Int.J.Curr.Microbiol.App.Sci (2017) *6*(7): 2829-2837

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 7 (2017) pp. 2829-2837**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2017.607.394

Available Macro Nutrient Status and their Relationship with Soil Physico-Chemical Properties of Mirzapur District of Uttar- Pradesh, India

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Keywords

Macronutrient, Physico-chemical properties, Correlation, Narayanpur block Mirzapur.

Article Info

Accepted:
29 June 2017
Available Online:
10 July 2017

A B S T R A C T

Soil fertility evaluation of an area is an important aspect in context of sustainable agriculture production. The macro nutrients govern the fertility of soils and control the growth and yields of crops. In the present investigation Narayanpur block was selected in the district Mirzapur of Uttar Pradesh and studied the available macronutrient status and their relationship with physico-chemical properties. Mirzapur district have different cropping systems and irrigated by Ganga canal and Tube well tributaries. Seven representative villages were chosen and 10 surface soil (0-15 cm) samples collected from each village and analyzed for physico-chemical properties and available N, P, K, and S status using standard laboratory procedures. Results of the study indicated that soils of Narayanpur block were Medium to High in organic carbon. Out of 75 collected soil samples, 96% were Low in available nitrogen and medium to high in available phosphorus, potassium and Sulphur Medium to high in soil.

Introduction

In developing countries like India, where land-person ratio is rapidly narrowing, the only means of meeting the needs of agricultural produce is through increased productivity without detriment to environment and sustainability. Soil characterization in relation to evaluation of fertility status of soils of an area is an important context of sustainable agriculture production. Nitrogen, phosphorus, potassium, and Sulphur are important soil nutrients which control the fertility and yield of the crops. Because of imbalanced and inadequate fertilizer use coupled with low efficiency of other inputs, the Response Efficiency of chemical fertilizer nutrients has declined tremendously under intensive agriculture in recent years. Variation in nutrient supply is natural phenomenon and some of them may be sufficient where others may be deficient. According to (Lal and Singh), fertility encompasses physical, chemical and biological degradation process. This is pre-requisite for determining appropriate conservation activities in monitoring our natural resource base. With the advances in

information technology the data on soils, weather and other data can be integrated in making such decisions (Das, 1999). The stagnation in crop productivity cannot be boosted without judicious use of macro and micronutrient fertilizers to overcome existing imbalances or deficiencies.

Uttar Pradesh, the fourth largest State in the country in terms of geographical area, is located in the northwestern part of the country. It has a geographical area of 243,290 square kilometer, which constitute 7.33% area of the country and 16.50% of national population (Census, 2011 Provisional data). The prospects of agriculture in the State largely depend on timely arrival of monsoon. Where rainfall pattern indicates that during the current monsoon season, the State has received 650 mm rainfall in southwest monsoon and 1000 mm southeastern against the normal rainfall of 741 mm. where soils are having low to medium soil fertility, low to medium water holding capacity, medium infiltration rate and shallow in depth in some areas (Mathur and Yadav, 2006). 1368960 hectare area is under problematic soils (saline and alkaline).

Due to scarcity of rainfall there is limited availability of ground water. The crops suffer medium to high temperature. The water holding capacity is inadequate in lighter soils. The nitrogen and organic carbon status of the soils, in general is medium. The soils are well supplied with potassium. Micro elemental deficiencies particularly zinc and Sulphur has also been observed in pockets. Present investigation was useful in judging the deficiency of various nutrients and thereby use of fertilizers depending on their status. The present study was conducted to recognize the status of macronutrient and their relationship with physico-chemical properties in the soils of Narayanpur block district Mirzapur (U.P).

