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Soil fertility status of different blocks in Balasore district of coastal Odisha, India

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Abstract
An investigation on GPS based soil physico-chemical properties of three different block (Bhograi, Jaleswar, Sadar) of Balasore district was under taken during the year 2019-20. 27 soil samples were collected at three different depth (0-15, 15-30, 30-40 cm) and analysed at the department of soil science and agricultural chemistry, NAI, SHUATS. The soils were slightly acidic in reaction (pH 5.5-6.5). The electrical conductivity of soil of entire studied area were less than 1 dS m^{-1}. The soil organic carbon status was low to medium, ranges from 0.27 to 0.78%. The available nitrogen content of entire studied area was low (106 to172.47 kg ha^{-1}). The available Olsen phosphorus and potassium content varied in between 4.75 to23.48 kg ha^{-1} and 77.50 to 244.21 kg ha^{-1}. The exchangeable Ca and Mg ranges from 2.93-10.87 and 1.27 to 4.77 cmol (p^+) kg^{-1}. The sulphur content of soil ranged from 3.75 -7.50 mg kg^{-1}. The fertility data base would be very useful for extension functionaries, agricultural officers, scientist and above all the farmers for a sustainable crop production.

Keywords: soil fertility status, physico-chemical properties, pH, EC, OC, nitrogen, potassium, phosphorus, soil analysis, Balasore district

Introduction
Balasore, a district of Odisha which comes under North Eastern Coastal Plain Agro Climatic Zone of Odisha (Nanda *et al.*, 2008) [16]. Soil is the life supporting system and one of the most vital and the precious natural resources of country. Socio economic development of the people depend on the soil that sustains life on the Earth. Soil, land and water are crucial element for a long and healthy human existence, as well as the foundation for agricultural development (Das *et al.*, 2009) [4]. Efficient management of soil and water resources is a major challenge for the scientists, planners, administers and farmers to ensure food, water and environmental security for the present and future generations (Kanwar, 2000) [20]. Soil test-based fertility management is an effective tool for of agricultural soils that have high degree of spatial variability which find out the soil fertility related production constrains in the study area and offer corrective steps for maximum crop production (Rawal *et al.*, 2018) [23]. Global Positioning System and Geographic Information System (GPS-GIS) can be efficiently use for monitoring soil fertility status Fertilizer use can be better optimized by utilizing knowledge of “soil fertility maps” prepared with the help of Geographical Information System (Dash *et al.*, 2018) [5]. GPS- based soil fertility can also be used to track the health of the soil over time (Swain *et al.*, 2019) [26].

Material and Methods
A. Experimental Site
The study area includes an unconsolidated coastal sector of Subarnarekha delta, extend from Rasulpur to Udaipur. The investigated area is bordered on the north by the Mayurbanja District, on the south by Bay of Bengal and on the west by the state of Odisha’s Bhadrak District. As deltaic low lying coast line Stretch, this area has a flat alluvium surface with ground level ranging from 2.5 3.5 meters above mean sea level. soil samples were selected from 9 villages namely Kirtaniajalpahi (lat. 21034’48.51721” N, long. $87^0$22’41.53792" E), NM Padia (lat. $21^0$35’2.13949" N, long. $87^0$23'12.01452" E), Ausa (lat. $21^0$37'26.89731" N, long. 87023’33.49901” E), Sugo (lat. 21047’50.97687” N, long. $87^0$17'36.72635" E), Kasidiha (lat. $21^0$48'12.95989" N, long. $87^0$16'5.0971" E), Ambliatha (lat. 21048’34.17454” N, long. $87^0$15'21.38852"E), Kasipada (lat. 21036’55.28808” N, long. 8701’26.42376”E), Nuagaon (lat. 2106’36.80964”N, long. 84043’25.39128”E), Pinchabani (lat. 21036’44.35812”N, long $86^0$59'59.78256’’E) for studying the GPS based soil fertility status from the 3 blocks of Balasore district namely Bhograi, Jaleswar, Sadar. Normal Annual Rainfall of Balasore district is 1592 mm and the mean Annual Rainfall is 1723 mm.

