Current Journal of Applied Science and Technology

40(4): 98-104, 2021; Article no.CJAST.65627
ISSN: 2457-1024
(Past name: British Journal of Applied Science & Technology, Past ISSN: 2231-0843, NLM ID: 101664541)

Assessment of Soil Fertility Status of Kanwara Minor Lift Canal Command Area in Banda District of Bundelkhand using Nutrient Index Values

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CJAST/2021/v40i431299
Editor(s):
(1) Dr. Alessandro Buccolieri, Università del Salento, Italy.
Reviewers:
(1) María Elena Sánchez-Pardo, Instituto Politécnico Nacional, México.
(2) Neimar de Freitas Duarte, Federal Institute of Minas Gerais, Brazil.
Complete Peer review History: http://www.sdiarticle4.com/review-history/65627

Original Research Article

Received 02 January 2021
Accepted 04 March 2021
Published 03 April 2021

ABSTRACT

A study was conducted to assess the fertility status of Kanwara minor lift canal command area using Nutrient Index values of different soil parameters under study in 2019-20. A systematic set of two hundred and eleven georeferenced soil samples were collected and analysed following the standard sampling and analytical procedure. The analysed values of different parameters were categorized in low, medium and high and further used in determination of the nutrient index. NI value of soil organic carbon was 1.16, 1.00 for available N, 1.47 for available P and 2.55 for available K respectively. Regarding the fertility class based on Nutrient Index values it was deficient in organic carbon, available N and available P while, sufficient in soil available K. This requires immediate attention towards the management of nutrients to restore the soil fertility and sustain crop productivity.

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Keywords: Nutrient index; productivity; soil organic carbon; crop productivity.

1. INTRODUCTION

Soil is one of the most important and valuable gift of natural world to human being. Incongruously, it is one of the most neglected natural resources on the earth's surface. In addition, an interminable wealth can produce goods and services, if managed properly. According to the FAO report, more or less 95% of food products comes from the soil directly or indirectly. However, the formation of only one inch of soils takes thousands of years.

In the recent scenario with increasing demand of growing population requires implementing the advances regarding agricultural technology. There are four basic components of soil, which is the major storehouse of the plant nutrients. Therefore, it is very necessary to maintain the soil fertility to analyse the quantity of each nutrient present and their behaviour in soil. Soil fertility is the ability of soil to supply the plant nutrient element required for optimum growth of plants. It is natural dynamic property that is influenced by the natural and anthropogenic factors.

It is primarily depleted by excessive and intense cultivation as well as inappropriate soil management practices. Depletion of uppermost fertile soiloccurs with the losses in nutrient rich organic top soil due to runoff and erosion [1]. As in the present agriculture context human population exponentially increases, though the population pressure disturbs the ecosystem of earth to produce the demand of a growing population in large extent. Constant cropping with enhancing the crop yields removes nutrient from soil extensively. Excessive and unbalanced use of chemical fertilizers, inappropriate and untimely application of irrigation and other agronomic practices also depletes the soil quality [2]. Low fertility status in India is major constraints to achieving higher productivity [3]. Fertility of soil varied during the growing season because of the principal and practices applied to productions and with the addition of different inputs such as fertilizers, manure, compost, mulches and amendment material. Therefore, soil testing has the potential to know the existing productiveness, and provides a further status of nutrient accessibility for fertilizer recommendation and ultimate crop production as well as to maintain optimum soil fertility status throughout the year. It is measured in terms of the amount of available nutrient present in the soil at any time, area or particular circumstances. Hence, the assessment of soil fertility of the area or region is much needed to attain the sustainability of agriculture (Singh and Mishra, 2012). In order to obtain good agronomic yield and maintaining the soil health and quality as well as sustainable agriculture production the knowledge about the nutrient depletion is must. If all these things will be predetermined, it will provide a sound basis for applying the nutrient as required for desirable production. Soil fertility status can be assessed by means of applying nutrient index methods and different fertility indicators for the delineation of the area. Therefore, in the present study, an effort has been made to assess the fertility status of Kanwara minor lift canal command area using the nutrient index method.