Materials and Methods

Study area

Mirzapur is an Eastern most district of Uttar Pradesh state in North India. The town of Mirzapur is the district headquarters and located between Geographical area of Mirzapur is 4521 km^2 (latitude 23^0 52″to 25^0 32″N and longitude 82^0 72″to 83^0 33″E). Mirzapur is situated at the point where the side of Ganga river. Narayanpur block is one of the four tehsil of Mirzapur district, located Eastern-western area. The climate of Narayanpur block is marked by with large variation of temperature, where mean monthly maximum temperature during summer months (May to July) reaches up to 47°C and minimum temperature during winter months (December and January) sometimes goes as low as 0°C or even less. The Mean annual rainfall is 750 mm. The region is irrigated by the Ganga River and Channel Dams. Major crops (Table 1) of the region are Rice, wheat, Groundnut, Soyabean, grams, barely and sugarcane and Horticultural crop like fruits, vegetable, and flowers. Industries in Mirzapur district are based on agriculture.

Soil sampling and analysis

Surface soil of the farmer's field from different villages of Narayanpur block of Narayanpur district, were sampled randomly to a depth of 0-15 cm in V shape with the help of Khurpi. Each soil sample was mixed thoroughly and about a half kilogram of composite sample from farmer's fields was analyzed. The physical properties of soil viz. bulk density by core method, particle density by pycnometer method and porosity was measured following the procedure ofKlute and Dirksen. Soil pH and electrical conductivity (EC) of the soil samples in soil: water suspension (1:2.5) was measured using a glass electrode in a digital pH meter and

systronics electrical conductivity meter, respectively. Organic carbon was determined by wet digestion method of Walkley and Black, available Nitrogen by Alkaline permanganate method, Available Phosphorus by colorimetric method using sodium bicarbonate, Available Potassium by ammonium acetate extraction method, Available Sulphur by turbidimetric method.

Statistical analysis

The relationship between different soil characteristics and macronutrient contents in soils were determined using correlation coefficients formula

$$r = \sqrt{\frac{SP\ (xy)}{SS\ (x),\ SS\ (y)}}$$

r = Correlation coefficient
SP (xy) = Sum product of x, y variables
SS (x) = Sum of square of x variable
SS (y) = Sum of square of y variable.

Results and Discussion

Physico-chemical properties of soil

Physico-chemical properties of Soil The data on pH, EC, B.D., P.D. and organic carbon are presented in table 2 which revealed that the pH of soils ranged varies 6.4 to 8.2, with average value of 7.5. Absence of luxuriant vegetation further decreases level of organic matter in these soils. It is expected that a decrease in rainfall or Increase in the pH due to precipitation of $CaCO_3$ and also increases soil pH. The soils of Narayanpur block were neutral to moderately alkaline in reaction. This might be due to medium to high base saturation of soils. Kumar and Babel (2011), Sharma *et al.,* (2013) and Nigam *et al.,* (2014) Singh *et al.,* (2015) also recorded similar findings.

The electrical conductivity of Narayanpur block (Table 2) varied from 0.11 to 0.32 dS m^{-1} with an average value of 0.18 dS m^{-1}. The values indicated that salinity is not a problem in these soils. Similar result was observed by Sharma *et al.,* (2013) and Kumar and Babel (2011).

Bulk density and Particle density ranged from 1.09 to 1.41 and 2.04 to 2.70 Mg m^{-3} respectively with a mean value of 1.28 and 2.40 Mg $m^{-3}$the results are confirmatory with results obtained by Pranagal and Chmielowski in soils of South-Eastern Poland (2012).

Estimates of organic carbon are used to assess the amount of organic matter in soils. Soil organic matter content can be used as an index of N availability because the N content in soil organic matter is relatively constant. The data on percent organic carbon content ranged between 0.14 to 0.86 percent with a mean value of 0.42 percent (Table 2), Thus majority of the soil samples of Narayanpur block were Low to medium in their organic matter status. The high temperatures prevailing in the area might be responsible for rapid decomposition of organic matter. These findings are in agreement with the results reported by Sharma *et al.,* (2013) in soils under continuous vegetable based cropping systems at Indian Institute of Vegetable Research, Varanasi.