The mean maximum summer temperature is 45 °C and the mean minimum winter temperature is 9 °C. The relative humidity varies between 30 to 90 percentages. The climate is Humid Sub-tropical climate.

B. Soil Sampling
Total 27 numbers of composite (0-15 cm, 15-30 cm, 30-45 cm) soil samples were collected from the studied area which includes 3 samples from each village from 3depth. Composite soil samples were collected along with latitude and longitude of the area with the help of GPS instrument.

C. Analysis of Soil
The soils were analysed for its pH (1: 2.5::Soil: water) (Jackson, 1958), EC (1:2:Soil:water) (Wilcox, 1950), Organic Carbon (Wakley and Black, 1934) [28], Available Nitrogen (Subbiah and Asija, 1956) [25], Available Phosphorus (Olsen *et al.*, 1954) [21], Available Potassium (Toth and Prince, 1949) [27], Exchangeable Ca and Mg (Schwarzenbach *et al.*,1946) [24], Available Sulphur (William and Steimberg, 1959) [30].

D. Statistical Analysis
The data recorded during the course of investigation was subjected to statistical analysis of Completely Randomized Design (CRD) as per the method of "Analysis of Variance" (ANOVA) technique (Fisher, 1954) [7].

E. Soil Fertility Index
Fertility index was calculated as per the formula suggested by (Parkar 1951) [22] such as Nutrient Index Value

$$= \frac{\text{No.of samples (Low)}*1+\text{No.of samples (Medium)}*2+\text{No.of samples(High)}*3}{\text{Total No.of samples}}$$

Results
Soil pH
The pH of soils of all the 3 blocks (Bhograi, Jaleswar, Sadar) of Balasore district was found moderately acidic to slightly acidic. The pH of the investigated area ranged from 5.6 to 6.93 with an average value 6.3. The Kasidiha and Pinchhabani was found strongly acidic. Similar findings were also recorded by (Mishra *et al.*, 2015) [10].

Table 1: Soil pH of farmer's field at 0-15, 15-30, 30-45 cm depth

Village	0-15 cm	15-3 cm	30-4 cm	Total	Mean
Kirtaniajalpahi	6.6	6.4	6.3	19.3	6.43
NM Padia	6.5	6.9	6.7	20.1	6.70
Ausa	6.8	6.5	7.5	20.8	6.93
Sugo	5.9	6.6	7	19.5	6.50
Kasidiha	5.3	5.5	5.8	16.6	5.53
Ambliatha	5.8	6.7	7.1	19.6	6.53
Kasipada	6.8	6.4	6.7	19.9	6.63
Nuagaon	6.15	6.32	6.5	18.97	6.32
Pinchhabani	5.8	5.2	5.8	16.8	5.6
f-test		S			
S. Em (±)		0.31			
C.D. (P = 0.05)		0.66			

Soil Electrical Conductivity (dS m^{-1})
Entire study area was found to be less than 1dSm^{-1}. Hence all the soil in the study area is safe for all types of crops production with respect to the soluble salts. Similar findings were also recorded by (Mishra *et al.*, 2015) [10].

Table 2: Soil electrical conductivity (dSm^{-1}) of farmer's filed at 0-15, 15-30, 30-45 cm depth

Village	0-15 cm	15-3 cm	30-4 cm	Total	Mean
Kirtaniajalpahi	0.085	0.07	0.07	0.225	0.08
NM Padia	0.16	0.14	0.12	0.42	0.14
Ausa	0.09	0.03	0.05	0.17	0.06
Sugo	0.09	0.26	0.15	0.5	0.09
Kasidiha	0.16	0.11	0.15	0.42	0.14
Ambliatha	0.16	0.06	0.1	0.32	0.11
Kasipada	0.06	0.08	0.4	0.54	0.18
Nuagaon	0.24	0.16	0.31	0.71	0.24
Pinchabani	0.36	0.3	0.24	0.9	0.30
f-test		S			
S. Em (±)		0.63			
C.D. (P = 0.05)		0.13			

