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# Soil Fertility Assessment of Some Villages in Kankadahad Block of Odisha

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## ABSTRACT

An assessment of soil status of Kankadahad block of Odisha was carried out to determine the basic physico-chemical properties of the soil, based on which site specific nutrient recommendations can be adopted. The study was carried out in four selected villages of the block. Results revealed that soils mostly belong to the textural class of loamy sand and sandy loam. Soils are acidic in reaction, safe concerning electrical conductivity. Soil organic carbon contents varied from 1.4 to 12 g $kg^{-1}$. Available nitrogen, phosphorus and potassium contents of soils varied from 50 to 225, 7 to 36 and 120 to 509 kg $ha^{-1}$, respectively. Soil acidity, low availability of available nitrogen and phosphorus were identified to be the major soil-related crop production constraints of the study area.

**Keywords:** Kankadahad, Soil acidity, Constraints.

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## 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 Kankadahad block of Odisha located in the Mid-Central Table Land Agro-Climatic Zone. Four villages of the block namely Kantapal, Kandhara, Dangapal and Kankadahad 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 soil management decisions to achieve sustainable crop production goals.

## MATERIALS AND METHODS

Kankadahad block is located in the Northern part of the Dhenkanal District of Odisha and is 20 kms away from the state highway running from Talcher to Duburi. This block is surrounded by Keonjhar District on the North, Jajpur District on the East, Kamakhyanagar and Parjang block of the Dhenkanal District on the South and Palallahara block of Angul District on the West (Fig. 1). Soil samples were collected from four different villages of the block namely Kantapal, Kandhara, Dangapal and Kankadahad. All the four villages are surrounded by dense forests and two tributaries of the river *Brahmani* called *Ramial* and *Dolia* River. The life line of these four villages is *Ramial* River, which intersects the state high way 26.5 kms away from Kankadahad. All the four villages under study including the surrounding villages are irrigated by the canal system of Dandadhar *Dam* both in *kharif* and *rabi* season. The mean annual rainfall of the study area is 1421mm. The mean maximum summer temperature is 38.7° C and the mean minimum winter temperature is 14.0° C. The climate is hot, moist and sub-humid. The soils of this Agro-Climatic Zone are mostly alluvial, red and lateritic (*Haplustalfs, Plinthustalfs, Ochraqualfs*) (Nanda *et al.* 2008). The area has been cultivated for a diverse range of crops such as groundnut, arhar, horse gram, vegetable in uplands; maize and groundnut in medium lands; rice and sugarcane in low lands (Pattanayak 2016).

Total 40 numbers of GPS based composite surface (0–15 cm) soil samples were collected from the study area which includes 10 samples from each village from different land types such as upland, medium land and low land. Soil sampling data including latitude, longitude and elevation above mean sea level was collected using a GPS instrument (Garmin make; model: 76MAPCSx). 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 (Subbi-

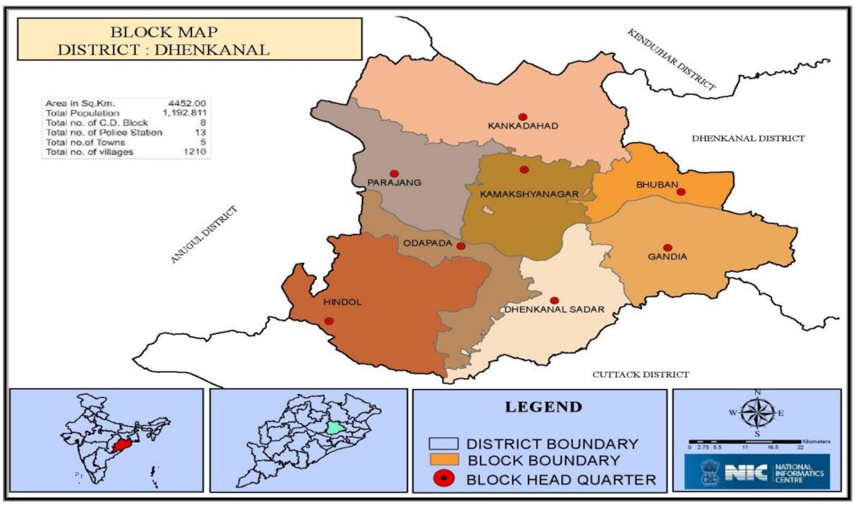


**Fig. 1.** Block map of Dhenkanal District.

ah and Asija 1956), phosphorus (Bray and Kurtz 1945) and potassium (Hanway and Heidel 1952).

