Environment and Ecology 41 (2) : 759—764, April– June 2023
ISSN 0970-0420

# Soil Fertility Assessment of Sugarcane Growing Villages in Samastipur District of Bihar

**Ajeet Kumar, Sayan Chattopadhyay,
Sunita Kumari Meena**

Received 2 December 2022, Accepted 21 January 2023, Published on 24 April 2023

## ABSTRACT

An assessment of soil status of Hasanpur and Rosera blocks of Samastipur district of Bihar was carried out to determine the basic physico- chemical properties of the soil, based on which site-specific nutrient recommendations can be made so that problems of nitrate contamination in water of that area may be minimized. The study was carried out in four selected villages from each of the block. Results revealed that soils mostly belong to the textural class of sandy clay loam and sandy loam. Soils are alkaline in reaction, safe concerning electrical conductivity. Soil organic carbon contents varied from 0.26% to 0.61%. Available nitrogen, phosphorus ($P_2O_5$) and potassium ($K_2O$) contents of soils varied from 142.65 to 275.97, 19.76 to 34.61 and 136.60 to 237.58 kg $ha^{-1}$, respectively. Low organic carbon, low availability of available nitrogen and available phosphorus were identified to be the major soil-related crop production constraints of the study area.

**Keywords** Hasanpur, Rosera, Organic carbon, Available nitrogen, Available phosphorus.

## INTRODUCTION

Soil fertility is the inherent capacity of soil that enables it to provide essential plant elements in quantities and proportions for the growth of a specified plant when other factors are favorable (Panda 2010). It indicates plant growth with respect to nutrients available in the soil. Soil fertility evaluation is a basic factor for the sustainable planning of a particular area (Khadka *et al.* 2018). Determination of soil available nutrient status of an area using Global Positioning System (GPS) helps in formulating site-specific balanced fertilizer recommendations along with making critical decisions on nutrient management (Dash *et al.* 2018). Keeping this concept in cognizance, an attempt has been made in the present investigation to determine the soil fertility status of sugarcane growing areas of Hasanpur and Rosera blocks of Bihar located in the Agro-Climatic Zone-I of Bihar. Four villages were selected from each of the blocks i.e., total 8 sugarcane growing villages were selected. From Hasanpur block Shasan, Mahuli, Rampur Rajawa and Jagarnathpur South were selected while from Rosera Rashulpur Dharha, Chakthat West, Jahangirpur South and Rohua were selected for analysis of primary physico-chemical properties of the soil. This kind of village-level survey is highly necessary for taking region-specific

Ajeet Kumar*[1], Sunita Kumari Meena[3]
[1]Assistant Professor-cum-Scientist, [3]Assistant Professor
Department of Soil Science, Dr Rajendra Prasad Central Agricultural University, Sugarcane Research Institute, Pusa (Samastipur) 848125, Bihar, India

Sayan Chattopadhyay[2]
[3]Assistant Professor
Department of Soil Science, Dr Rajendra Prasad Central Agricultural University, Faculty of Agriculture, DRPCAU, Pusa (Samastipur) 848125, Bihar, India

Email: ajeetrau@gmail.com
*Corresponding author

soil management decisions to achieve sustainable crop production goals without hampering the soil quality and contamination of surface of ground water of the sugarcane growing area of Bihar.

## MATERIALS AND METHODS

### Experimental site

Hasanpur block is located at 25°51'39''N- latitude and 85°46'56''E- Longitude in the Samastipur District of Bihar State. It belongs to Darbhanga Division. Hasanpur block is surrounded by Bithan block towards East, Chhaurahi block towards west, Gadhpura block towards South and Singhia block towards North (Fig. 1). Rosera is a subdivision on the bank of River Budhi Gandak. It is a municipality in Samastipur district. Rosera block consists of 48 villages. It is located at 25° 47' 55'' N- latitude and 86° 0' 11' E- longitude. In North there is Shivaji Nagar block while in West there are Khanpur and Bibhutpur blocks. In west there is Hasanpur block and in south there is Khudabandpur block of Begusarai.

### Soil sampling:

Soil samples were collected from eight different villages of the two blocks and all the villages are surrounded by tributaries of the river Gandak and Burhi gandak River. The life line of these four villages is River. Samastipur is traversed by a number of rivers including Budhi Gandak, Baya, Kosi, Kamla and Jhamwari and Balan, which are both the offshoots of Burhi Gandak. The Ganges also skirts the district on the south. All the eight villages under study including the surrounding villages are irrigated by the canal system of mentioned river both in *kharif* and *rabi* season.

