Plant Archives Vol. 23, No. 1, 2023 pp.269-273 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2023.v23.no1.045

SHEER DISTRIBUTION OF PHYSICO-CHEMICAL CHARACTERISTICS OF DUBAHAR BLOCK SOILS OF DISTRICT BALLIA, UTTAR PRADESH, INDIA

Prinsu Singh[1], Anil Kumar Singh[1*], Ashok Kumar Singh[1] and Sandip Kumar Gupta[2]

[1]Department of Soil Science and Agricultural Chemistry, Sri Murli Manohar Town Post Graduate College, Ballia, Uttar Pradesh, India

[2]Department of Soil Science and Agricultural Chemistry, Jananayak Chandrashekhar University Ballia, Uttar Pradesh, India

*Corresponding author; Email: singhanil80@gmail.com

Anil Kumar SinghORCIDID Number:0000-0001-9240-9193

(Date of Receiving : 22-12-2022; Date of Acceptance : 01-03-2023)

ABSTRACT

The present study was undertaken to find out the sheer distribution of physico-chemical characteristics of Dubahar block soils of district Ballia, Uttar Pradesh. To do so depth wise soil samples from two profiles were collected from villages Nagva (Pedon - 1) and Dubahar (Pedon -2) (one profile from each village). Standard analysis methods were followed for the analysis of the physico-chemical characteristics of the soils. Results revealed that the pH of the soils was found to be moderately acidic to slightly alkaline (6.3 to 7.7) in reaction whereas soil EC was found to be in normal range (0.889 to 1.017). Soil organic carbon content varied between low to high range (0.23 to 0.90%) whereas calcium carbonate content was recorded (0.27 to 2.92%). The available N, P, K, and S content in soil varied from (169.6 to 291.7 kg ha^{-1}), (6.23 to 15.28 kg ha^{-1}), (324.8 to 548.6 kg ha^{-1}) and (5.0 to 21.2 mg kg^{-1}), respectively. The bulk density of soil ranged between (1.44 to 1.58 Mg m^{-3}) and water holding capacity (30.0 to 37.8%). The textural class of the soil was found to be clayey to clay loamy.

Keywords: Available primary nutrients distribution, secondary nutrients contents, soil texture, and Soil organic carbon.

Introduction

Soil profile study is considered to be one of the most important aspects for information on soil formation and its characteristics. In general, the horizons property of a soil profile follows the topography of a landscape. Designation of horizon boundaries comes from soil colour, texture, structure, consistence, root distribution, effervescence, rock fragments, and reactivity measurements. A profile characteristic of soil provides the basic information required in planning an efficient system of soil and water management in general, and for dryland conditions in particular. The amount of water stored in a profile depends on soil physical properties like depth, texture, bulk density, aggregation etc. (Patgiri *et al.*, 1993). Soil study and their analysis have played a historical role in soil fertility maintenance and sustainability in agriculture, whereas imbalance and inadequate fertilizer use causes low efficiency of other agro inputs. The efficiency of chemical fertilizer nutrients declining tremendously in intensive agriculture day by day over the last decades. Sustainability of the soil is the need of today's agriculture (Singh *et al.*, 2014).Soil test-based fertility management has been effective tool for increasing the productivity of cultivated soils that have a high degree of spatial variability resulting from the combined effects of physical, chemical and biological processes (Govaerts, 1998). In India, these include the prevalence of small holding systems of farming as well as the lack of infrastructural facilities for extensive soil testing (Sen *et al.*, 2008). Moreover, the changes in the climate due to global warming and ever-dwindling arable land due to population pressure are increasing the strain on available resources for sustainable food production (Deka *et al.*, 2018). Therefore, the present investigation was undertaken to study the physico-chemical characteristics of the soils of Dubahar block of district Ballia, Uttar Pradesh for optimum utility and management of soil.

Materials and Methods

Study area

District Ballia is the easternmost part of the state of Uttar Pradesh, India, which lies between the parallel of 25°23' and 26°11' North latitude and 83° 38' and 84°39' East longitude and 59.29 m to 64.92 meters above the sea level. The mean annual rainfall ranges from 950-1150 mm.