## RESULTS AND DISCUSSION

Four villages of Kankadahad block of the Dhenkanal District namely Kantapal, Kandhara, Dangapal and Kankadahad are included in the present investigation for studying the basic physico-chemical properties and fertility status of soil concerning primary macronutrients.

### Soil color

The soil color of all the soil samples ranged from Yellow (10 YR 7/6) to Yellowish Red (5 YR 5/8). The soil color of Kantapal, Kandhara, Dangapal and Kankadahad village ranged from yellow (10 YR 7/6) to yellowish red (5 YR 5/8), brownish yellow (10 YR 6/6) to very pale brown (10 YR 8/2), strong brown (7.5 YR 5/8) to brownish yellow (10 YR 6/6) and strong brown (7.5 YR 5/8) to brownish yellow (10 YR 6/6), respectively. Such a yellow-red combination of value can be attributed to the presence of a high amount of iron and high moisture regime of the soil (Dash *et al.* 2019c).

### Mechanical composition of soils

The sand, silt and clay content in the soils of Kantapal village were found to vary in between 72.8 to 88.8, 3.9 to 11.9 and 6.2 to 19.3%, respectively; that of Kandhara village varied between 73.8 to 85.8, 7.6 to 12.0 and 6.6 to 15.3%, respectively; that of Dangapal varied between 71.2 to 85.8, 6.9 to 13.0 and 6.2 to 16.4%, respectively; that of Kankadahad village varied between 71.8 to 93.8, 2.9 to 10.0 and 3.3 to 18.6%, respectively (Table 1). The average clay content was found to be 13.0, 10.5, 11.1 and 10.4% in Kantapal, Kandhara, Dangapal and Kankadahad village, respectively (Table 1). Similar findings have also been observed by Nayak *et al.* (2014), Mishra *et al.* (2014). Out of all the analyzed soil samples, 73 % of the soils are classified under the textural class of loamy sand, 22 % under sandy loam and 2 % under the class of sand. Hence, the soils are well-drained, well infiltrated and are more suitable for sand loving crops. But, the soils are expected to offer soil constraints like poor nutrient and water holding capacities

### Soil reaction

Soil pH (1:2) of surface soil samples of Kantapal village were found to vary in between 4.9 to 6.5 with a mean value of 5.5; that of soils of Kandhara village varied between 4.6 to 5.8 with a mean value of 5.0; that of Dangapal varied between 4.4 to 6.9 with a mean value of 5.5 and that of soils of Kankadahad village varied between 5.4 to 6.7 with a mean value of 6.2 (Table 2). The data showed a gradual increase in soil pH value towards low land, which could be attributed to the process of deposition of basic captions in the same through the process of drainage and leaching during intensive rainfalls. Since 90 % of soils belong to the acid soil category, soil acidity appears to be a major crop production constraint in the study area. Soil acidity can offer several other soil limitations such as toxic effects of certain elements (Fe, Al), nutrient imbalance and reduced microbial activity. Similar findings have also been reported earlier by Dash *et al.* (2019a), Priyadarshini *et al.* (2017), Satpathy *et al.* (2015).

### Electrical conductivity

Electrical conductivity (1:2) of surface soil samples

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

| Name of village | % Sand | | % Silt | | % Clay | |
|---|---|---|---|---|---|---|
| | Range | Mean | Range | Mean | Range | Mean |
| Kantapal | 72.8 to 88.8 | 80.1 | 3.9 to 11.9 | 6.9 | 6.2 to 19.3 | 13.0 |
| Kandhara | 73.8 to 85.8 | 80.4 | 7.6 to 12.0 | 9.0 | 6.6 to 15.3 | 10.5 |
| Dangapal | 71.2 to 85.8 | 79.9 | 6.9 to 13.0 | 8.9 | 6.2 to 16.4 | 11.1 |
| Kankadahad | 71.8 to 93.8 | 82.1 | 2.9 to 10.0 | 7.5 | 3.3 to 18.6 | 10.4 |