### Climatic condition

The average annual temperature is 25.2 °C in Samastipur. The annual rainfall is 1236 mm. The driest month is November and the most precipitation falls in July. The warmest month of the year is May while January has the lowest average temperature. The mean maximum summer temperature is 38.7 °C and the mean minimum winter temperature is 7.0 °C. The climate is hot, moist and sub-humid. The soils of this Agro-Climatic Zone are mostly alluvial in nature.

### Cropping pattern

The area has been cultivated for a diverse range of crops such as vegetable in uplands; maize, wheat, sugarcane in medium lands; sugarcane and rice in low lands. Total 40 numbers of GPS based compos-

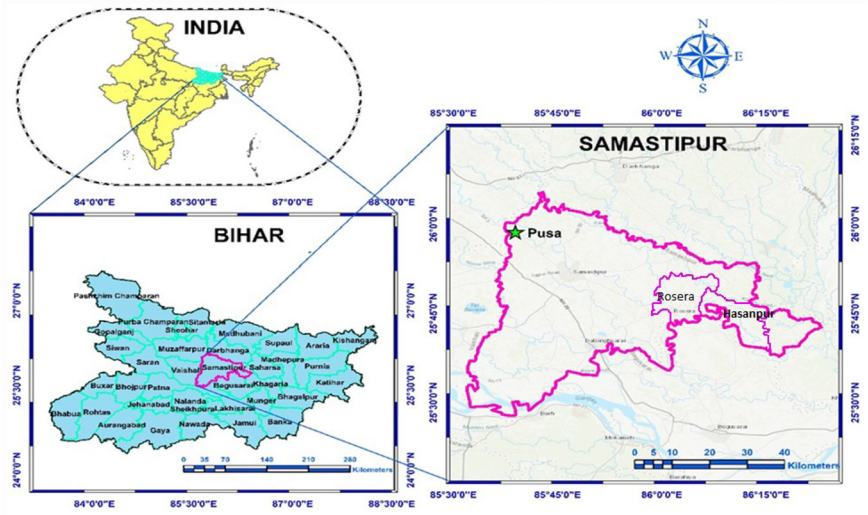


**Fig. 1.** Location map of the study area.

**Table 1.** Mechanical composition of soils of the study area.

| Name of village | % Sand | | % Silt | | % Clay | |
|---|---|---|---|---|---|---|
| | Range | Mean | Range | Mean | Range | Mean |
| Rasulpur Dharha | 55.00-59.50 | 57.30 | 21.50-24.00 | 22.70 | 18.00-23.00 | 20.00 |
| Shasan | 57.00-62.00 | 59.40 | 20.00-22.50 | 21.40 | 17.00-23.00 | 19.20 |
| Mahuli | 56.00-62.00 | 58.80 | 19.00-21.00 | 19.90 | 19.00-25.00 | 21.30 |
| Chakthat West | 56.00-61.00 | 58.20 | 19.50-23.00 | 21.60 | 18.00-22.50 | 20.20 |
| Jahangirpur South | 54.50-58.50 | 56.40 | 16.50-21.50 | 19.00 | 21.50-26.00 | 24.60 |
| Rampur Rajawa | 55.75-62.00 | 59.20 | 20.50-24.50 | 21.75 | 17.50-21.00 | 19.05 |
| Jagarnathpur | 58.50-61.50 | 59.80 | 18.00-22.50 | 20.70 | 18.00-22.00 | 19.50 |
| Rohua | 59.00-61.00 | 60.10 | 18.25-21.00 | 19.70 | 19.50-21.75 | 20.20 |

ite surface (0–30 cm) soil samples were collected from the study area which includes 5 samples from each village. Soil sampling data including latitude, longitude and elevation above mean sea level was collected using a GPS instrument (Garmin make; model: 76 MAPCSx).

**Soil analysis:**

Soils were analyzed for its textural class by Bouyoucos Hydrometer method (Bouyoucos 1962), pH (1:2) (Jackson 1973), EC (1:2) (Jackson 1973), organic carbon (Walkley and Black 1964) as described by Page *et al.* (1982), available nitrogen (Subbiah and Asija 1956), phosphorus (Bray and Kurtz 1945) and potassium (Hanway and Heidel 1952).

