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Study on Soil Nutrient Status According to Global Positioning System in Different Blocks of Birbhum District of West Bengal

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Authors' contributions

This work was carried out in collaboration among all authors. Author SM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author MK managed the analyses of the study. Author FHR edited the whole manuscript and managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

A GPS based soil sampling and testing was done in 10 blocks of Birbhum district under monitoring of Rathindra Krishi Vigyan Kendra, Birbhum during 2018 and 2019. In this regard, some soil chemical properties were analysed through *Mridaparikshak* (soil testing kit). After statistical analysis, pooled data of different soil nutrients were compared based on GPS to prepare a data base for easy fertiliser recommendation of different crops without soil testing. It was found that soil pH (6.29 to 5.50), soil O.C (0.77 to 0.31%), available K (292.12 to 226.60 kg/ha), available B (0.81 to 0.17 mg/kg) and available Fe (44.4 to 21.5 mg/kg) had been decreased with the increase in latitude from 23°04' 07.4500" to 24°11' 15.3400" and longitude. Recommendation of more liming, organic manure, K, B may be done accordingly. On the other hand, available N (184.0 to 296.95 kg/ha), available P (15.05 to 62.76 kg/ha), available S (11.43 to 44.52 kg/ha) and available Zn (0.20 to 1.04 mg/kg) showed sharp direct relation with the increase in Latitude as supported by higher CV value.

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1. INTRODUCTION

Degradation of agro-ecosystems is related to important changes in soil quality like loss of structure, increase of soil erosion, loss of essential nutrients and soil organic matter decrease, increasing dependence on non-renewable resources and biodiversity loss [1]. For increasing productivity, soil test-based fertility management becomes an effective and important tool of agricultural soils with high degree of spatial variability resulting from the combined effects of physical, chemical or biological processes [2]. However, major constraints obstruct wide scale adoption of soil testing in most developing countries. In India, these include the prevalence of small holding systems of farming as well as lack of infrastructural facilities for extensive soil testing [3]. Intensive agriculture without adequate and balanced use of chemical fertilizers, non-eco-friendly tillage practices, and with little or no use of organic manure caused severe fertility deterioration of agricultural soils resulting in stagnating or even declining of crop productivity and soil health [4] only. The application of mineral fertilizers is the most advantageous and the fastest way to increase crop yields. The deficiency of these nutrients in crops leads to various types of disorders in many commercially important crops [5]. Soil testing provides the information about the nutrient availability of the soil upon which the fertilizer recommendation for maximizing crop yield is made. Soil testing is usually followed by collecting composite soil samples in the fields without geographic reference. The results of such soil testing are not useful for site specific recommendations and subsequent monitoring [6]. Soil available nutrients status of an area using global positioning system (GPS) will help in formulating site specific balanced fertilizer recommendation and to understand the status of soil fertility. Under this context, Geographic Positioning System (GPS)-based soil fertility mapping has appeared as a promising alternative. Use of such maps as a decision support tool for nutrient management will not only be helpful for adopting a rational approach compared to farmer's practices or blanket use of state recommended fertilization but will also reduce the necessity for elaborate plot-by-plot soil testing activities. However, information pertaining to such use of GPS-based fertility maps are inadequate in India [7]. Keeping in view the above, importance of mineral fertilizers for crop growth and yield, the present study was carried out with an objective to assess the macro-nutrients, i.e., available Nitrogen (N), Phosphorus (P), Potassium (K), Sulphur (S) and Micronutrients, i.e., Zinc (Zn), Boron (B) and Iron (Fe) distribution in the surface soils. In this occasion, a study on GPS based soil testing was done to evaluate the soil nutrient status of ten blocks of Birbhum district of West Bengal.

2. MATERIALS AND METHODS

Birbhum is a district situated at red and lateritic belt with an average altitude of 58.90 m above from mean sea level under sub-humid, semi-arid region of West Bengal. It consists of 19 blocks and out of these 19 blocks, 10 blocks were randomly selected to collect soil samples. Samplings of soil were done according to the recommended process [8]. The soil of the experimental field was sandy loam in texture and well drained. Different chemical attributes were analysed like pH [9], Organic Carbon [10], available Nitrogen [11], available Phosphorus [12], available Potassium [13] etc. and other micronutrients like Zn, Fe and B [14] following the recommended methods. The samples were analysed using a soil test kit namely *Mridaparikshak* machine recommended by ICAR-Indian Institute of Soil Science, Bhopal, India. The obtained data were analysed following the standard statistical method [15,16] and the data of both the years i.e. 2018 and 2019 were pooled.