Soil sampling and physico-chemical analysis

Soil samples were collected from two village of Dubahar block viz. Nagva and Dubahar of the area from the well-cultivated field on 26 July, 2019. The sites were chosen carefully taking into consideration the ground cover, micro relief, degree of erosion, surface drainage, proximity to trees and all other factors likely to affect the soil in comparison with the normal type. Nagva village, soil sampling was done from soil depth 0-15, 15-30, 30-45, 45-60, 60-75, 75-90, 90-105,105-120, 120-135 and 135-150 cm whereas Dubahar village, samples were collected from 0-30, 30-45, 45-60, 60-75, 75-90, 90-115, 115-137, 137-155 cm soil depth. About 2 kg of soil from each depth were obtained in clean polythene bags separately. Soil samples were collected using clean khurpi, scale and bucket. Soil pH was determined in a 1:2.5 soil water suspension using a glass electrode. Electrical conductivity (EC) was determined in 1:2.5 soil-water supernatant using conductivity bridge and expressed as dSm^{-1} (Jackson, 1973). The rapid titration method used to determine soil organic carbon (SOC) (Walkley and Black, 1934). Available nitrogen (N) was determined using the alkali extractable method (Subbiah and Asija, 1956), available phosphorus (P) by Olsen's *et al.* (1954) and available potash (K) through ammonium acetate extractable method as described by Muhr *et al.* (1965). Available sulphur (S) was extracted using a 0.15 per cent calcium chloride solution (Williams and Steinbergs, 1969). Calcium carbonate ($CaCO_3$) was determined using rapid titration method (Puri, 1930). Soil bulk density and water holding capacity was determined using the method as described by Kanwar and Chopra (1998). Soil texture (sand, silt and clay %) was determined using the Hydrometer method (Bouyoucos, 1962).

Results and Discussion

Soil pH and EC

The soil pH data of both the pedons showed wide variation with soil depth (Table 1 and 2). Pedon-1 soil showed higher pH 7.5 at 105 to 120 cm soil depth whereas lowest pH 6.3 at 120 to 135 cm soil depth. However, pedon-2 showed lower pH 6.6 at 0 to 30 cm depth and higher pH 7.7 at 137- 155 cm soil depth. The soil pH showed slightly acid to mildly alkaline in both the pedon. EC of the soil found to be under the normal range (0.889 to 1.017 dSm^{-1}) in both the pedons of Dubahar block. Similarly, Gupta *et al.* (2019)reported EC in the normal rangefound to be safe for crop growth in the soils of Bairia block.

Soil organic carbon

The depth-wise distribution of soil organic carbon revealed variation for both the pedons (Table 1 and 2). The soil organic carbon content percent varied between low to medium range (0.23% to 0.90%) which decreased with increasing soil depth in both the pedons. Organic carbon content in surface soil (0 to 15 cm) of pedon-1 was observed to be 0.90 % and in sub-surface soil (135 to 150 cm depth) it was 0.27% whereas in pedon 2 organic carbon content was found to be 0.72 % in surface soil (0 to 30 cm) and 0.23 % in sub-surface soil (137 to 155 cm). A similar trend of decreasing soil carbon content with increasing soil depth was reported by Singh *et al.* (2019).

Available N content in soil

The available N content in pedon-1 soil was found to be maximum 260.29 kg ha^{-1} in surface soil (0 to 15 cm) and minimum 169.61 kg ha^{-1} was recorded in the sub-surface (120 to 135 cm soil depth). Pedon-2 showed maximum available N291.65 kg ha^{-1} in surface horizon (0 to 30 cm depth) whereas minimum 185.02 kg ha^{-1} in lower horizon (137 to 155 cm depth) Table 1 and 2. The available N content exhibited a decreasing trend with increasing soil depths in both the pedon. Surface soil has shown greater available N value might be possibly due to the accumulation of natural vegetation residues and application of organic materials. The available N in soil decreased with surface to subsurface horizon due to decreased organic carbon with depth Prasuna Rani *et al*. (1992) and Hijbeek *et al*. (2018).

Available P content in soil

Similar to the N content, the higher available P content was observed in surface soil than subsurface. The available P in pedon-1 was found to be maximum 15.28 kg ha^{-1} in the surface horizon (0 to 15 cm) and minimum 8.37 kg ha^{-1} in the sub-surface horizon (135 to 150 cm depth). In the pedon-2 maximum P 8.90 kg ha^{-1} was recorded in the upper horizon (0 to 30 cm) and a minimum of 6.00 kg ha^{-1} in the lower horizon (115 to 137 cm soil depth) Table 1 and 2. Available P content in Pedon-1 decreased with increasing soil depth whereas in pedon -2 irregular patterns was recorded. Similarly, (Kirmani 2004 and Bhat, 2010) observed irregular P content in soils with depths due to changes in weathering intensity of phosphatic minerals in soils.