Status of available primary macronutrients in soil

The status of N, P and K has been shown in tables 3, 4 and 5. Available nitrogen content of these soils ranged between 131.71 to 332.00 kg $ha^{-1}$with a mean value of 188.02 kg ha^{-1}. On the basis of the ratings suggested by Muhr *et al.,* (1965) 96% of the soil samples were found to be low (< 280 kg N ha^{-1}) and remaining 4 % in the category of medium (280 to 560 kg N ha^{-1}) (Table 5). Most of the

sample was shown the medium availability of nitrogen. The availability of nitrogen is not only an essential part of carbohydrates, fats and oils but also an essential ingredient of proteins. The available nitrogen is an important factor to increase the soil fertility. Low nitrogen status in the soils could be due to low amount of organic carbon in the soils and uncertain rainfall has a major impact on availability of nitrogen. Similar results were observed by Verma *et al.,* (2005) and Singh *et al.,* (2015).

The available phosphorous content in these soils varied from 10.46 to 64.39 kg ha^{-1} with a mean value of 25.79 kg ha^{-1}, On the basis of the limits suggested to Muhr *et al.,* (1965) most of the soil samples (46.66%) were medium (12.5 to 25 kg P ha^{-1}) in available phosphorus status and 52% were under high (P >25 $Kgha^{-1}$) category. It is a constituent of the cell nucleus, essential for cell division and the development of meristematic tissues at the growing points. It makes 0.1 to 0.5% of dry weight of the plant. According to Gupta *et al.,* (2006) the normal value of phosphorus in soil should be (12.5 to 25 kg ha^{-1}). Higher Phosphorus may be due to fixed phosphorus pool of phosphate contains inorganic phosphate compounds that are very insoluble and organic compounds that are resistant to mineralization by microorganisms in soil. These findings are in agreement with the results reported by Meena *et al.,* (2006) in soil of Tonk district of Rajasthan.

Status of available potassium content in these soils ranged from 112.00 to 806.4 kg ha^{-1} with a mean value of 299.15 kg ha^{-1}. According to Muhr *et al.,* (1965) out of 75 soil samples, 62.66% soil samples were found under medium (135 to 335 kg K ha^{-1}) range and 33.34% soil samples under high (>335 kg K ha^{-1}) available K minerals. Pulakeshi *et al.,* (2012) observed similar results from soils in Mantagani village of North Karnataka.

Status of available secondary macronutrient

The data on status of available S, in soils of Narayanpur block of Sri Narayanpur district are presented in tables 3, 4 and 5. The available sulphur content in soils of Narayanpur block ranged from 12.8 to 30.5 kg ha^{-1} with an average value of 22.43 kg ha^{-1}. Plant roots absorb sulphur in the form of $SO4^{-2}$ from the soil solution. Keeping this fact in view, the soil under study may be classified as deficient (20 kg S ha^{-1}) category as per the categorization given by Muhr *et al.,* (1965) According to these categories, 29.34% samples were found under medium and remaining 66.66% samples were found under high category. Thus, the soils of Narayanpur block of district Mirzapur are likely to well respond to Sulphur fertilization. High available sulphur in these soils is due to sulphur bearing minerals. These results are comparable with those reported by Giri *et al.,* (2002) Singh and Mishra (2012).

Correlation between physico-chemical properties and available macro nutrients in the soils of Narayanpur block

The data on correlation between soil properties and available nutrients in top soil of Narayanpur block are presented in table 6 revealed the soil Nitrogen was found Non-significant correlation with pH(r=.048), EC (r=.195), Bulk density (r=.078), and Organic Carbon (r=.022), the Nitrogen in soil negatively Non-Significant with Particle density comparable with the relationship reported by Somasundaram *et al.,* (2013) and Kartikeyan *et al.,* (2014).

Available phosphorus were found Negatively Non significant correlation with Bulk density (r=-.174), Particle density (r=-.195), Organic Carbon (r=-.155).

