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# Investigating Post-Harvest Soil Properties of Summer Greengram (*Vigna radiata* L.) under the Influence of Sulphur, Organic Manures and Biofertilizers

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**ABSTRACT: A field experiment was conducted at Soil and Water Management, NARP Phase-II (NARP Farm), Cotton Research Sub Station, N.A.U., Achhalia (South Gujarat Agro Climatic Zone-II) during summer season of 2021 to investigated the impact of sulphur, organic manure and biofertilizers on soil properties after harvest of greengram. Twelve treatment combinations were tested in a factorial randomized block design with three replications. Sulphur levels (20kg/ha, 30kg/ha, 40kg/ha) were combined with organic manure (5 t FYM/ha, 1 t vermicompost/ha) and biofertilizers (control, PSB + *Rhizobium* inoculation). Greengram variety GM-6 was sown, and recommended practices were followed. Soil samples were analyzed for various parameters using established methods. Sulphur application at 40 kg/ha significantly improved organic carbon, available nitrogen, phosphorus, potassium, sulphur and iron in soil. Organic manure, especially FYM at 5 t/ha, enhanced organic carbon, available nitrogen, phosphorus, potassium and sulphur. Biofertilizer inoculation with PSB and *rhizobium* significantly increased organic carbon, available nitrogen, phosphorus, potassium, sulphur and zinc in soil. Interaction effects revealed that combining sulphur, organic manure and biofertilizer synergistically increased available sulphur in soil. This study underscores the importance of sulphur, organic manure and biofertilizers in enhancing soil fertility.**

**Keywords:** Greengram, sulphur, organic manures, biofetilizers, soil properties.

## INTRODUCTION

Greengram (*Vigna radiata* L.) is a pivotal pulse crop in India, known for its short growth cycle, high yield potential and exceptional nutritional value as food, feed and forage. It covers approximately 34.37 lakh hectares of land nationwide, producing 17.83 lakh tonnes, averaging 519 kg per hectare. In Gujarat alone, it occupies 0.90 lakh hectares, yielding 0.55 lakh tonnes, with an average productivity of 611 kg per hectare in 2019-20 (Anonymous., 2020). Sulphur plays a significant role in pulse crop growth, particularly in protein and vitamin formation. It also enhances nodulation in legumes, thereby improving nitrogen fixation. Throughout the greengram growth cycle, sulphur influences various aspects, from plant height to grain yield (Kumar *et al*., 2012). Sulphur is crucial in amino acids such as cysteine, methionine and cistin, vital for protein synthesis in plants, contributing to pulse and oilseed quality. Combining nutrient application with organic manure, like farmyard manure (FYM) and vermicompost, can act as a source of nutrients and complexing agents. These materials form the stable complexes with native nutrients, preventing their loss and enhancing nutrient efficacy. Integrated Plant Nutrient Systems (IPNS) improve fertilizer efficiency, promoting sustainable crop production. Microorganisms, including bacteria and fungi, solubilize phosphorus, making it accessible to plants (Sharma *et al*., 2000). Certain soil bacteria and fungi, such as *Bacillus*, *Pseudomonas*, *Aspergillus* and *Penicillium*, which are convert insoluble phosphates into soluble forms through organic acid secretion. This process enhances phosphorus uptake, outperforming chemical fertilizers. *Rhizobium* inoculation is a cost-effective and safe method for nitrogen supply in greengram, facilitating biological nitrogen fixation and increasing nitrogen availability.

## MATERIALS AND METHODS

A field experiment was conducted at Soil and Water Management, NARP Phase – II (NARP Farm), Cotton Research Sub Station, N.A.U., Achhalia (South Gujarat Agro Climatic Zone - II) (AES- I) during summer season of 2021 to Investigate Post-Harvest Soil Properties of Summer Greengram (*Vigna radiata* L.) under the Influence of Sulphur, Organic Manures and Biofertilizers. The soil of the experimental field was clay in texture medium in available nitrogen, medium in phosphorus and high in available potassium. Total twelve treatment combinations comprising of three sulphur levels [20 kg S/ha ($S_1$), 30 kg S /ha ($S_2$) and 40 kg S/ha ($S_3$)] combined with two organic manure levels [5 t FYM/ha ($O_1$) and 1 t vermicompost/ha ($O_2$)] along with two levels of bio-fertilizer [control ($B_0$) and PSB +

*Rhizobium* inoculation ($B_1$)] were tested in factorial randomized block design with three replications. Greengram variety GM-6 was sown by opening of furrow at a distance of 30 × 10 cm. The full dose of fertilizers was applied according to the treatments manually before sowing the seeds. Biofertilizer was applied as seed inoculation (each 10 ml/kg). The phosphorus was applied as DAP. All the recommended cultural practices and plant protection measures were followed throughout the experimental periods.