3. RESULTS AND DISCUSSION

Analysis of the data of soil samples from ten (10) blocks of Birbhum district has been tabulated and showed in the Table-1 and described in the Fig. 1. It has been discussed according to GPS of the mentioned blocks. Increasing or decreasing trend has been followed among the various soil chemical attributes like pH, organic carbon, available nitrogen, available phosphorus, available potassium, available zinc, available boron, available sulphur and available iron.

3.1 Soil pH

The perusal of the data revealed that pH of the soil had an inverse relation with latitude and longitude. With the increase in latitude from

23°04' 07.4500" in Labpur Block to 24°11' 15.3400" in Rampurhat -1 Block the pH value became lower (6.29 to 5.50). Here Rampurhat-I block had highest latitude with lowest pH value among all the ten mentioned blocks followed by Rampurhat-II and Mayureswar-I block. Therefore, requirement of lime is more in Rampurhat-1 Block followed by Rampurhat-II and Mayureswar-1 Block. The requirement is gradually decreased upto Labour Block. However lower CV value (5.1%) indicates that there was not too much difference among the pH values. In general pH value in all the blocks of the district is low i.e soil is moderate to strong acidic in nature. Similar type of result on soil pH in different blocks of Birbhum districts was found by previous authors, [17]. So liming is required generally in all the blocks of the District.

3.2 Soil Organic Carbon (O.C)

Similarly, analysis of data depicted in the Table revealed that soil organic carbon had also an inverse relation with latitude and longitude. With the increase in latitude soil organic carbon decreased (0.77 to 0.31%). Rampurhat-I block with highest latitude had lowest organic carbon content among all the ten mentioned blocks followed by Rampurhat-II and Mayureswar-I block. Recommendation of more organic manure application may be done in Rampurhat-I block and requirement of organic manure will be decreased accordingly upto labpur block. Whereas, Labpur block, having lowest latitude, showed highest available soil organic carbon. The higher CV value (31.8) indicates that there was much more difference among the soil organic carbon of different blocks. Organic carbon content in the study blocks are low to medium. This result is at par with the findings of earlier researchers [18]. Recommendation of more to medium quantity of organic manure may be done according to different crops.

3.3 Available Nitrogen (N)

Observation of the data in the table revealed that available nitrogen had a direct relation with latitude and longitude. With the increase in latitude available nitrogen also increased. Here Rampurhat-I block had highest latitude (24°11' 15.3400") with the highest available nitrogen content (296.95 Kg/ha) among all the ten mentioned blocks followed by Rampurhat-II and Mayureswar-I block. On the other hand, Labpur block, having lowest latitude (23°04' 07.4500"), showed lowest available nitrogen (184.00 kg/ha). Therefore, crops in Labpur block require more fertiliser N than those of other blocks. The medium range of CV value (17.8%) indicates that there was medium but clear difference in available nitrogen content of different blocks. Most of the study blocks contain low available nitrogen in soil. The result corroborates with the observation of earlier scientists [18] and more nitrogenous fertiliser application is recommended in those locations.

3.4 Available Phosphorus (P)

It was observed from the Table that available phosphorus had a strong direct relation with latitude and longitude. With the increase in latitude available phosphorus also increased. Rampurhat-I block with highest latitude had highest available phosphorus among all the ten mentioned blocks followed by Rampurhat-II and Mayureswar-I block. Labpur block, having lowest latitude (23°04' 07.4500"), showed lowest available phosphorus (15.05 kg /ha). This is supported by the lowest pH in Labpur block. Crop cultivation in Labpur block require more phosphatic fertiliser application than those of other blocks. In this case higher CV value (55.1%) indicates that there was sharp difference among the available phosphorus content of different blocks (Fig.1). Low to medium available phosphorus content in soil is found in the study blocks of the district. This might be due to phosphate fixation by iron and aluminium in low pH condition. This result agrees with observations of different researchers [19,20].

3.5 Available Potassium (K)

The data recorded in the table revealed that available potassium had a low inverse relation with latitude and longitude. The low CV value (8.6%) supported the available K status within the blocks. With the increase in latitude available potassium decreased. Here Rampurhat-I block showed had highest latitude (24°11'15.34") while the available potassium content in the soil of Rampurhat-I block was lowest (226.60 Kg/ha) among all the ten mentioned blocks followed by Rampurhat-II and Mayureswar-I block. Labpur block, having lowest latitude (23°04' 07.45"), showed highest available potassium (292.12 kg/ha). Available K content in soil is medium in general in all the blocks [17].

