypsum, followed by 5.0 t ha^{-1} FYM and 4.0 t ha^{-1} gypsum, where the lowest pH and EC values were recorded. However, these results were found from a year-long experiment conducted in the old city of Kandahar province and may be recommended.

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Introduction

FYM and gypsum are the most influential amendments for maintaining soil physical and chemical properties, and they play an essential role in reducing the high pH and EC to some extent. Applying gypsum and FYM (Farm Yard Manure) in saline fields as a remediation method can effectively alleviate plant defects caused by contaminating salts in saline soil. This approach works by mitigating the adverse impact of salts, thus enhancing the soil's suitability for plant growth (Cha-Um et al., 2011). The application of amendments like gypsum contributes calcium to the soil solution through dissolution. In the case of elemental sulfur, acids, and $Al_2(SO_4)_3$, chemical and biological reactions occur, indirectly replacing sodium from the soil exchange complex. This process aids in enhancing soil physical properties and facilitates the leaching of sodium salts. Gypsum and FYM have successfully ameliorated sodic and saline-sodic soils, effectively mitigating the adverse effects of saline soil and water (Muhammad and Khattack, 2011). The combined application of gypsum and farmyard manure has significantly improved the physical and chemical properties of saline-sodic soil. Gypsum aids in replacing sodium with calcium, thus reducing salinity, while farmyard manure contributes organic matter, enhancing soil structure, water retention, and nutrient availability. Together, they work synergistically to improve soil aeration, drainage, and overall fertility, making the soil more conducive to plant growth in saline-sodic conditions. (Bekele et al., 2019). According to the above facts and the importance of FYM and gypsum application for soil alkalinity and salinity remediation, an investigation was required in Kandahar province.

Problem Statement

Most of the Afghanistan, especially Kandahar soils, are alkaline and have salt problems in many areas. Due to the accumulation of salts and high pH, plants growth and yield are always negatively affected. Therefore, a field experiment of two amendments (FYM and gypsum), which play an essential role in reducing soil alkalinity and salinity, was carried out to find the best effects of these amendments and a suitable solution for the mentioned problems.

Research Questions

1. What will the effects of FYM be in ameliorating alkaline and salty soils?
2. What will the effects of gypsum be in the amelioration of alkaline and salty soils?
3. What will the interaction effects of these amendments be if they are used together?

Research Hypothesis

In high-pH soil, the availability of many nutrients is lower; therefore, FYM and gypsum may have synergistic effects on each other regarding the availability of nutrients and soil amelioration.

Methods and Materials

The experiment titled "Farm yard manure and gypsum effects on soil pH and EC in the semi-arid region of Kandahar, Afghanistan" utilized a split-plot design with three main plots representing different Farm Yard Manure (FYM) doses (0, 5, and 10 t ha^{-1}) and three subplots representing various gypsum doses (0, 2, and 4 t ha^{-1}), replicated three times. It aimed to assess the impact of FYM and gypsum on soil pH and electrical conductivity (EC). The soil in this experiment was sandy loam in texture, with initial pH and EC values of 8.32 and 0.56 dS/cm, respectively. FYM and gypsum were incorporated into the top 15 cm of soil before sowing the bean crop. Soil samples were collected from a depth of 0-15 cm at intervals of 30 days after sowing (DAS) and post-harvest. These samples were dried at room temperature, and subsequently, pH and EC were measured with the help of pH meter and EC meter, respectively, using a 1:2.5 soil solution. Data analysis followed the standard methodology of the OPSTAT online program, employing the F-test and critical difference (CD) values at P=0.05 to determine the significance of treatment effects, which were utilized to ascertain significant differences between treatment means.

Results

The field experiment was conducted in the old city of Kandahar province in 2023 to examine the effects of two amendments (FYM and Gypsum) on soil pH and EC in a common bean field. The experiment was carried out in a split-plot design, comprising three main plots of FYM (0, 5, and 10 t ha^{-1}) and three subplots of gypsum levels (0, 2, and 4 t ha^{-1}). The results indicated a significant decrease in soil pH with increasing FYM addition across all crop growth stages. The lowest pH value was notably recorded at the harvest stage when 10 t ha^{-1} FYM was applied. Similarly, soil pH showed a significant decrease among the gypsum levels with increasing gypsum application, reaching its lowest value at the harvest stage with 4.0 t ha^{-1} gypsum.

Interaction effects between FYM and gypsum on soil pH were significant at all crop growth stages. The best treatment was a combination of 10 t ha^{-1} FYM and 4.0 t ha^{-1} gypsum, pursued by 5.0 t ha^{-1} FYM and 4.0 t ha^{-1} gypsum, with the lowest pH value recorded (Tables 2 and 3).