## RESULTS AND DISCUSSION

Total eight villages of Hasanpur and Rosera blocks of the districts namely Shasan, Mahuli, Rampur Rajawa, Jagarnathpur South, Rashulpur Dharha, Chakthat West, Jahangirpur South and Rohua are included in the present investigation for studying the basic physico-chemical properties and fertility status of soil concerning primary macronutrients.

**Mechanical composition of soils**

The soil texture (USDA) of sugarcane growing area of Samastipur district was varying from sandy loam to sandy clay loam. The range of sand, silt and clay in 0-30 cm layer was 54.50 to 62.00 %, 16.50 to 24.50 % and 17.00 to 26.00 % respectively, showing considerable variance. The maximum average sand percentage (61%) was found in the village Rohua while minimum sand (%) was found in the village Jahangirpur South. Maximum average silt was recorded to be 22.70 % in the village Rasulpur Dharha and minimum average silt content (19.00%) was recorded to be in the village Jahangirpur South. Maximum average clay content (24.60%) was recorded in the village Jahangirpur South while minimum average clay content (19.05%) was reported from the village Rampur Rajawa (Table 1). 50 % of the total soil samples were reported to be in the class Sandy Clay Loam (SCL) and 50 % were in the class Sandy Loam (SL). Findings regarding mechanical composition was in line with the findings of Mahto and Rai (2020).

**Chemical properties of soils**

*Soil pH*

pH (1:2.5) of soil samples from 0-30 cm of Rasulpur Dharha village were found to vary in between 7.51 to 7.97 with a mean value of 7.75, that of soils of village Shasan varied between 7.48 to 8.01 with a mean value of 7.77, that of Mahuli varied between 7.76 to 8.12 with a mean value of 7.95, that of soils of Chakthat West village varied between 7.83 to 8.19 with a mean value of 8.01, that of soils of Jahangirpur South ranged between 7.87 to 8.19 with a mean of 7.98, that of Rampur Rajawa varied between 7.90 to 8.17 with a mean value of 8.06 and that of soils of Jagarnathpur and Rohua villages were ranged between 7.85 to 8.10 and 7.76 to 8.27 with a mean value of 7.96 and 8.01 respectively. Highest average pH was found in the village Rampur Rajawa (8.06) followed by Chakthat West (8.01) while the village Rashulpur Dharha recorder for lowest average soil pH (7.75). The pH of soil from sugarcane growing

**Table 2.** Chemical properties of soils of the study area.

| Name of village | pH (1:2.5) | | EC (1:2.5) (dS $m^{-1}$) | | OC (g $kg^{-1}$) | |
|---|---|---|---|---|---|---|
| | Range | Mean | Range | Mean | Range | Mean |
| Rasulpur Dharha | 7.51-7.97 | 7.75 | 0.148-0.212 | 0.174 | 0.37- 0.61 | 0.50 |
| Shasan | 7.48- 8.01 | 7.77 | 0.136-0.225 | 0.190 | 0.28-0.52 | 0.38 |
| Mahuli | 7.76- 8.12 | 7.95 | 0.113-0.234 | 0.161 | 0.27-0.51 | 0.39 |
| Chakthat West | 7.83-8.19 | 8.01 | 0.122-0.241 | 0.179 | 0.32- 0.52 | 0.41 |
| Jahangirpur South | 7.87- 8.19 | 7.98 | 0.126-0.226 | 0.172 | 0.27-0.41 | 0.33 |
| Rampur Rajawa | 7.90- 8.17 | 8.06 | 0.133-0.223 | 0.177 | 0.31-0.53 | 0.42 |
| Jagarnathpur | 7.85- 8.10 | 7.96 | 0.129-0.207 | 0.168 | 0.26- 0.56 | 0.41 |
| Rohua | 7.76 - 8.27 | 8.01 | 0.118-0.243 | 0.171 | 0.38-0.60 | 0.49 |

areas of Samastipur district were moderately alkaline in reaction (Table 2). Similar findings have also been reported by Mahto and Rai (2020).