Table.1 Description of sampling sites

S.N.	Village Name	Cropping pattern
1.	Nakahara	Groundnut-Potato, Rice-Potato, Groundnut-Pea
2.	Raipuriya	Groundnut-Wheat, Rice-Wheat, Groundnut-Pea
3.	JalalpurMaafi	Groundnut-Potatoes, Bajra-Wheat, Soyabean-Potato
4.	Dixitpur	Rice-Wheat-Mustard, Bajra-Sugarcane, Groundnut-Potato
5.	Kailahat	Groundnut-Pea-Mustard, Soyabean-Potato, Rice-Wheat
6.	Bagahi	Groundnut-Potato, Rice-Potato, Groundnut-Pea
7.	Kolana	Rice-Wheat-Mustard, Rice-Sugarcane, Bajra-Wheat

Table.2 Physico-chemical properties of soils of Narayanpur block

Soi characteristics	Range	Mean	S.D	
1.		pH(1:2.5)	6.4-8.2	7.5
0.48				
2.		E.C. (dS m-1)	0.11-0.32	0.18
0.04				
3.		B.D.(mg^{-3})	1.09-1.141	1.28
0.076				
4.		P.D. (mg^{-3})	2.04-2.70	2.40
0.13				

Table.3 Status of available macronutrients viz. available N, P, K, and S in soils of Narayanpur block

Soil characteristics	Range	Mean	S.D.
1. Available N(kg $ha^{-1)}$	131.71-332	188.02	37.65
2. Available P(kg ha^{-1})	10.71-64.39	25.79	9.07
3. Available K(kg ha^{-1})	112-806.4	299.15	133.5
4. Available S(kg ha^{-1})	6.51-39.06	23.25	8.80

Table.4 Rating limits for soil test values used in India (Muhr*et al.,* 1965)

Nutrients	Rating of the soil test values		
	Low	Medium	High
Organic carbon (%)	< 0.5	0.5 – 0.75	> 0.75
Available N(kg ha^{-1})	<280	280 – 560	>560
Available P (kg ha^{-1})	<12.5	12.5 – 25	>25
Available K (kg ha^{-1})	<135	135 – 335	>335
Available S (kg ha^{-1})	<10	10-20	>20

Fig.1 Location of Narayanpur block in Mirzapur district.

Correlation between physico-chemical properties and available macro nutrients in the soils of Narayanpur block