Chemical studies about soil properties *viz.* Soil EC, pH, bulk density, available organic carbon and available nutrients (N, P, K, S, Fe, Mn, Zn and Cu) were determined as per different methods (Table 1). The data were analyzed statistically by adopting the standard procedures described by Panse and Sukhatme (1985). The purpose of the analysis of variance was to determine the significant effect of treatments on post harvest soil properties.

**Table 1: Methods followed for soil sample analysis.**

| Parameter | Method | References |
|---|---|---|
| pH | Potentiometric | Jackson (1979) |
| EC | Schofield method | Jackson (1979) |
| Bulk density | Standard core method | Black *et al.* (1965) |
| Organic carbon | Walkley and Black's method | Walkley and Black (1934) |
| Available N | Alkaline permanganate oxidation | Subbiah and Asija (1956) |
| Available $P_2O_5$ | Spectro photometric (0.5M $NaHCO_3$, pH 8.5, blue colour) | Olsen *et al.* (1954) |
| Available $K_2O$ | Flame photometric (Neutral N $NH_4OAc$) | Jackson (1979) |
| Available sulphur | 0.15% $CaCl_2$ extractable method | Chopra and Kanwar (1976) |
| DTPA extractable Fe, Zn, Mn and Cu | Atomic absorption spectrophotometer method (DTPA) | Lindsay and Norvell (1978) |

## RESULTS AND DISCUSSION

*A. Effect of Sulpur*

Perusal of the data (Table 2) revealed that organic carbon content and available nutrients (N, $P_2O_5$, $K_2O$, S and Fe) in soil significantly influenced by the effect of sulphur application.

The application of sulphur @ 40 kg/ha resulted in a substantial and statistically significant increase in soil organic carbon content as compared to the other sulphur application levels following the harvest. Furthermore, the levels of available nitrogen, phosphorus, potassium, sulphur and iron in the soil, when sulphur was applied @ 40 kg/ha, exhibited significantly higher values compared to the corresponding nutrient levels observed under different sulphur application rates. These findings emphasize the notable impact of the 40 kg/ha sulphur application on both soil organic carbon content and the availability of essential nutrients, suggesting its effectiveness in enhancing soil quality and nutrient provision for subsequent crops. The observed rise in available nitrogen in soil following sulphur treatment aligns with expectations, as sulphur is an essential component of enzymes crucial for efficient nitrogen uptake. A deficiency in sulphur can significantly disrupt nitrogen metabolism. Consequently, the post-harvest soil's available phosphorus content also exhibited improvement as a result of sulphur addition. This increase in available phosphorus levels can be attributed to the positive impact of sulphur application. Furthermore, the available sulphur status of the soil after greengram harvest displayed enhancement due to sulphur application, which could be attributed to the residual effects of the sulphur fertilizer. This suggests that the prior application of sulphur continued to positively influence soil sulphur availability even after the main crop cycle. These findings underscore the intricate relationships between sulphur, nitrogen, phosphorus, and sulphur's lasting influence on soil nutrient dynamics in the context of greengram cultivation. Similar findings were also reported by Bera and Gosh (2015); Kokani *et al.* (2015); Kudi *et al.* (2018).

The various levels of sulphur application did not manifest their significant influence on soil EC, pH, bulk density, available Mn, available Zn and available Cu after the harvest of greengram.

*B. Effect of Organic Manure*

The data analysis indicated that soil parameters such as organic carbon and available nutrients (nitrogen, phosphorus, potassium and sulphur) were significantly impacted by the application of organic manures. Specifically, these parameters exhibited notable variations due to the influence of organic manure treatments. Conversely, certain other soil characteristics including EC, pH, bulk density and the availability of micro-nutrients did not exhibit significant differences as a result of the organic manure treatments. These parameters remained relatively consistent and were not significantly affected by the application of organic manures (Table 2).