Available K content in soil

The available K content in soils of both the pedons ranged between (324.80 to 548.60 kg ha^{-1}) Table 1 and 2. The available K content in soils of pedon-1 was found to be 548.60 kg ha^{-1} at (0 to 15 cm depth) surface horizon and 356.40 kg ha^{-1} at subsurface horizon (135 to 150 cm depth). The pedon-2 showed maximum K 369.60 kg ha^{-1} at (0 to 30 cm) upper soil whereas minimum K 324.8 kg ha^{-1} at (137 to 155 cm) lower soil depth. The amount of available K content followed a regular trend of decreasing with increasing depth in both pedons. The higher amount of available K content in surface soils was might be due to greater exposure of minerals to weathering agents at surface than subsurface soils. Similar findings have been observed by Naik (2014) and Ho *et al*. (2019).

Available S content in soil

Available S content in soil at depth 0 to 150 cm horizons ranged between 11.28 to 5.0 mg kg^{-1} in pedon-1 and in pedon-2 it ranged from 12.24 to 9.5 mg kg^{-1} at depth 0 to 155 cm depth (Table 1 and 2). The amount of available sulphur decreased with increasing the soil depth irrespective the pedon. A greater amount of available sulphur was found in surface soil than in sub-surface soil resulting from its recycling over the years by plants and subsequent organic matter accumulation Bhatnagar *et al*. (2003) and Devi *et al*. (2015).

Exchangeable calcium and magnesium

The amount of exchangeable calcium and magnesium data (pedon-1 and 2) are presented in Table 1 and 2. The maximum exchangeable calcium content in pedon-1 was found to be 14.30 [cmol (p+) kg^{-1}] at 0 to 15 cm soil depth and minimum 8.00 [cmol (p+) kg^{-1}] at 135 to 150 cm soil depth. In pedon-2 maximum exchangeable calcium content 28.00 [cmol (p+) kg^{-1}] was recorded at (0-30 cm) whereas minimum 22.90 [cmol (p+) kg^{-1}] at (137 to 155 cm soil depth. Pedon-2 showed a high amount of exchangeable calcium compared to pedon-1. Exchangeable Ca content decreased with increasing soil depth. The amount of exchangeable magnesium in pedon-1 resulted highest 8.60 [cmol (p+) kg^{-1}] in the surface soil (0 to 15 cm soil depth) and lowest exchangeable magnesium 5.10 [cmol (p+) kg^{-1}] in sub-surface soil (135-150 cm depth). Pedon-2 recorded maximum 21.25 [cmol (p+) kg^{-1}] at (75-90 cm) depth soil whereas minimum 16.2 [cmol (p+) kg^{-1}] at (90- 115 cm) depth. The exchangeable calcium and magnesium content did not follow any regular pattern with respect to depth might be due to plant and recycling of unusual amount of Ca^{2+} and Mg^{2+} (Raghuwanshi *et al.* 2011).

Soil calcium carbonate ($CaCO_3$) content

The depth-wise distribution of soil calcium carbonate was measured for both the pedons and presented in Table 1 and 2. Results revealed that pedon-1 showed high amount of calcium carbonate (2.92%) in surface soil (0 to 15 cm) and a low content of calcium carbonate (0.27%) in (135-150 cm) soil horizon. Pedon-2 showed 2.87 % $CaCO_3$ in (0-15 cm) soil and 1.05 % in (137-155 cm) soil. Similar to Ca and Mg content, calcium carbonate content also not followed a regular pattern due to the presence of free calcium and the calcareous nature of the soils. Similar results have been demonstrated by Surya (2014).

Soil bulk density (BD) and water holding capacity (WHC)

Soil bulk density and water holding capacity are important physical properties of soil which was measured in both the pedon soil samples and data are depicted in Fig.-1. The pedon-1 soil bulk density value varied from 1.44 Mg m^{-3} (137 to 155 cm) to 1.58 Mg m^{-3} (15 to 45 cm) whereas in pedon-2, the lowest BD 1.45 Mg m^{-3} (137 to 155 cm) and highest 1.53 (75 to 90 cm) soil. These results are in close conformity with the findings of Reddy and Naidu (2016).