Soil Organic Carbon (%)
The organic carbon ranges from 0.27 – 0.64. In the entire study area organic carbon status was found to be low to medium. The village Ausa show a highest content of organic matter. The result clearly shows that the gradual decrease of SOC from surface layer to deep sub surface layer. This could be related to increase cropping intensity combined with increased crop residue assimilation. Similar findings also been reported by (Mishra 2013) [11], (Digel *et al.*, 2018) [6], (Swain *et al.*, 2019) [26].

Table 3: Soil organic carbon (%) of farmer's filed at 0-15, 15-30, 30-45 cm depth

Village	0-15 cm	15-30	30-45	Total	Mean
Kirtaniajalpahi	0.34	0.26	0.22	0.82	0.27
NM Padia	0.54	0.41	0.25	1.2	0.40
Ausa	1.17	0.78	0.4	2.35	0.78
Sugo	0.62	0.56	0.2	1.38	0.46
Kasidiha	0.58	0.39	0.23	1.2	0.40
Ambliatha	0.44	0.35	0.29	1.08	0.36
Kasipada	0.67	0.44	0.36	1.47	0.49
Nuagaon	0.47	0.31	0.29	1.07	0.36
Pinchabani	0.98	0.58	0.35	1.91	0.64
f-test		NS			
S. Em (±)		0.17			
C.D. (P = 0.05)		0.36			

Available nitrogen In Soil (kg ha^{-1})
The available nitrogen ranged from 106 to 207.4kg ha^{-1} with a mean of 152.05 kg ha^{-1}. All the soil sample were categorized under low nitrogen content. The variation in N content may be related to soil management, application of the FYM and fertilizers to previous crop. The result obtained in the present study are in agreement with the findings of (Nalawade and Palwe 2014) [15] and (Kadlag *et al.*, 2016) [19].

Table 4: Available Nitrogen (kg ha^{-1}) in soil of farmer's filed at 0-15, 15-30, 30-45 cm depth

Village	0-15	15-30	30-45	Total	Mean
Kirtaniajalpahi	94.4	134.6	89	318	106
NM Padia	145.6	148.6	105.8	400	133.33
Ausa	138.2	156.8	120.4	415.4	138.46
Sugo	150.4	155.8	165.8	472	157.33
Kasidiha	157.4	168.8	147.4	473.6	157.86
Ambliatha	129.4	139.8	122.8	392	130.66
Kasipada	215.4	238.6	168.4	622.4	207.46
Nuagaon	154.6	206	134.2	494.8	164.93
Pinchabani	186	201.6	129.8	517.4	172.46
f-test		S			
S. Em (±)		20.81			
C.D. (P = 0.05)		43.72			

Available Phosphorus (kg ha^{-1}) In Soil

The available phosphorus in my investigated area ranged from 4.41 to 23.47 kg ha^{-1} with a mean of 13.3kg ha^{-1}. Must of the soils were under low category for available phosphorus. As per the findings of the low amount available P may be due to application of lower doses of P fertilizer, fixation of P on clay minerals, or $CaCO_3$ surface with the time elapsed between fertilizer application and crop uptake. Similar results were noticed by (Barik *et al.*, 2017) [3].