The application of FYM @ 5 t/ha led to a significantly higher content of organic carbon in the soil compared to the application of Vermicompost @ 1 t/ha. This increase in organic carbon can be attributed to the well-documented process whereby heterotrophic microbes produce extracellular enzymes that break down organic matter into its fundamental organic components. These simpler compounds are then utilized by other microorganisms for their growth and metabolic processes. Consequently, the decomposition of microbial biomass contributes to the enrichment of soil with organic carbon. The significant difference in organic carbon content observed at the time of harvest underscores the effectiveness of FYM application in this regard. These findings are consistent with previous studies by Kokani *et al*. (2015) ; Kharadi and Bhuriya

(2020).

Furthermore, the application of FYM @ 5 t/ha resulted in significantly higher levels of available nitrogen, phosphorus, potassium and sulphur in the soil compared to the application of Vermicompost @ 1 t/ha. The increase in available nitrogen due to organic manure treatment can be attributed to the introduction of nitrogen through the mineralization of organic matter. Additionally, the mineralization of FYM played a vital role in maintaining adequate phosphorus, potassium and sulphur levels in the soil. These findings align with the research conducted by Ranpariya *et al*. (2017); Karnavat *et al*. (2018).

*C. Effect of Biofertilizer*

The data analysis revealed that the application of biofertilizer inoculation had a significant impact on several soil parameters, including organic carbon and available nutrients (nitrogen, phosphorus, potassium, available sulphur and zinc) in the soil following the harvest. The application of biofertilizer inoculation did not exert a significant influence on several key soil parameters following the harvest. Specifically, soil EC, pH, bulk density and the availability of iron, manganese and copper were found to remain relatively unchanged and were not significantly affected by the biofertilizer inoculation. Specifically, the soil's organic carbon content exhibited a significant increase when seeds were inoculated with both PSB and *Rhizobium* (each @ 10 ml/kg seed) as compared to the control after the harvest. Moreover, the availability of essential nutrients such as nitrogen, phosphorus, potassium, sulphur and zinc in the soil was significantly higher in treatment $B_1$ as compared to the control. The observed increase in available nitrogen under the biofertilizer treatment aligns with expectations, as it is a result of the enhanced mobilization of nitrogen and the fixation of atmospheric nitrogen by *Rhizobium*. Similarly, the increased availability of phosphorus in the biofertilizer-inoculated treatment is attributed to the solubilization effect of phospho-bacteria, which converts previously unavailable phosphorus into a form that is readily accessible to plants. The augmented availability of potassium and sulphur in the biofertilizer-inoculated treatment can be attributed to the increased mobilization of these nutrients within the soil. These findings are in line with previous research conducted by Jat *et al.* (2012) and Patel *et al.* (2016), further emphasizing the positive impact of biofertilizer inoculation on soil nutrient availability and organic carbon content, which can contribute to enhanced crop growth and productivity.