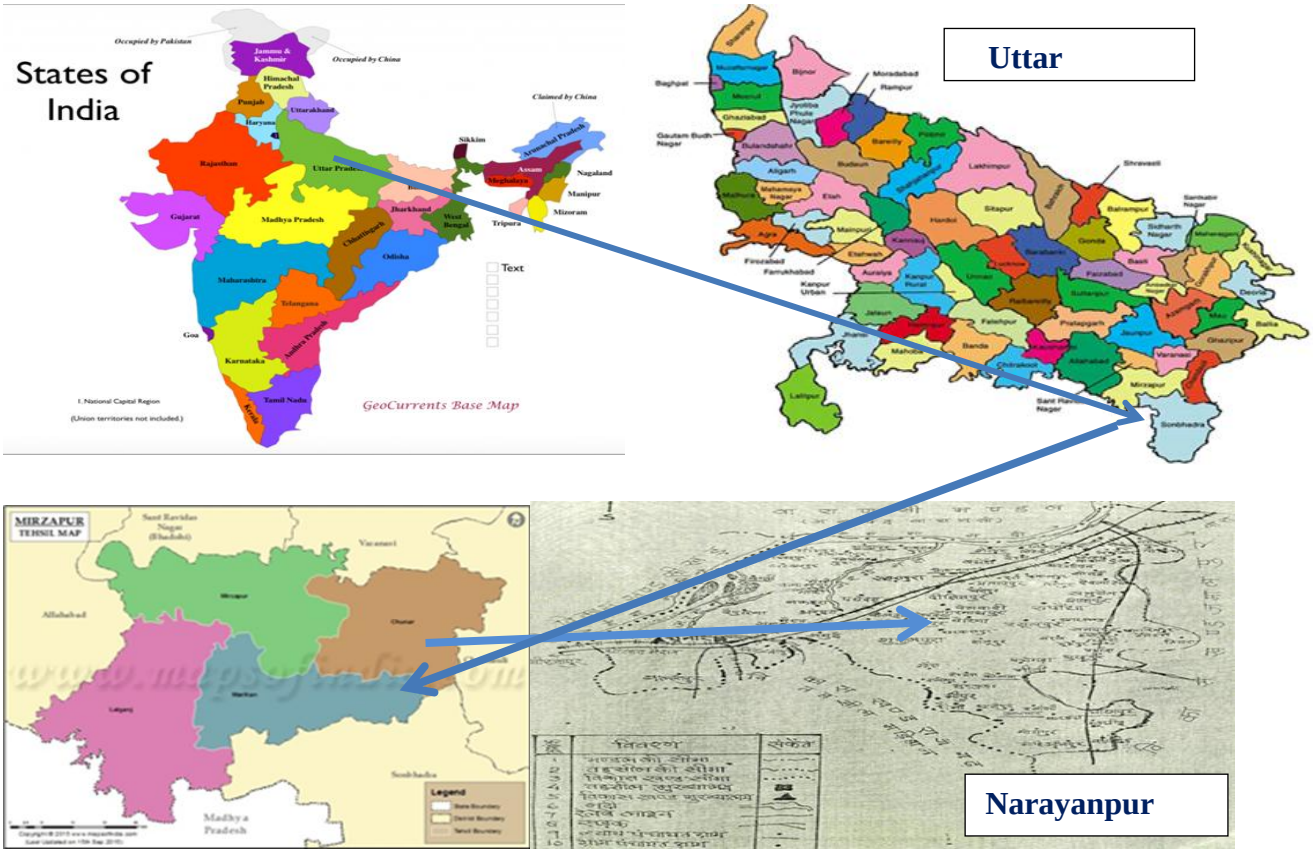

Table.5 Classification OC% and available Macro nutrients status content in soils of Narayanpur block

S.No	Elements	No of Samples	% of samples	No of samples	% of samples	No of samples	% of samples
		Low		Medium		High	
1.	OC	47	62.67	20	26.67	8	10.66
2.	N	72	96	3	4	0	0
3	P	1	1.34	35	46.66	39	52
4	K	3	4	47	62.66	25	33.34
5	S	3	4	22	29.34	50	66.66

Table.6 Correlation between physico-chemical properties and available macro nutrients in the soil of Narayanpur block

	N	P	K	S
pH	.048	.74	.224	- 0.113
EC	.195	.031	-.096	.097
BD	.078	-.174	. 118	-.061
PD	-.107	-.195	.235*	.080
OC	.022	-.155	.026	-.121

Positively non-significant correlation with pH and EC. Jatav and Mishra (2013) have also reported the similar results in soil of Mewar region of Rajasthan and Janjgir (2012) district of Chhattisgarh.

Available Potassium was found positively Significant correlation with Particle density (r=235*) and Non-significant correlation with P^H (r=.224), Bulk density (r=.118), Organic Carbon (r=.026).The Potassium in soil Negatively Non- significant Correlation with EC. Similar relationship was also noticed by Chauhan (2001).

Available sulphur in these soil show negatively significant correlation relationship with pH (r=-.113), Bulk density (r=.061), Organic Carbon (r=-.121). Positively correlation with EC and Particle density, these results corroborate the finding of Meena *et al.,* (2006) positive correlation (r= 0.051) of organic carbon and available sulphur. This relationship was existed because of most of the sulphur is associated with organic matter.

It can be concluded that the soil from Narayanpur block of Mirzapur district is categorized under neutral to moderately saline and alkaline in reaction. Organic carbon is low in range in the soils of studied area. About, 97% of soil samples found in medium available nitrogen, available phosphorus found medium (37%) to high (67%) and available potassium also recorded in similar range. Among the secondary macronutrient, available S noticed medium (44%) to high (56%) and exchangeable calcium, magnesium found sufficient in range.

Acknowledgements

The authors are highly grateful to the Head of Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University Varanasi for providing necessary facility to carry out this work.

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How to cite this article:

Bharteey, P.K., Y.V. Singh, P.K. Sharma Sukirtee, Maneesh Kumar and Avinash Kumar Rai. 2017. Available Macro Nutrient Status and their Relationship with Soil Physico-Chemical Properties of Mirzapur District of Uttar- Pradesh, India. *Int.J.Curr.Microbiol.App.Sci.* 6(7): 2829-2837. doi: https://doi.org/10.20546/ijcmas.2017.607.394