The pedon-1 showed higher WHC36.35% in surface soil (0 to 15 cm) and lower value 35.2 % in sub surface soil (135 to 150 cm) though the differences were very minute whereas in pedon -2 WHC was 34.20% in upper horizon (0 to 30 cm) and 30.00% in lower horizon (137 to 155 cm). The per cent WHC decreased with increasing depth in pedons-2 whereas pedon -1 showed irregular trend with depth. Similar results have been reported by Devi *et al.* (2015).

Soil texture

Data pertaining to sand, silt, and clay percent (pedon-1 and 2) are depicted in Fig.-1 showed wide variation due to soil profile depth. The sand, silt and clay per cent were found in a proportional amount. Sand and silt content decreased with increasing soil depth whereas clay content increased with increasing depth in both the pedon horizons. The percentage of sand, silt and clay content in pedon-1 varied from 43.0 to 25.2 %, 36.0 to 32.0 % and 40.0 to 21.0 %, respectively whereas in pedon-2 sand, silt and claywas found in the range of 40.0 to 32.0 %, 35.0 to 27.0 % and 37.0 to 29.0%, respectively. Similarly, Pandey and Girish, (2007) reported that depending on depth textural class of soil varied from clay to loam.

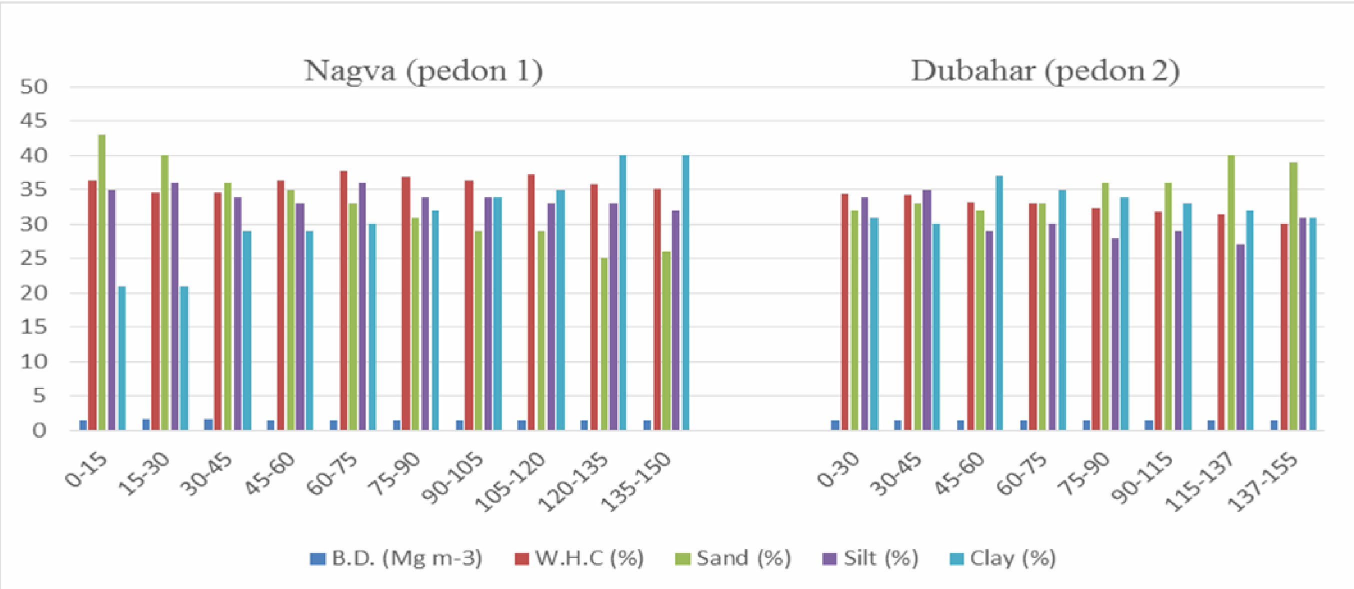

Fig. 1 : Vertical distribution of soil physical properties of Pedon-1 and Pedon-2 in relation to soil depth

Table 1 : Sheer distribution of physico-chemical properties of soil of Pedon -1 (Nagva village).