1.1 Study Site and Climate

The present study was conducted, choosing the Kanwara minor lift canal command area, which is a part of Badokhar Khurd block of district Banda. Geographically, it was lying between 80.2841 East and 80.3213 West longitude and 25.5486 North and 25.5064 South latitude covering an area of 602.405 ha.

The climate of the study area is typically semi arid with extreme strong summer. The average annual rainfall is 902 mm. Out of which 80% rainfall is received from June to September (MIDH report on Banda, 2015). Annual temperature is uniformly high ranges, from 30-44°C in summer 20-24°C rainy and 14-21°C in winters. The study area is predominantly covered with Hyperthermic soil temperature and Ustic soil moisture regime [4].

2. MATERIALS AND METHODS

In order to assess the fertility status of the Kanwara minor lift canal command area two hundred and eleven surface (0-15 cm) geo-located samples were collected using a GPS receiver. All the samples were collected based on the visual changes observed during the survey of study area *viz*. soil color, slope *etc.*

Collected soil samples were air dried in a shady place, grinded using pestle and mortar, sieved through a 2mm sieve, and stored in a plastic container with proper levelling. After, all these

processes, soil samples basic chemical properties*viz.* soil organic carbon, available N, P and K were analysed by adopting standard analytical procedures. Soil organic carbon was analysed using Walkley and Black [5] method. Available nitrogen was determined by alkaline permanganate method described [6]. Available phosphorous was determined by Olsen et al. [7] using a spectrophotometer. Available potassium was determined by neutral ammonium acetate method using flame photometer as described by Hanway and Heidal [8].

2.1 Nutrient Index

For the comparison of soil fertility level of any area by obtaining a single value of nutrients it is required to calculate the nutrient index of each nutrient and based on that single value fertility status can be interpreted. It is a measure of capacity of soil to supply plant nutrients [9]. Parker et al. [10] firstly introduced the soil nutrient index approach that has been adopted and modified time to time by many researchers like Shetty et al. [11], Pathak [12], Singh et al. [13], Sidharam et al. (2017) *etc.* NI is used to assess the soil fertility status based on the number of samples belonged to three categories, *i.e.* low, medium and high, and classified according to the specific rating chart.

The NI values for different nutrient elements are calculated as follows:

$$Nutrient\ Index = \frac{(N_L \times 1 + N_M \times 2 + N_H \times 3)}{N_T}$$

Where,

N_L= Number of samples in low category
N_M = Number of samples in medium category
N_H = Number of samples in high category
N_T = Total number of samples

Particular nutrient element having NI value <1.67 is considered as 'Low' for 1.67-2.33 as 'Medium' and for above 2.33 as 'High' (Ramamoorthy and Bajaj, 1969).

3. RESULTS AND DISCUSSION

The present investigation was carried out with the objective to assess the fertility status using Nutrient Index value of Kanwara minor lift canal command area in Banda district of Bundelkhand for available major nutrients.

3.1 Nutrient Index Value for Fertility Rating of the Study Area

From the study area collected samples were analysed and nutrient index value for each nutrient under study is calculated from the number of samples belongs to low, medium and high category. Fertility rating of the area was classified as low (<1.67), medium (1.67-2.33) and high (>2.33) based on the nutrient index value.

3.2 Soil Organic Carbon (SOC)

The nutrient index value of soil organic carbon was 1.16 and categorised as low. The majority of the samples (83.89%) were recorded the low followed by medium (16.11%)in soil organic carbon value considering the critical limit of ≤0.50% as low, 0.51 to 0.75% as medium and >0.75% of high OC value. Khan et al. (2017) also reported almost similar results in soils of Banda district.

3.3 Soil Available Nitrogen (N)

The value regarding the nutrient index of available N was 1.00 categorised as low. Most of the soil samples (99.53%) having the low in available nitrogen considering the critical limit of ≤280 kg ha^{-1} for low, 281-560 kg ha^{-1} for medium and >560 kg ha^{-1} for high. Tagore et al. [15] revealed the similar findings in soils of the Chambal region of Madhya Pradesh.

3.4 Soil Available Phosphorous (P)

The NI value for available phosphorous was 1.47 showing the lower index value. The majority of the sample in low (54.03) followed by medium (44.55%) category on the critical limit of ≤10 kg ha^{-1} for low, 11-25 kg ha^{-1} for medium and >25 kg ha^{-1} for high. The present study was found in close conformity with the findings of [16,17].