**Table 2: Post harvest soil properties as influenced by sulphur, organic manures and biofertolizers.**

| Treatments | EC (ds/m) | pH | BD ($Mg/m^3$) | OC (%) | Available nutrients | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | N (kg/ha) | $P_2O_5$ (kg/ha) | $K_2O$ (kg/ha) | S (mg/kg) | Fe (mg/kg) | Mn (mg/kg) | Zn (mg/kg) | Cu (mg/kg) |
| **Sulphur (S)** | | | | | | | | | | | | |
| $S_1$-20 kg S/ha | 0.281 | 7.13 | 1.281 | 0.321 | 265.5 | 31.92 | 293.0 | 10.74 | 21.07 | 24.10 | 0.99 | 1.15 |
| $S_2$-30 kg S/ha | 0.277 | 7.09 | 1.268 | 0.347 | 279.1 | 34.51 | 313.9 | 13.90 | 22.16 | 24.24 | 0.99 | 1.17 |
| $S_3$-40 kg S/ha | 0.275 | 7.00 | 1.267 | 0.388 | 309.9 | 38.74 | 347.6 | 20.48 | 23.20 | 24.30 | 1.00 | 1.21 |
| S.Em.± | 0.004 | 0.06 | 0.015 | 0.005 | 3.62 | 0.52 | 3.99 | 0.23 | 0.20 | 0.30 | 0.01 | 0.02 |
| CD at 5% | NS | NS | NS | 0.015 | 10.6 | 1.53 | 11.7 | 0.68 | 0.59 | NS | NS | NS |
| **Organic manures (O)** | | | | | | | | | | | | |
| $O_1$-FYM 5 t/ha | 0.280 | 7.02 | 1.269 | 0.363 | 301.1 | 37.19 | 336.0 | 17.97 | 22.29 | 24.44 | 1.00 | 1.19 |
| $O_2$-Vermicompost 1 t/ha | 0.276 | 7.12 | 1.275 | 0.340 | 268.7 | 32.92 | 300.4 | 12.11 | 21.99 | 23.98 | 0.98 | 1.17 |
| S.Em.± | 0.003 | 0.05 | 0.012 | 0.004 | 2.96 | 0.43 | 3.26 | 0.19 | 0.17 | 0.25 | 0.01 | 0.01 |
| CD at 5% | NS | NS | NS | 0.012 | 8.7 | 1.25 | 9.6 | 0.56 | NS | NS | NS | NS |
| **Bio-fertilizer (B)** | | | | | | | | | | | | |
| $B_0$-No inoculation | 0.280 | 7.09 | 1.281 | 0.332 | 278.4 | 34.01 | 310.2 | 14.48 | 22.11 | 24.17 | 0.94 | 1.19 |
| $B_1$-PSB + *Rhizobium* inoculation | 0.276 | 7.06 | 1.263 | 0.372 | 291.3 | 36.10 | 326.2 | 15.60 | 22.17 | 24.25 | 1.04 | 1.17 |
| S.Em.± | 0.003 | 0.05 | 0.012 | 0.004 | 2.96 | 0.43 | 3.26 | 0.19 | 0.17 | 0.25 | 0.01 | 0.01 |
| CD at 5% | NS | NS | NS | 0.012 | 8.7 | 1.25 | 9.6 | 0.56 | NS | NS | 0.03 | NS |
| **Interaction** | | | | | | | | | | | | |
| S×O | | | | | | | | | | | | |
| S.Em.± | 0.005 | 0.09 | 0.021 | 0.007 | 5.12 | 0.74 | 5.64 | 0.33 | 0.29 | 0.43 | 0.02 | 0.02 |
| CD at 5% | NS | NS | NS | NS | 15.00 | NS | NS | 0.97 | NS | NS | NS | NS |
| S×B | | | | | | | | | | | | |
| S.Em.± | 0.005 | 0.09 | 0.021 | 0.007 | 5.12 | 0.74 | 5.64 | 0.33 | 0.29 | 0.43 | 0.02 | 0.02 |
| CD at 5% | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| O×B | | | | | | | | | | | | |
| S.Em.± | 0.004 | 0.07 | 0.017 | 0.006 | 4.18 | 0.60 | 4.61 | 0.27 | 0.23 | 0.35 | 0.02 | 0.02 |
| CD at 5% | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| S×O×B | | | | | | | | | | | | |
| S.Em.± | 0.007 | 0.13 | 0.029 | 0.010 | 7.24 | 1.04 | 7.98 | 0.47 | 0.40 | 0.61 | 0.03 | 0.03 |
| CD at 5% | NS | NS | NS | NS | NS | NS | NS | 1.37 | NS | NS | NS | NS |
| CV(%) | 4.65 | 3.16 | 3.97 | 4.96 | 4.40 | 5.16 | 4.34 | 5.37 | 3.17 | 4.34 | 4.71 | 4.84 |
| **Initial status** | 0.265 | 7.23 | 1.310 | 0.350 | 282.2 | 36.01 | 318.9 | 10.96 | 19.51 | 22.30 | 0.98 | 1.07 |

*D. Interaction Effect*

The interaction effects of Sulphur and organic-manure treatments displayed significant influences on the available nitrogen and available sulphur in the soil following the harvest of greengram, as illustrated in Fig. 1 and 2, respectively. However, when considering the interaction effects of Sulphur, organic-Manure and Biofertilizer treatments, a significant impact was observed specifically on the available sulphur (S) status in the soil after the greengram harvest, as depicted in Fig. 3.