Soil depth (cm)	pH (1:2.5)	EC (dSm^{-1})	Organic Carbon (%)	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)	Sulphur (mg/kg)	Ca [cmol (p+) kg^{-1}]	Mg [cmol (p+) kg^{-1}]	$CaCO_3$ (%)
0-15	7.3	1.002	0.90	260.29	15.28	548.60	11.28	14.30	8.60	2.92
15-30	7.2	1.003	0.80	257.15	15.04	492.80	11.06	12.20	8.75	2.05
30-45	7.2	1.001	0.64	254.01	13.20	470.40	10.20	11.50	7.70	2.67
45-60	7.3	1.002	0.58	238.33	12.86	459.20	9.30	13.50	6.80	2.07
60-75	6.4	0.998	0.51	188.16	12.37	448.00	9.00	12.68	6.80	1.15
75-90	7.2	1.001	0.50	185.02	11.67	436.80	8.80	10.50	6.70	0.67
90-105	7.3	1.002	0.41	181.81	10.43	414.40	7.50	9.80	6.30	1.75
105-120	7.5	1.005	0.41	175.61	9.89	336.20	6.30	9.30	5.80	1.37
120-135	6.3	0.889	0.40	169.61	9.26	358.40	5.60	8.60	5.40	0.37
135-150	6.6	0.997	0.27	171.20	8.37	356.40	5.00	8.00	5.10	0.27

Table 2 : Vertical distribution of physico-chemical properties of Pedon-2 soils (Dubahar village).

Soil depth (cm)	pH (1:2.5)	EC (dSm^{-1})	Organic Carbon (%)	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)	Sulphur (mg/kg)	Ca [cmol (p+) kg^{-1}]	Mg [cmol (p+) kg^{-1}]	$CaCO_3$ (%)
0-30	6.6	0.996	0.72	291.65	8.90	369.60	12.24	28.00	20.20	2.87
30-45	6.8	0.998	0.67	282.92	8.25	369.30	11.36	24.20	18.30	2.25
45-60	7.2	1.011	0.55	260.28	8.13	358.40	11.14	25.30	19.31	2.30
60-75	6.7	0.999	0.65	228.92	7.98	358.02	10.80	25.50	19.76	2.15
75-90	6.7	0.999	0.64	213.25	8.39	347.20	10.40	26.24	21.25	1.40
90-115	7.1	1.009	0.58	188.16	7.47	345.50	10.20	24.60	16.19	1.10
115-137	6.8	0.998	0.63	206.97	6.23	342.05	9.80	23.70	18.50	1.07
137-155	7.7	1.017	0.23	185.02	8.04	324.80	9.50	22.90	17.69	1.05

Conclusion

Results of the present study revealed that the pH of the soils found to be moderately acidic to mildly alkaline in reaction whereas EC values lies in the normal range. Soil organic carbon content recorded low to high however, calcium carbonate shows non-calcareous to moderately calcareous. The available N, P, K, and S content in soil varied from low to medium, low, high, and low to medium, respectively. The textural class of the soil was found to be clayey to clay loam.

Conflict of interests

The authors declare that there is no competing interest.

References

Bhat, M.I. (2010). Characterization. classification and nutrient indexing of saffron growing soils of district Pulwama. Thesis submitted to SKUAST-Kashmir Srinagar pp. 110-113.

Bhatnagar, A.K.; Bansal, K.N. and Trivedi, S.K. (2003). Distribution of Sulphur in some profiles of Shivpuri District of Madhaya Pradesh. *Journal of The Indian Society of Soil science.* 51: 74-76.

Bouyoucos, G.J. (1962). Hydrometer method improved for making particle size analysis of spils. *Agron. J.* 54: 464.

Deka, D.A.; Singh, K. and Singh, A.K. (2018). Effect of Drought Stress on Crop Plants with Special Reference to Drought Avoidance and Tolerance Mechanisms: As review. *Int. J. Curr. Microbiol. App. Sci.,* 7(09): 2703-2721.

Devi, P.A.V.; Naidu, M.V.S and Rama Krishna Rao, A. (2015) Characterization and classification of sugarcane growing soils in southern agro-climatic zone: A Case study in eastern mandals of Chittoor District in Andhra Pradesh. *Journal of the Indian Society of Soil Science,* 63: 245-258.