Table 5: Available Phosphorus (kg ha^{-1}) in soil of farmer's filed at 0-15, 15-30, 30-45 cm depth

Village	0-15	15-30	30-45	Total	Mean
Kirtaniajalpahi	15.5	30.85	24.08	70.43	23.47
NM Padia	21.1	10.5	22.5	54.1	18.03
Ausa	5.4	22.1	12.25	39.75	13.25
Sugo	2.88	10.6	15.2	28.68	9.56
Kasidiha	6.9	22.6	18.9	48.4	16.13
Ambliatha	7.5	20.2	13.7	41.4	13.8
Kasipada	2.5	9.9	0.85	13.25	4.416
Nuagaon	18.5	20.1	11.2	49.8	16.6
Pinchabani	3.75	9.01	1.5	14.26	4.75
f-test			S		
S.Em (±)			5.30		
C.D. (P = 0.05)			11.14		

Available Potassium (kg ha^{-1}) In Soil

The available K of block Bhograi ranges from 66.75 – 101.04 kg ha^{-1}, for block Jaleswar 117 – 314.36 kg ha^{-1} and in block Sadar 75.3 – 269.46 kg ha^{-1}. Village Sugo, Kasidiha, Ambliatha, Kasipada and Nuagaon were in medium range of available potassium content. 44% of my studies area show the available potassium increased with increasing soil depth, which could be due to the development of the soil from residual parent materials, mostly feldspars and micas, which are mostly potash bearing minerals, as well as the effect of potassium depletion by the crops from the surface horizon. The mean available potassium of these three blocks is 142.59 kg ha^{-1}. Similar results also found by (Dash *et al.*, 2018) [5].

Table 6: Available potassium (kg ha^{-1}) in soil of farmer's filed at 0-15, 15-30, 30-45 cm depth

Treatments	0-15	15-30	30-45	Total	Mean
Kirtaniajalpahi	67.36	89.8	106	263.16	87.72
NM Padia	78.59	72.3	81.6	232.49	77.49
Ausa	101.04	120	66.75	287.79	95.93
Sugo	296.21	151.53	117	564.74	188.24
Kasidiha	157.18	266.86	167.5	591.54	197.18
Ambliatha	314.36	287.29	130.98	732.63	244.21
Kasipada	269.45	145.3	111.21	525.96	175.32
Nuagaon	98.2	169.39	75.3	342.89	114.29
Pinchabani	84.75	111.05	113.09	308.89	102.96
f-test			S		
S. Em (±)			49.61		
C.D. (P = 0.05)			104.23		

Exchangeable Calcium [cmol (p$^+$) kg^{-1}]

The entire studied area was under low category of calcium with a mean value of 6.9 cmol (p$^+$) kg^{-1}. Similar also observed by (Pulakeshi, 2010).

Table 7: Exchangeable calcium [cmol (p$^+$) kg^{-1}] in soil of farmer's filed at 0-15, 15-30, 30-45 cm depth

Village	0-15	15-30	30-45	Total	Mean
Kirtaniajalpahi	10.4	11.8	1.6	23.8	7.93
NM Padia	4.11	7.9	1.2	13.21	4.40
Ausa	18.8	10.4	3.4	32.6	10.86
Sugo	2.9	14.9	3.2	21	7
Kasidiha	7.3	8.9	3.5	19.7	6.56
Ambliatha	11.5	5.8	1.5	18.8	6.26
Kasipada	11.8	11.8	0.5	24.1	8.03
Nuagaon	12.3	8.5	3.5	24.3	8.1
Pinchabani	0.9	4.7	3.2	8.8	2.93
f-test			NS		
S. Em (±)			2.1		
C.D. (P = 0.05)			8.9		

Exchangeable Magnesium [cmol (p$^+$) kg^{-1}] In Soil

The data in respect of exchangeable magnesium content in soil were ranged from 1.2 – 4.7 cmol (p$^+$) kg^{-1} with the mean value of 2.76 cmol (p$^+$) kg^{-1}. Similar results were found also reported by (Anderson *et al.*, 2017) [1].