Table 1: Farmyard manure and gypsum effects on soil pH and EC at different stages of growth across the treatments

Treatments	Soil pH			Soil EC (mS/cm)		
	At 30 DAS	At 60 DAS	After harvest	At 30 DAS	At 60 DAS	After harvest
Farmyard manure (FYM) levels						
FYM (0 t ha^{-1})	8.30	8.31	8.29	0.55	0.53	0.52
FYM (5 t ha^{-1})	8.14	7.90	7.71	0.53	0.50	0.48
FYM (10 t ha^{-1})	8.09	7.85	7.60	0.51	0.45	0.43
SEm±	0.01	0.011	0.009	0.003	0.007	0.003
CD (P≤0.05)	0.040	0.044	0.036	0.012	0.028	0.014
Gypsum ($CaSO_4$) levels						
Gypsum (0 t ha^{-1})	8.25	8.12	7.96	0.57	0.55	0.54
Gypsum (2.0 t ha^{-1})	8.17	7.95	7.75	0.53	0.48	0.47
Gypsum (4.0 t ha^{-1})	8.03	7.90	7.67	0.50	0.44	0.42
SEm±	0.01	0.011	0.005	0.004	0.005	0.004
CD (P≤0.05)	0.031	0.035	0.017	0.011	0.017	0.014
Interaction (FYM x Gypsum)						
CD (P≤0.05)	S#	S#	S#	NS*	S#	S#

* Non-significant; # Significant

FYM and gypsum levels influenced soil EC. The significantly lowest EC value was recorded with the addition of 10 t FYM ha^{-1} over the rest of the treatments at all crop growth stages. Increasing the dose of gypsum significantly decreased soil EC among the gypsum treatments. The significantly lowest EC value was recorded at the harvest stage of the crop with the addition of 4.0 t ha^{-1} gypsum (Table 1).

Table 2: Interaction between FYM and Gypsum on soil pH at different crop growth stages across treatments.

Farmyard manure (FYM) levels	Soil pH at 30 DAS			Soil pH at 60 DAS		
	Gypsum levels			**Gypsum levels**		
	(0 t ha^{-1})	(2.0 t ha^{-1})	(4.0 t ha^{-1})	(0 t ha^{-1})	(2.0 t ha^{-1})	(4.0 t ha^{-1})
FYM (0 t ha^{-1})	8.32	8.23	8.13	8.31	8.12	7.92
FYM (5 t ha^{-1})	8.22	8.17	8.03	8.08	7.87	7.74
FYM (10 t ha^{-1})	8.22	8.10	7.93	7.97	7.86	7.73
	SEm±	CD (P≤0.05)		SEm±	CD (P≤0.05)	
FYM at the same level as Gypsum	0.017	0.059		0.019	0.066	
Gypsum at the same level as FYM	0.017	0.059		0.019	0.066	

Table 3. Interaction between FYM and Gypsum on soil pH after crop harvest across treatments.

Farmyard manure (FYM) levels	Soil pH after harvest		
	Gypsum levels		
	(0 t ha^{-1})	(2.0 t ha^{-1})	(4.0 t ha^{-1})
FYM (0 t ha^{-1})	8.31	8.00	7.92
FYM (5 t ha^{-1})	7.89	7.65	7.60
FYM (10 t ha^{-1})	7.68	7.61	7.49
	SEm±	CD (P≤0.05)	
FYM at the same level as Gypsum	0.012	0.043	
Gypsum at the same level as FYM	0.015	0.035	

Interaction effects of gypsum and FYM on soil EC were non-significant at 30 DAS and were significant at 60 DAS and harvest. The lowest value of soil EC was registered in the treatment combination of 10 t FYM ha^{-1} and 4.0 t gypsum ha^{-1} applications (Table 4).

Table 4: Interaction between FYM and Gypsum on soil EC at 60 DAS and after harvest of the crop across treatments

Farmyard manure (FYM) levels	Soil EC at 60 DAS			Soil EC after harvest		
	Gypsum levels			**Gypsum levels**		
	(0 t ha^{-1})	(2.0 t ha^{-1})	(4.0 t ha^{-1})	(0 t ha^{-1})	(2.0 t ha^{-1})	(4.0 t ha^{-1})
FYM (0 t ha^{-1})	0.58	0.52	0.48	0.57	0.51	0.46
FYM (5 t ha^{-1})	0.55	0.51	0.43	0.54	0.49	0.40
FYM (10 t ha^{-1})	0.52	0.42	0.41	0.49	0.41	0.40
	SEm±	CD (P≤0.05)		SEm±	CD (P≤0.05)	
FYM at the same level as Gypsum	0.010	0.036		0.007	0.024	
Gypsum at the same level as FYM	0.012	0.033		0.006	0.026	

Discussion

The result of the present investigation entitled (Farm yard manure and gypsum effects on soil pH and EC in a semi-arid region of Kandahar, Afghanistan) observed that 10 t ha^{-1} FYM application reduced soil pH and EC at all stages. As the FYM supplies integrated nutrients, which increase soil fertility, it also releases some acids in the soil and causes a decrease in pH and EC. Therefore, they play a role. Comparable results were found by Rathi et al., 2020; Sundhari et al., 2018; Khalil et al., 2015 & Sarwar et al., 2011. Similarly, the high dose (4 t ha^{-1}) gypsum application reduced soil pH and EC significantly at 60 and 90 DAS and were not significant at 30 DAS. Gypsum in the early stage may not replace Na properly, and later, it has affected and become substantial. Gypsum can reduce soil pH and EC; these findings were given by Rathi et al., 2020 Zoca & Penn, 2017 Khalil et al., 2015 Brautigan et al., 2014Sarwar et al., 2011 & Khan et al., 2010.