3.5 Soil Available Potassium (K)

The NI value for available potassium was 2.55 showing the higher index value. The majority of the samples were in high (55.45%) followed by medium (44.55%) category on the critical limit of ≤120 kg ha^{-1} for low, 121-280 kg ha^{-1} for medium and >280 kg ha^{-1} for high. Tagore et al. [15] also reported higher nutrient index value for soil available potassium in soils of Sanwer tehsil of Indore district of Madhya Pradesh.

The result regarding the nutrient index value showed that the area was deficient in soil organic carbon, available nitrogen and phosphorous whereas, sufficient in soil available potassium in the soils of the study area.

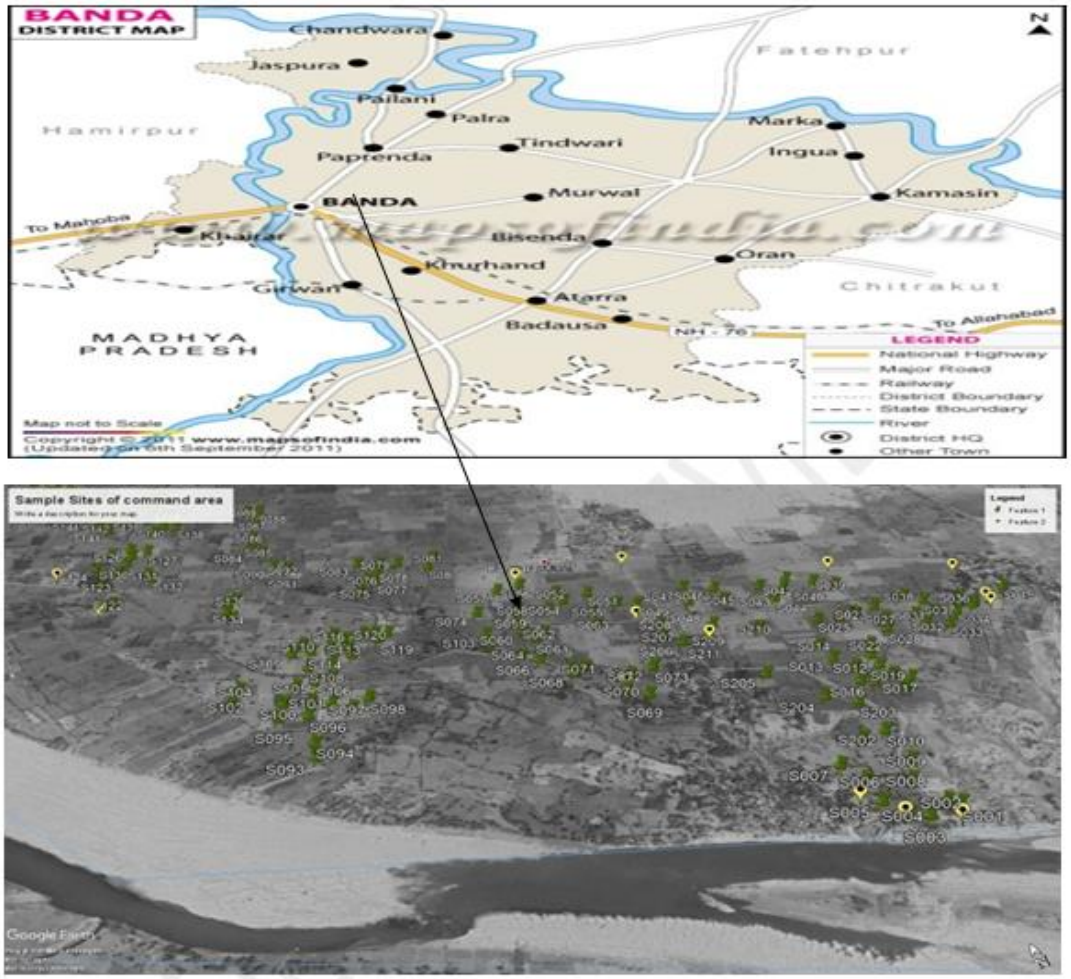

Fig. 1. Location map of sample site

Table 1. Rating chart of nutrient index values

S. No.	Nutrient Index	Value	Interpretation
1	Low	<1.67	Low fertility status
2	Medium	1.67-2.33	Medium fertility status
3	high	>2.33	High fertility status