In the context of the S×O interaction, it was noted that the combination $S_3O_1$, which involved the application of 40 kg S/ha and 5 t FYM/ha, recorded significantly higher levels of available nitrogen and available sulphur in the soil post-harvest compared to the other treatment combinations. Regarding the interaction between S×O×B, the combination $S_3O_1B_1$, which entailed the application of 40 kg S/ha, 5 t FYM/ha, along with PSB + *Rhizobium* inoculation, exhibited significantly elevated levels of available sulphur in the soil after the greengram harvest. Notably, this combination's performance was on par with $S_3O_1B_0$, $S_2O_1B_1$ and $S_3O_2B_1$ combinations. These results underscore the synergistic effects of combining organic manure and biofertilizer inoculation with sulphur application, leading to enhanced availability of sulphur in the soil post-harvest.

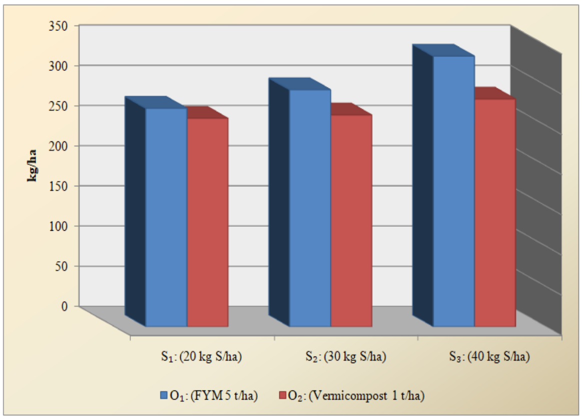


**Fig. 1.** Available nitrogen in soil after harvest as influenced by S × O interaction.

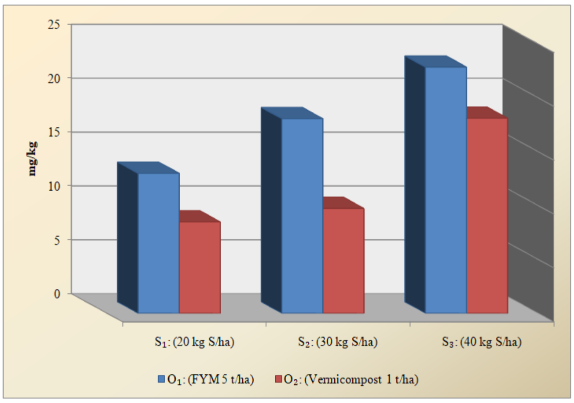


**Fig. 2.** Available sulphur in soil after harvest as influenced by S × O interaction.

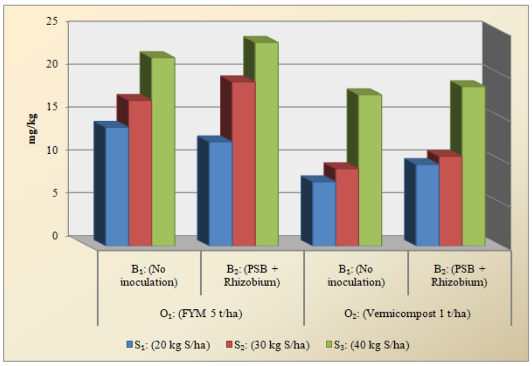


**Fig. 3.** Available sulphur in soil after harvest as influenced by S × O × B interaction.

## CONCLUSIONS

The results of this study highlight the significant influence of sulphur, organic manures and biofertilizers on post-harvest soil properties in summer greengram cultivation. Higher sulphur application, especially in combination with organic manures and biofertilizers, positively impacted nutrient availability and soil characteristics. These findings underscore the potential of integrated nutrient management strategies (40 kg S/ha, 5 t FYM/ha along with PSB + *Rhizobium* inoculation) to enhance soil fertility and greengram productivity.

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**Conflict of Interest.** None.