Alkaline soils, especially those in arid and semi-arid climates, include $CaCO_3$ in the profile and ongoing hydrolysis of $CaCO_3$ maintains the release of OH- in the soil solution which causes higher pH of soil:

$$CaCO_3 + H_2O = Ca^{2+} + HCO_3^- + OH^-$$

*Electrical conductivity (EC)*

The electrical conductivity of different villages in the Samastipur varied from 0.113 to 0.243 $dSm^{-1}$ in soil depths of 0 to 30 cm. The maximum average EC value (0.190 $dSm^{-1}$) was recorded in village Shasan while the minimum average value of EC (0.161 $dSm^{-1}$) was reported in the village Mahuli (Table 2). EC measures the amount of salt in the soil solution. The EC of all the cultivated soils were less than 1.0 $dSm^{-1}$. Since the EC of soils is less than 1.0 $dSm^{-1}$, the category of the soils in terms of conductivity (total soluble salts) is normal (<1 $dSm^{-1}$) and soils under the study area are safe for all types of crop production concerning the soluble salt content (Dash *et al.* 2019).

*Organic carbon (OC)*

Soil Organic Carbon (SOC) of soil samples (0-30 cm) of Rasulpur Dharha, Shasan, Mahuli, Chakthat West, Jahangirpur South, Rampur Rajawa, Jagarnathpur & Rohua respectively were observed to range between 0.37-0.61%, 0.28-0.52%, 0.27-0.51%, 0.32-0.52%, 0.27-0.41%, 0.31-0.53%, 0.26-0.56% and 0.38-0.60 % respectively with mean of 0.50%, 0.38%, 0.39%, 0.41%, 0.33%, 0.42%, 0.41% and 0.49% (Table 2). 25% of the collected soil samples were reported to be in medium in soil organic carbon content while 75 % of the samples were in low range. As most of the soils were low in organic carbon content Farm Yard Manure (FYM) or sugarcane trash biochar (Mary and Anitha 2019) can be applied to increase the organic matter content. Similar findings have also been reported by Mahto and Rai (2020).

*Available nitrogen*

Available nitrogen of soil samples from 0-30 cm of Rasulpur Dharha village were found to vary in between 188.16 to 250.88 kg $ha^{-1}$ with a mean value of 218.27 kg $ha^{-1}$, that of soils of village Shasan varied between 200.70 to 250.88 kg $ha^{-1}$ with a mean value of 218.26 kg $ha^{-1}$, that of Mahuli varied between 163.07 to 213.25 kg $ha^{-1}$ with a mean value of 188.16 kg $ha^{-1}$, that of soils of Chakthat West village varied between 150.53 to 238.34 kg $ha^{-1}$ with a mean value of 198.20 kg $ha^{-1}$, that of soils of Jahangirpur South ranged between 157.58 to 224.34 kg $ha^{-1}$ with a mean of 186.63 kg $ha^{-1}$, that of Rampur Rajawa varied between 200.70 to 275.97 kg $ha^{-1}$ with a mean value of 245.86 kg $ha^{-1}$ and that of soils of Jagarnathpur and Rohua villages were ranged between 142.65 to 213.25 kg $ha^{-1}$ and 200.70 to 263.42 kg $ha^{-1}$ with a mean value of

**Table 3**. Fertility rating for soils of Bihar (Nanda *et al.* 2008).

| Sl. No. | Name of the nutrients | Low | Medium | High |
|---|---|---|---|---|
| 1 | Organic carbon (g $kg^{-1}$) | <0.5 | 0.5-0.75 | >0.75 |
| 2 | Available N (kg $ha^{-1}$) | <250 | 250-500 | >500 |
| 3 | Available $P_2O_5$ (Bray's P) (kg $ha^{-1}$) | <25 | 25-50 | >50 |
| 4 | Available $K_2O$ (kg $ha^{-1}$) | <125 | 125-300 | >300 |

183.44 kg $ha^{-1}$ and 233.59 kg $ha^{-1}$ respectively (Table 3). Highest average available nitrogen was found in the village Rampur Rajawa (245.86 kg $ha^{-1}$) while the village Jagarnathpur recorder for lowest average soil available nitrogen (183.44 kg $ha^{-1}$). 82.5 % of the total soil samples were found to be of low in available nitrogen content and 17.5% of the soil samples were in medium range. Hence, low nitrogen content in the soils is a major constraint of the study area. Adding a sufficient quantity of organic matter and growing leguminous crops are sustainable ways, which can be adopted to enrich soil nitrogen. To meet crop demand additional sources of nitrogenous fertilizers can be applied to achieve the targeted yield for various crops including sugarcane.