Table 8: Exchangeable magnesium [cmol (p$^+$) kg^{-1}] in soil of farmer's filed at 0-15, 15-30, 30-45 cm depth

Village	0-15	15-30	30-45	Total	Mean
Kirtaniajalpahi	2	1.75	0.05	3.8	1.26
NM Padia	3.5	1.08	1	5.58	1.86
Ausa	2.5	2.12	2.1	6.72	2.24
Sugo	4	4.2	2.5	10.7	3.56
Kasidiha	5.3	2.78	1	9.08	3.02
Ambliatha	2.6	2.11	1	5.71	1.90
Kasipada	2.5	4.8	3.75	11.05	3.68
Nuagaon	0.6	5.1	2.01	7.71	2.57
Pinchabani	4	8.9	1.4	14.3	4.76
f-test			NS		
S. Em (±)			1.50		
C.D. (P = 0.05)			3.16		

Available Sulphur (mg kg^{-1})

The available sulphur in soils of Bhograi, Jaleswar and Sadar block of Balasore district ranged from 3.75 to 6.25ppm. In the entire study area was found to be in range of low to medium. The available sulphur content of investigated area decreased with increasing the soil depth. This could be attributed to a larger concentration of organic matter in the upper layers than in the deeper layers, as well as differences in land usage. Similar results were also observed by (Nahak *et al.*, 2016) [18] and (Mishra 2016) [18].

Table 9: Available sulphur (mg kg^{-1}) in soil of farmer's filed at 0-15, 15-30, 30-45 cm depth

Village	0-15	15-30	30-45	Total	Mean
Kirtaniajalpahi	6.25	1.25	3.75	11.25	3.75
NM Padia	5	5	2.5	12.5	4.17
Ausa	11.25	6.25	5	22.5	7.50
Sugo	5	3.75	1.25	10	3.33
Kasidiha	7.5	1.25	3.75	12.5	4.17
Ambliatha	5	1.25	3.75	10	3.33
Kasipada	10	7.5	1.25	18.75	6.25
Nuagaon	5	3.75	1.25	10	3.33
Pinchabani	6.25	3.75	1.25	11.25	3.75
f-test			NS		
S. Em (±)			2.22		
C.D. (P = 0.05)			4.67		

Soil Fertility Index

The soil fertility status of the Bhograi, Jaleswar and Sadar block of Balasore district was estimated as per Parker's nutrient index value and the available primary nutrients i.e., N, P, K status of the soils categorized as low.

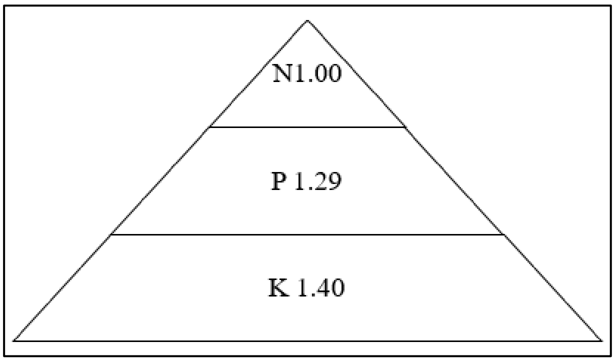

Fig 1: Nutrient Fertility Pyramid

In pyramid toward the top, it become narrow and nutrient index value also reduces which indicates less availability of respective nutrient in soil with respect to bottom nutrients and requirement is maximum in the soil.

Conclusion

Under this investigation it was concluded that soil of area around Balasore district slightly acidic in nature but low in salt content so almost all crops are suitable for the production. And the organic carbon content was medium to high in range, low in available nitrogen content, low to medium phosphorus and nitrogen content. With respect to secondary macronutrient the available exchangeable calcium, magnesium and sulphur content of soil was low. The deficient nutrient may be replenished to avoid the suffering from their deficiency and optimum utilization of nutrients. Integrated nutrient management (INM) may be adopted for sustainable soil fertility management as well as to achieve higher crop production.

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Conflict of Interest

As a corresponding Author, I Jyotiranjan Jena, confirm that none of the others have any conflict of interest associated with this publication.

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