Table 1. GPS wise soil nutrient status of different blocks of Birbhum District of West Bengal in 2018 and 2019

Name of the block	Latitude (N)	Longitude (E)	pH	OC (%)	N (kg/ha)	P (kg/ha)	K (kg/ha)	S (mg/kg)	Zn (mg/kg)	B (mg/kg)	Fe (mg/kg)
Labpur	23°04'07.4500"	87°05'01.1500"	6.29	0.77	184.00	15.05	292.12	11.43	0.20	0.81	44.40
Dubrajpur	23°43'37.0550"	87°22'29.0902"	6.29	0.69	185.35	15.14	289.55	11.48	0.37	0.41	42.45
Khairasole	23°47'23.0000"	87°15'38.5000"	6.18	0.69	195.95	17.92	284.50	11.56	0.40	0.35	35.20
Suri-I	23°53'55.0400"	87°31'46.3600"	6.13	0.65	205.55	18.07	270.70	11.78	0.44	0.32	35.10
Mayureswar-II	23°54'30.0600"	87°48'01.0400"	6.07	0.59	216.50	20.18	263.50	15.73	0.48	0.31	30.50
Md.Bazar	23°56'45.0110"	87°33'01.0200"	5.99	0.55	244.55	22.37	255.50	16.24	0.56	0.29	29.55
Suri-II	23°56'45.1100"	87°34'33.1200"	5.93	0.42	259.00	25.99	246.65	30.01	0.70	0.27	23.51
Mayureswar-I	24°03'05.0100"	87°41'13.0100"	5.62	0.36	265.65	32.07	243.00	30.31	0.95	0.26	22.45
Rampurhat-II	24°08'15.3400"	87°54'30.0103"	5.51	0.32	282.45	39.43	240.65	33.78	0.86	0.20	21.74
Rampurhat-I	24°11'15.3400"	87°42'06.1200"	5.50	0.31	296.95	62.76	226.60	44.52	1.04	0.17	21.50
SD	-	-	0.31	0.17	41.47	14.81	22.59	11.96	0.28	0.18	8.51
CV	-	-	5.1	31.8	17.8	55.1	8.6	55.1	46.1	52.9	27.8