Source: Parker et al. [10]

Table 2. Rating chart for soil test values of nutrients

Nutrient	Rating		
	Low	Medium	High
Organic carbon (%)	≤0.5	0.51-0.75	>0.75
Available N (kg ha^{-1})	≤ 280	281-560	>560
Available P (kg ha^{-1})	≤10	11-25	>25
Available K (kg ha^{-1})	≤120	121-280	>280

Source: Dhyan Singh, P.K. Chhonkar and B.S. Dwivedi [14]

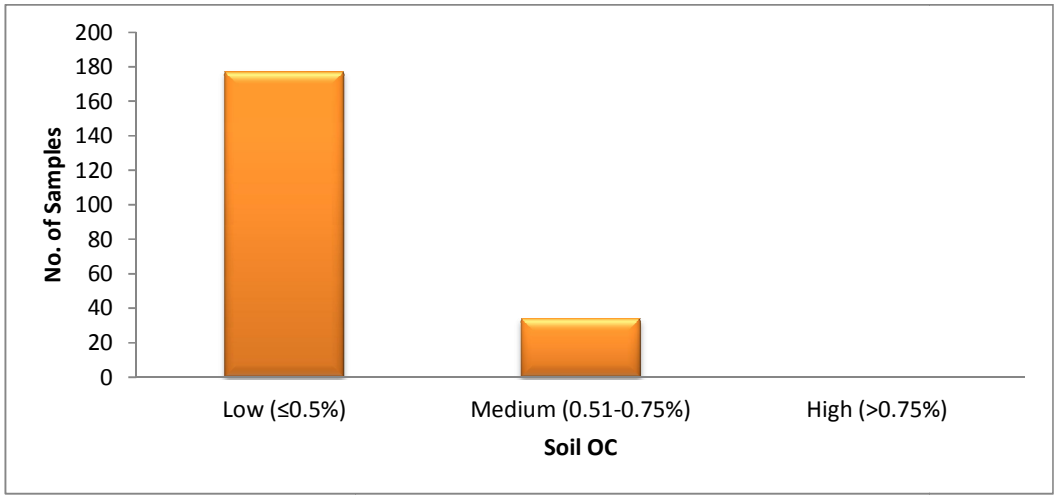

Fig. 2. Graphical representation of low, medium and high content of OC

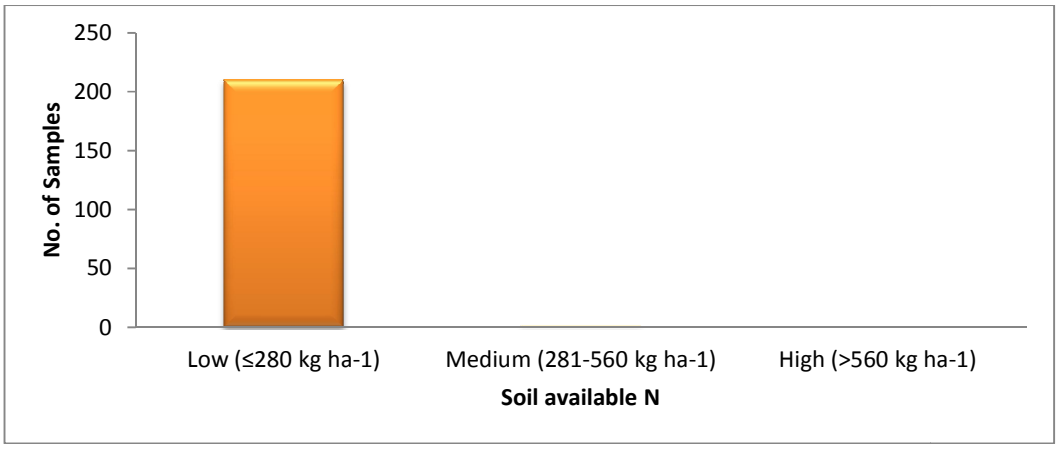

Fig. 3. Graphical representation of low, medium and high content of available N

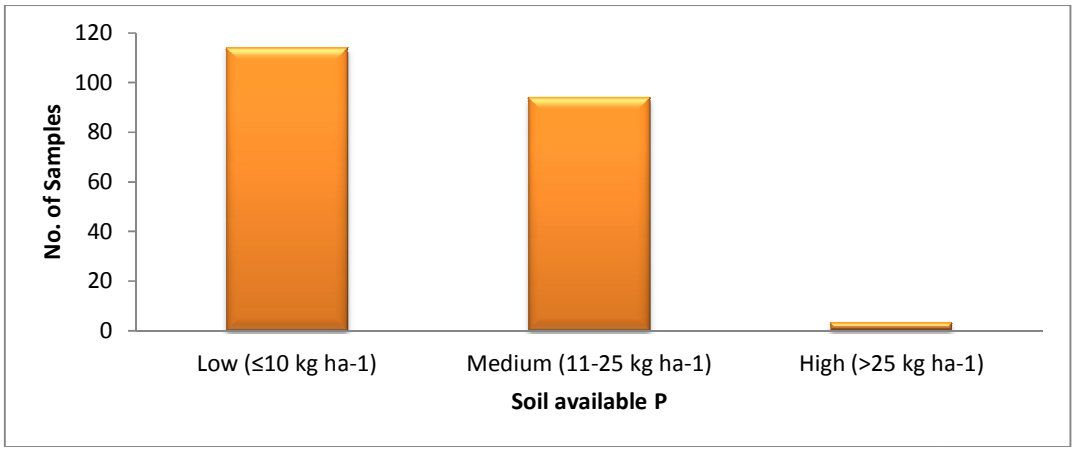

Fig. 4. Graphical representation of low, medium and high content of available P

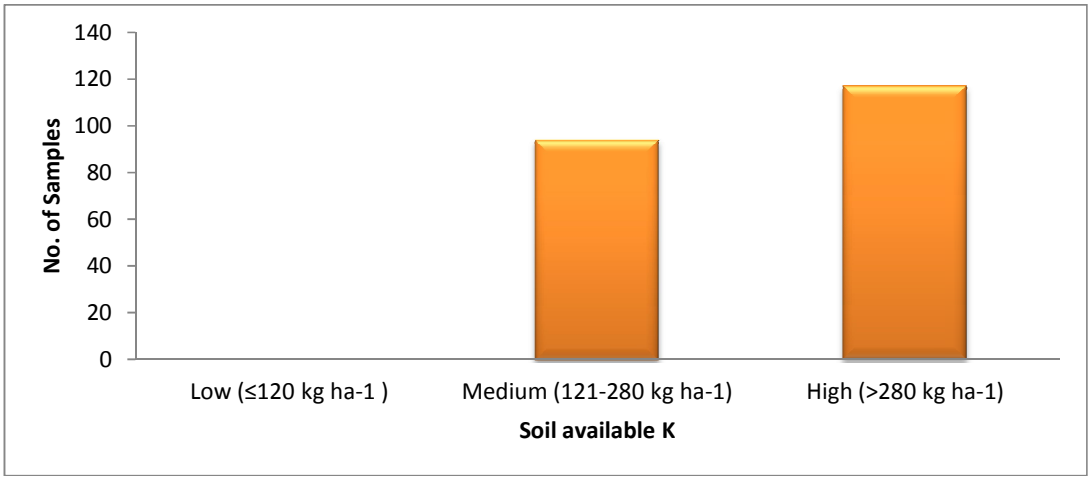

Fig. 5. Graphical representation of low, medium and high content of available K

4. CONCLUSIONS

The study revealed that the Soil organic carbon was low to medium having 83.89% in the low category. Available N was low in most of the samples. Available P was low to medium and Available K was medium to high. From the NI values, it was observed low in OC, available N and P and high in available K. Overall, the soil fertility level of the study area was low except potassium. Therefore, the area needs to be emphasised on site-specific nutrient management, use of organics as nutrient sources and appropriate agronomic practices to improve the fertility status.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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