Interaction effects between FYM and gypsum were significant on soil pH at all crop growth stages and were substantial on soil EC at 60 and 90 DAS of the crop. The lowest soil pH and EC were found at the harvest stage with the 10-t ha^{-1} application of FYM and 4-t ha^{-1} gypsum application. As the interaction effects of both amendments are synergistic and high usage levels gave better results in this study, the high level of both amendments became the best treatment. FYM and gypsum usage together found by several researchers like Rathi et al., 2020 Bekele et al., 2019 Sundhari et al., 2018 Khalil et al., 2015 Prapagar et al., 2012 Niazai et al., 2001 as the best treatment for soil alkalinity and salinity reduction.

Conclusion

An experiment on FYM and gypsum effects on soil pH and EC was carried out in the old city of Kandahar province, and it was found that FYM and gypsum play essential roles in reducing soil alkalinity and salinity. Soil application of 10 t ha^{-1} FYM and 4 t ha^{-1} gypsum significantly reduced soil pH and EC. From the results of the present study, the application of 10 t ha^{-1} FYM and 4 t ha^{-1} gypsum is recommendable. However, this research was done for one year in Kandahar province, which needs repetition for more validation and sound recommendations.

Conflict of Interest: The author(s) declared no conflict of interest.

References

Bekele, T., Lemma, W., & Solomon, T. (2019). Effect of Gypsum and Farmyard Manure on Selected Physicochemical Properties of Saline Sodic soil, at Amibara, Ethiopia. *Int. J. Nov. Res. Life Sci*, *7*, 15-26.

Brautigan, D. J., Rengasamy, P., & Chittleborough, D. J. (2014). Amelioration of alkaline phytotoxicity by lowering soil pH. *Crop and Pasture Science*, 65(12), 1278-1287.

Cha-Um, S., Pokasombat, Y., & Kirdmanee, C. (2011). Remediation of salt-affected soil by gypsum and farmyard manure-Importance for the production of Jasmine rice. *Australian Journal of Crop Science*, *5*(4), 458-465.

Khan, M. J., Jan, M. T., Khan, A. U., Arif, M., & Shafi, M. (2010). Management of saline sodic soils through cultural practices and gypsum. *Pakistan Journal of Botany*, 42(6), 4143-4155.

Khalil, A., Qadir, G., Abdul-Rehman, J., Nawaz, M. Q., Rehim, A., Jabran, K., & Hussain, M. (2015). Gypsum and farm manure application with chiseling improve soil properties and performance of fodder beet under saline-sodic conditions. *International Journal of Agriculture and Biology*, 17(6).

Muhammad, D. O. S. T., & Khattak, R. A. (2011). Wheat yield and chemical composition as influenced by integrated use of gypsum, pressmud and FYM in saline-sodic soil. *Journal of the Chemical Society of Pakistan*, 33(1), 82-89.

Niazi, B. H., Ahmed, M., Hussain, N., & Salim, M. (2001). Comparison of sand, gypsum and sulphuric acid to reclaim a dense saline sodic soil. *International Journal of Agriculture and Biology*, 3(3), 316-318.

Prapagar, K., Indraratne, S. P., & Premanandharajah, P. (2012). Effect of soil amendments on reclamation of saline-sodic soil.

Rathi, D., Antil, R. S., Sharma, M. K., & Sheoran, S. (2020). Effect of fym and gypsum on distribution of micronutrient in soil under sodic water irrigation: A long-term study. *Journal of the Indian Society of Soil Science*, 68(1), 100-106.

Sarwar, G., Ibrahim, M., Tahir, M. A., Iftikhar, Y., Haider, M. S., Noor-Us-Sabah, N. U. S., ... & Zhang, Y. S. (2011). Effect of compost and gypsum application on the chemical properties and fertility status of saline-sodic soil. *Korean Journal of Soil Science and Fertilizer*, 44(3), 510-516.

Sundhari, T., Thilagavathi, T., Baskar, M., Thuvasan, T., & Eazhilkrishna, N. (2018). Effect of gypsum incubated organics used as an amendment for sodic soil in green gram. *International Journal of Chemical Studies*, 6, 304-308.

Zoca, S. M., & Penn, C. (2017). An important tool with no instruction manual: a review of gypsum use in agriculture. *Advances in Agronomy*, 144, 1-44.