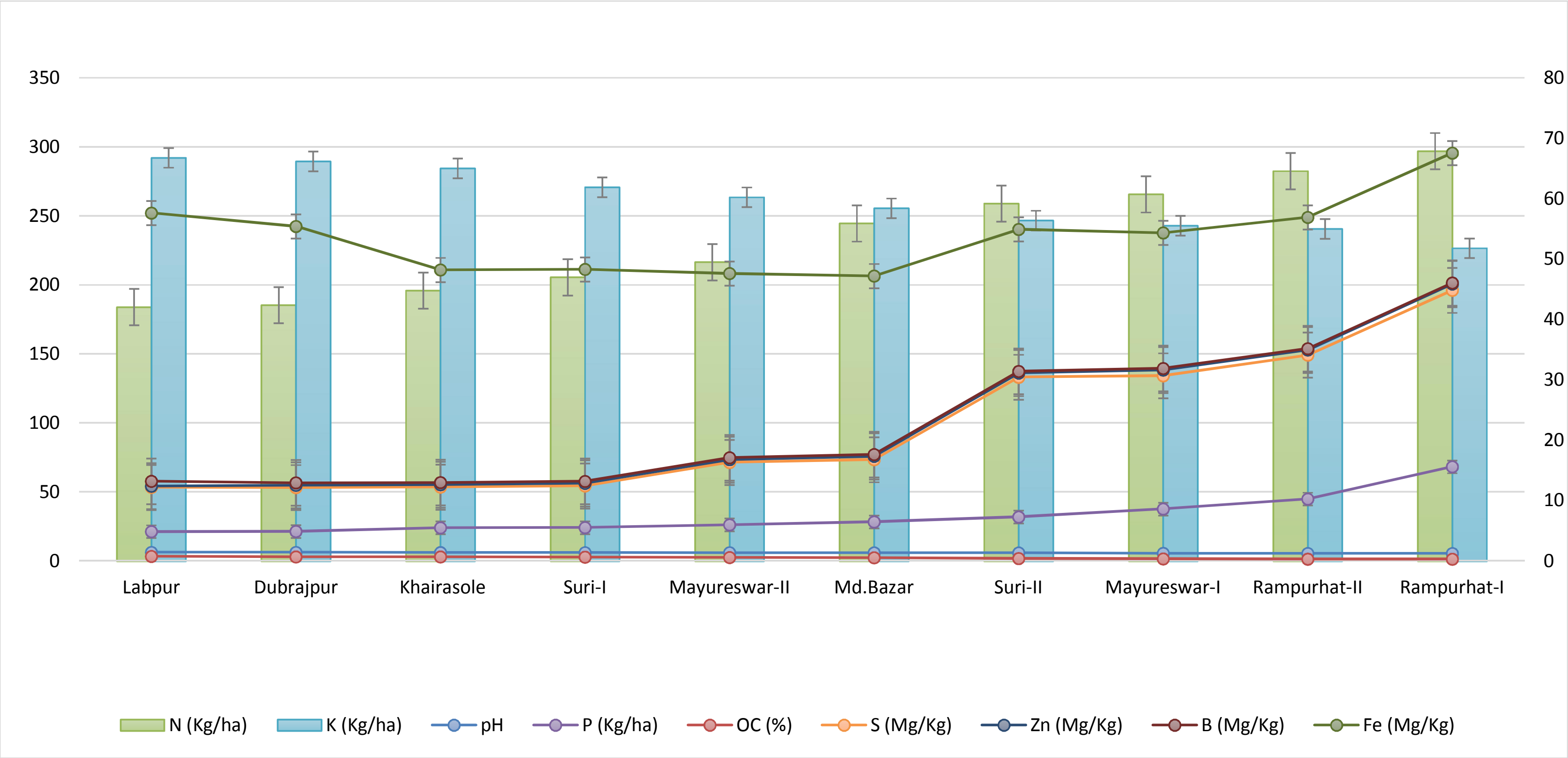

Fig. 1. Trend of soil nutrient status of ten blocks of Birbhum District of West Bengal

3.6 Available Sulphur (S)

Analysis of data indicated that like available phosphorus, available sulphur also had a strong direct relation with latitude and longitude. With the increase in latitude, available sulphur increased sharply (11.43 to 44.52 mg/kg) with very high CV value (55.1%). Rampurhat-I block showed highest latitude with highest available sulphur content in the soil among all the ten mentioned blocks followed by Rampurhat-II (33.78 mg/kg) and Mayureswar-I (30.31 mg/kg) block. Wherever, Labpur block, having lowest latitude, showed lowest available sulphur content in soil and thus crops in this block require more amount of sulphur containing fertiliser. Varying level of sulphur content is found in the study blocks.

3.7 Available Zinc (Zn)

The perusal of the data in the table revealed that available zinc had a strong direct relation with latitude and longitude. With the increase in latitude, available zinc content in soil was increased gradually and sharply (Fig.1). Rampurhat-I block with highest latitude (24°11' 15.3400") had highest available zinc content (1.04 mg/kg) in the soil among all the ten mentioned blocks followed by Rampurhat-II and Mayureswar-I block. Wherever, Labpur block, having lowest latitude, showed lowest available zinc (0.20 mg/kg) and it is very much related to soil pH. Soil or foliar application of Zn may be recommended in this block. In this case higher CV value (46.1%) indicates that there was much more difference among the available zinc of different blocks. The results corroborates with the findings of Nisab *et al* [18] in Birbhum district.

3.8 Available Boron (B)

From the analysed data in the table, it is found that available boron had a strong inverse relation with latitude and longitude (Fig. 1). With the increase in latitude (from 23°04' 07.45" in Labpur Block to 24°11'15.34" in Rampurhat -1 Block) available boron decreased gradually (0.81 to 0.17 mg/kg). Therefore, application of boron as either soil or foliar spray may be recommended in the blocks with higher latitude. Similar trend of results are found as in the case of available K content. In this case high CV value (52.9%) indicates that there was remarkable difference among the available boron of different blocks. Generally, available boron content in most of the study blocks is found low. Previous researchers [18] found similar trend of results in Boron content in different Blocks of Birbhum district.

3.9 Available Iron (Fe)

The perusal of the data indicated that available iron had an inverse relation with latitude and longitude. With the increase in latitude (from 23°04' 07.45" in Labpur Block to 24°11' 15.34" in Rampurhat -1 Block) available Fe decreased gradually (44.4 to 21.5 mg/kg).Similar trend of result was obtained as in case of boron content. In general Fe content in soil is very high in all the blocks of the district. Actually, there is no need of Fe application for crop production in Birbhum district.

4. CONCLUSION

From the above study it may be concluded that with the increase in latitude from 23°04'07.45" in Labpur Block to 24°11'15.34" in Rampurhat-I Block the soil pH, organic carbon, available potassium, available boron and available iron content are decreasing sharply. So application of these nutrients is essential in Blocks with higher latitude like Rampurhat-1, Rampurhat-II for better crop production. On the other hand, available nitrogen, available phosphorus and available zinc content in soil are increasing with increase in latitude from 23°04'07.45" to 24°11'15.34" within the 10 blocks under study. Therefore, application of fertiliser containing these nutrients is important in the Blocks with lower latitude like Labpur, Dubrajpur. The farmers without soil testing may be benefitted by getting fertiliser recommendation with the GPS value of his field.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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