## Available phosphorus

Available soil phosphorus contents (as $P_2O_5$) of soil samples from 0-30 cm of Rasulpur Dharha village were found to vary in between 21.32-31.26 kg $ha^{-1}$ with a mean value of 26.83 kg $ha^{-1}$. that of soils of village Shasan varied between 22.69-32.49 kg $ha^{-1}$ with a mean value of 26.65 kg $ha^{-1}$, that of Mahuli varied between 22.68-34.58 kg $ha^{-1}$ with a mean value of 27.63 kg $ha^{-1}$, that of soils of Chakthat West village varied between 20.72-32.48 kg $ha^{-1}$ with a mean value of 27.05 kg $ha^{-1}$ that of soils of Jahangirpur South ranged between 18.28-28.79 kg $ha^{-1}$ with a mean of 24.21 kg $ha^{-1}$ that of Rampur Rajawa varied between 27.41-34.61 kg $ha^{-1}$ with a mean value of 30.62 kg $ha^{-1}$ and that of soils of Jagarnathpur and Rohua villages were ranged between 19.76-28.39 kg $ha^{-1}$ and 19.80-31.38 kg $ha^{-1}$ with a mean value of 23.28 kg $ha^{-1}$ and 28.01 kg $ha^{-1}$ respectively (Table 3). Highest average available phosphorus was found in the village Rampur Rajawa (30.62 kg $ha^{-1}$) while the village Jagarnathpur recorder for lowest average soil available phosphorus (23.28 kg $ha^{-1}$). 62.5 % of the total soil samples were found to be of medium in available phosphorus content and 37.5% of the soil samples were in low range. Since most soils are low to medium for P availability, the addition of P based fertilizers, organic manure and phosphorus solubilizing bacteria are recommended to enrich the P availability to the crops. Soil testing is required of farmers before P application. If soil testing is not practicable, then the broad application of the 75% recommended amount of P is permitted. Farmers may comprehend and make use of PSB in such situation as excess fixed P is found in soils (Singh *et al.* 2019).

### *Available potassium*

Available potassium of soil samples from 0-30 cm of Rasulpur Dharha village were found to vary in between 182.49-205.65 kg $ha^{-1}$ with a mean value of 193.58 kg $ha^{-1}$, that of soils of village Shasan varied between 187.34-236.75 kg $ha^{-1}$ with a mean value of 209.94 kg ha, that of Mahuli varied between 163.17-

**Table 4.** Soil fertility status of the study area.

| Name of village | Available N (kg $ha^{-1}$) Range | Mean | Available P (kg $ha^{-1}$) Range | Mean | Available K (kg $ha^{-1}$) Range | Mean |
|---|---|---|---|---|---|---|
| Rasulpur Dharha | 188.16-250.88 | 218.27 | 21.32-31.26 | 26.83 | 182.49-205.65 | 193.58 |
| Shasan | 200.70-250.88 | 218.26 | 22.69-32.49 | 26.65 | 187.34-236.75 | 209.94 |
| Mahuli | 163.07-213.25 | 188.16 | 22.68-34.58 | 27.63 | 163.17-197.77 | 180.58 |
| Chakthat West | 150.53-238.34 | 198.20 | 20.72-32.48 | 27.05 | 136.60-212.58 | 184.51 |
| Jahangirpur South | 157.58-224.34 | 186.63 | 18.28-28.79 | 24.21 | 167.29-221.84 | 196.83 |
| Rampur Rajawa | 200.70-275.97 | 245.86 | 27.41-34.61 | 30.62 | 164.78-237.58 | 205.42 |
| Jagarnathpur | 142.65-213.25 | 183.44 | 19.76-28.39 | 23.28 | 163.28-196.88 | 181.08 |
| Rohua | 200.70-263.42 | 233.59 | 19.80-31.38 | 28.01 | 191.48-229.86 | 210.95 |

197.77 kg $ha^{-1}$ with a mean value of 180.58 kg $ha^{-1}$, that of soils of Chakthat West village varied between 136.60-212.58 kg $ha^{-1}$ with a mean value of 184.51 kg $ha^{-1}$, that of soils of Jahangirpur South ranged between 167.29-221.84 kg $ha^{-1}$ with a mean of 184.51 kg $ha^{-1}$, that of Rampur Rajawa varied between 164.78-237.58 kg $ha^{-1}$ with a mean value of 205.42 kg $ha^{-1}$ and that of soils of Jagarnathpur and Rohua villages were ranged between 163.28-196.88 kg $ha^{-1}$ and 191.48-229.86 kg $ha^{-1}$ with a mean value of 181.08 kg $ha^{-1}$ and 210.95 kg $ha^{-1}$ respectively (Table 3). Highest average available potassium was found in the village Rohua (210.95 kg $ha^{-1}$) while the village Mahuli recorder for lowest average soil available potassium (180.58 kg $ha^{-1}$) (Table 4). All the soil samples were found to be in medium in available potassium content. Hence, soil potassium status was medium in most of the soils of the study area. The addition of potassium- based fertilizers are recommended to enrich the potassium availability to the crops.