## REFERENCES


Anonymous (2020). Kharif Pulses Prospects -2020-21 DPD, Bhopal

Bera, M. and Ghosh, G. K. (2015). Efficacy of sulphur sources on green gram (*Vigna radiata* L.) in red and lateritic soil of West Bengal. *International Journal of Plant, Animal and Environmental Sciences* 5(2): 109-116.

Black, C. A., Evans, D. D., Ensminger, L. E., White, J. L. and Cleark, F. E. (1965). *Methods of soil analysis-part 2: Chemical and microbial Properties, American society of agronomy, Inc., Publisher, Madison, Wisconsin, USA.*

Chopra, S. L. and Kanwar, J. S. (1976). *Analytical agricultural chemistry. Kalyani publishers, New Delhi.*

Jackson, M. L. (1979). Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd.

Jat, S. L., Prasad, K. and Parihar, C. M. (2012). Effect of organic manuring on productivity and economics of summer mungbean. *Annals of Agricultural Research* (New-Series) *33*(1&2), 17-20.

Karnavat, R., Pavaya, R. P., Malav, J. K., Chaudhary, N., Patel, I. M. and Patel, J. K. (2018). Effect of FYM, phosphorus and PSB on yield, nutrient content and uptake by greengram (*Vigna radiata* (L.) Wilckzek) on loamy sand. *International Journal of Chemical Studies*, *6*(2), 1026-1029.

Kharadi, R. R. and Bhuriya, K. P. (2020). Effect of organic and inorganic fertilizers on soil chemical properties of summer green gram. *Journal of Pharmacognosy and Phytochemistry*, 9(2): 432-435.

Kokani, J. M., Shah, K. A., Tandel, B. M. and Bhimani, G. J. (2015). Effect of FYM, phosphorus and sulphur on yield of summer blackgram and post-harvest nutrient status of soil. *The Bioscan*, *10*(1), 379-383.

Kudi, S., Swaroop, N., David, A. A., Thomas, T., Hasan, A. and Rao, S. (2018). Effect of different levels of sulphur and zinc on soil health and yield of greengram (*Vigna radiata* L.) Var. Patidar-111. *Journal of Pharmacognosy and Phytochemistry*, *7*(3), 2271-2274.

Kumar, R., Singh, Y. V., Singh, S., Latare, A. M., Mishra, P. K. and Supriya. (2012). Effect of phosphorus and sulphur nutrition on yield attributes, yield of mungbean (*Vigna radiata* L. Wilczek). *Journal of Chemical and Pharmaceutical Research*, *4*(5), 2571-2573.

Lindsay, W. L. and Norvell, W. A. (1978). Development of a DTPA micronutrient soil test for zinc, iron, manganese and copper. *Soil Sci. Amer. J.*, *42*, 421-508.

Olsen, S. R., Cole, C. V., Watanabe, F. S. and Dean, L. A. (1954). *Estimation of available phosphorus in soils by extraction with sodium bicarbonate. USDA Circular 939. U. S. Government Printing Office, Washington D. C.*

Panse, V. G. and Sukhatme, P. V. (1967). *Statistical Methods for Agricultural Workers. ICAR, New Delhi.*

Patel, A. R., Patel, D. D., Patel, T. U. and Patel, H. M. (2016). Nutrient management in summer green gram (*Vigna radiata* L.). *International Journal of Applied and Pure Science and Agriculture*, *2*(2), 133-142.

Ranpariya, V. S., Polara, K. B., Hirpara, D. V. and Bodar, K. H. (2017). Effect of potassium, zinc and FYM on content and uptake of nutrients in seed of summer greengram (*Vigna radiata* L.) and post-harvest soil fertility under medium black calcareous soil. *International Journal of Chemical Studies*, *5*(5), 1055-1058.

Sharma, N. P., Bali, S. V. and Gupta, D. K. (2000). Crop yield and properties of Inceptisol as influenced by residue management under rice-wheat sequence. *J. Indian Soc. Soil Sci.*, *48*(3), 506-509.

Subbiah, B. V. and Asija, G. L. (1956). A rapid procedure for the estimation of available nitrogen in soil. *Curr. Sci*., *25*, 259.

Walkley, A. and Black, I. A. (1934). An examination of the kjeldal method for determining soil organic matter, *Soil Science*, *37*, 29-38.

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