Goovaerts, P. (1998). Geostatistical tools for characterizing the spatial variability of microbiological and physico-chemical soil properties. *Biology and Fertility Soils*, 27(4): 315–334.

Gupta, S.K; Singh, Ashok K.; Singh, Anil K.; Ranjan, A. and Kumar, N. (2019). Physico-Chemical characterization of soils Bairia block district Ballia, Uttar Pradesh, *Journal of Pharmacognosy and Phytochemistry*. 8(2): 1445-1448.

Hijbeek, R.; Ten-Berge, H.F.M.; Whitmore, A.P.; Barkusky, D.; Schröder, J.J. and Van-Ittersum, M.K. (2018). Nitrogen fertiliser replacement values for organic amendments appear to increase with N application rates. *Nutrient Cycling in Agroecosystems* 110(1): 105-115.

Ho, S.Y.; Wasli, M.E.B. and Perumal, M. (2019). Evaluation of Physicochemical Properties of Sandy-Textured Soils under Smallholder Agricultural Land Use Practices in Sarawak, East Malaysia. *Applied and Environmental Soil Science*.

Jackson, M.L. (1973). Soil chemical analysis, Publication. By Prentice Hall of India Pvt. Ltd. New Delhi.

Kanwar, J.S. and Chopra, S.L. (1998). Analytical Agricultural Chemistry (Edn.) Kalyani Publishers, New Delhi.

Kirmani, N.A. (2004). Characterization, classification and development of lacustrine soils of Kashmir valley. Ph. D Thesis submitted to SKUAST-Kashmir Srinagar pp. 1-96.

Muhr, G.R.; Dutta, N.P. and Sankara, S. (1965). Soil Testing in India. USID, New Delhi, India.

Naik, S.K. (2014). Distribution of nitrogen, phosphorus, potassium and Zinc content in mango grown acidic soils of Jharkhand. *The Ecoscan,* 8(1-2): 135-139.

Olsens, S.R.; Cole, C.V.; Watanable, F.S. and Dean, L.A. (1954). Estimation of available phosphorus in soil by extraction with sodium bicarbonate. United States Department of Agriculture Circular 939.

Pandey, R.N. and Girish, B.H. (2007). Extractants and critical limits of available soil sulphur for maize (*Zea mays* L.). *Journal of the Indian Society of Soil science*. 55(3): 304-312.

Patgiri D.K.; Das M. and Baruah T.C. (1993) Effect of Mechanical Composition and Organic Matter on Soil Water Retention, *Journal of the Indian Society of Soil Science,* 41(3): 544 -545.

Puri, A.N. (1930). A new method for estimating total carbonates in soils. Imp. Agric. Res. Pusa Bull, pp. 7.

Raghuwanshi, S.R.S.; Tiwari, S.C.; Prabha, S.; Raghuwanshi, O.P.S.; Sasode, D.S. and Umat, R. (2011) Characterization of salt-affected soils of Bhind district of Madhya Pradesh. *Journal of the Indian Society of Soil Science,* 59: 388-391.

Reddy, S.K. and Naidu, M.V.S. (2016) Characterization and classification of soils in semi-arid region of Chennurmandal in Kadapa district, Andhra Pradesh. *Journalof the Indian Society of Soil Science,* 64: 207-217.

Sen, P.; Majumdar, K. and Sulewski, G. (2008). Importance of spatial nutrient variability mapping facilitate SSNM in small land holding systems. *Indian J. Fert.*; 4 (11): 43-50

Singh, A.K.; Chauhan, R.K. and Bisen, J.S. (2014). Role of soil organic matter in soil health sustainability.

International Journal on Agricultural Sciences, 5 (II): 219-227.

Singh, A.K. and Singh, A.K. (2019). Study of available potassium by different extracting reagents and fertility status of soils of bairia subdivision of Ballia, U.P.; *Asian Journal of Science and Technology*, 10 (04): 9584-9586.

Subaiah, B.V. and Asija, G.L. (1956). A rapid procedure for the determination of available nitrogen in soils. *Current Science,* 25: 259–60.

Walkley, A. and Black, J.A. (1934). An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. *Soil Science,* 37(1): 29–38.

Willams, Ch. and Steinberg, S.A. (1969). Soil sulphur fraction as chemical indices of available sulphur in some Australian soils. *Aust. J. Agric. Res.*, 10: 340-352.