## CONCLUSION

From the above region-specific small experiment, it was clear that the soils of Hasanpur and Rosera blocks of Bihar are alkaline in soil reaction, safe concerning soluble salt content. Soils are of low organic carbon content. Concerning the soil fertility status, soils are low in status for soil available nitrogen; low to medium for available phosphorus and that of medium for soil potassium. To increase the organic carbon content in soil addition of organic matter like FYM is necessary. The addition of sufficient organic matter is always recommended to maintain soil health as a whole. Also, the low availability of soil available nitrogen and phosphorus are the limiting factors of crop production. As per general recommendations for the soils of Bihar, 25% lower doses of fertilizers can be applied for the nutrients which are in high range of soil status and that of 25% more for those nutrients should be applied, which are low in range. Exact recommended doses of fertilizers for different crops can be applied for those nutrients which are present in medium range in the soils. Judicious management of soil nutrients maintains soil health and crop productivity besides curtailing the cost of production.

## ACKNOWLEDGMENT

The experimental findings are the part of post graduate research program of the Department of soil science, Sugarcane Research, Institute, Dr. Rajendra Prasad Central Agricultural University, Pusa, Authors are very grateful to Ms. Babita Kudi and Mr. Kunal Ji for their help during sampling and analysis of soil samples.

### REFERENCES

Bouyoucos GJ (1962) Hydrometer method improved for making particle size analyses of soils. *Agron J* 54 (5): 464-465.

Bray RH, Kurtz LT (1945) Determination of total, organic and available forms of phosphorus in soils. *Soil Sci* 59: 39-45.

Christy NM, Anitha PR (2019) Effect of sugarcane trash biochar on enhancement of soil health and sugarcane productivity. *Int J Curr Microbiol Appl Sci* 8(11): 2650-2660.

Dash PK, Mishra A, Saren S (2019) Vertical distribution of available nutrients in an Eastern Indian Catena. *Ann Pl Soil Res* 21 (4): 320-325.

Dash PK, Mishra A, Saren S, Revathi B, Sethy SK (2018) Preparation of GPS and GIS based soil fertility maps and identification of soil related crop production constraints of RRTTS and KVK farm, Dhenkanal located in the mid-central table land agro-climatic zone of Odisha, India. *Int J Chem Stud* 6 (5): 934-943.

Hanway JJ, Heidel H (1952) Soil analysis methods as used in Iowa State college soil testing laboratory. *Iowa State College Bull* 57: 1-31.

Jackson ML (1973) Soil Chemical Analysis, Prentice Hall of India, Private limited, New Delhi.

Khadka D, Lamichhane S, Bhantana P, Ansari AR, Joshi S, Baruwal P (2018) Soil fertility assessment and mapping of Chungbang farm, Pakhribas, Dhankuta, Nepal. *Adv Pl Agric Res* 8 (3): 219-227.

Mahto KS, Rai D (2020) Assessment of soil health of different blocks of Samastipur, Bihar by root health bio assay test. *Int J Curr Microbiol Appl Sci* 9(12) : 711- 717.

Nanda SK, Mishra A, Pradhan NK, Muralidharudu Y (2008) Soil testing and fertilizer recommendation in Orissa, STCR technical bulletin, OUAT, Bhubaneswar.

Page AL, Miller RH, Keeney DR (1982) Methods of Soil Analysis, Part-2 (edn). Monograph No-9, American Society of Agronomy, Agronomy series ASA SSA, Publishers, Madison, Wisconsin, USA.

Singh KK, Adarsh A, Kumari A (2019) Evaluation of soil fertility status in Kanti block under Muzaffarpur district of North Bihar. *Int J Chem Stud* 7(1) 4: 1375-1379.

Subbiah BV, Asija GL (1956) A rapid procedure for the determination of available nitrogen in soils. *Curr Sci,* pp 25259-25260.

Walkley AJ, Black IA (1964) Estimation of soil organic carbon by the chromic acid titration method. *Soil Sci* 37: 29—38.