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

| Name of village | Land type | pH (1:2) | | EC (1:2) (dS m$^{-1}$) | | OC (g kg$^{-1}$) | |
|---|---|---|---|---|---|---|---|
| | | Range | Mean | Range | Mean | Range | Mean |
| Kantapal | | | | | | | |
| | Upland | 4.9-5.0 | 4.9 | 0.23-0.28 | 0.24 | 1.4-6.4 | 4.01 |
| | Medium Land | 5.0-5.3 | 5.2 | 0.29-0.40 | 0.36 | 6.6-7.0 | 6.76 |
| | Low Land | 5.8-6.5 | 6.2 | 0.50-0.78 | 0.65 | 7.0-8.9 | 7.90 |
| Kandhara | Upland | 4.6-4.8 | 4.7 | 0.09-0.26 | 0.20 | 1.4-6.2 | 3.95 |
| | Medium Land | 4.8-5.0 | 4.9 | 0.27-0.33 | 0.31 | 6.6-7.0 | 6.76 |
| | Low Land | 5.1-5.8 | 5.5 | 0.42-0.86 | 0.60 | 7.8-12.0 | 9.17 |
| Dangapal | | | | | | | |
| | Upland | 4.4-4.7 | 4.5 | 0.08-0.29 | 0.22 | 4.6-7.0 | 6.24 |
| | Medium Land | 4.9-5.2 | 5.0 | 0.31-0.37 | 0.34 | 7.0-7.8 | 7.28 |
| | Low Land | 5.7-6.9 | 6.5 | 0.37-1.29 | 0.74 | 8.5-12.0 | 10.0 |
| Kankadahad | Upland | 5.4-5.9 | 4.8 | 0.22-0.26 | 0.24 | 2.7-4.6 | 3.51 |
| | Medium Land | 5.9-6.7 | 5.2 | 0.28-0.44 | 0.34 | 5.2-6.6 | 6.04 |
| | Low Land | 6.0-6.9 | 5.8 | 0.45-1.39 | 0.75 | 7.4-10.1 | 8.58 |

of the entire study area was found to be less than 2 dS m$^{-1}$ (Table 2). Hence, soils under the study area are safe for all types of crop production concerning the soluble salt content (Dash *et al*. 2019b).

## Organic carbon

Soil Organic Carbon (SOC) of surface soil samples of Kantapal, Kandhara, Dangapal and Kankadahad were observed to range between 1.4 to 8.9, 1.4 to 12.0, 4.6 to 12.0 and 2.7 to 10.1 g kg$^{-1}$, respectively. The average SOC contents of soils of the above four villages were determined to be 6.38, 6.87, 8.26 and 6.29 g kg$^{-1}$, respectively (Table 2). A higher range of SOC in low lands of the study sites can be attributed to higher cropping intensity in the same (Sethy *et al.* 2019). Average SOC contents are inferred to be of medium-range (Table 3), which enables the soils to go for a wide range of crops. Similar findings have also been reported by Swain *et al.* (2018), Mishra *et al.* (2013).

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

| Sl. No. | Name of the nutrients | Low | Medium | High |
|---|---|---|---|---|
| 1 | Organic carbon (g kg$^{-1}$) | <5.0 | 5.0-7.5 | >7.5 |
| 2 | Available N (kg ha$^{-1}$) | <250 | 250-500 | >500 |
| 3 | Available P (Bray's P) (kg ha$^{-1}$) | <14 | 14-40 | >40 |
| 4 | Available K (kg ha$^{-1}$) | <118 | 118-280 | >280 |

## Available nitrogen

Soil available nitrogen contents of surface soil samples of Kantapal village were found to vary in between 50 to 163 kg ha$^{-1}$ with a mean value of 108 kg ha$^{-1}$; that of soils of Kandhara village varied between 125 to 225 kg ha$^{-1}$ with a mean value of 169 kg ha$^{-1}$; that of soils of Dangapal varied between 100 to 225 kg ha$^{-1}$ with a mean value of 165 kg ha$^{-1}$; that of soils of Kankadahad village varied between 25 to 175 kg ha$^{-1}$ with a mean value of 124 kg ha$^{-1}$ (Table 4). Soils of the entire study area are found to be of low available nitrogen content. Hence, low nitrogen content in the soils is a major constraint of the study area. The results showed a gradual increase in average N content from upland to low land which may be due to

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

| Name of village | Available N ($kg\ ha^{-1}$) | | Available P ($kg\ ha^{-1}$) | | Available K ($kg\ ha^{-1}$) | |
|---|---|---|---|---|---|---|
| | Range | Mean | Range | Mean | Range | Mean |
| Kantapal | 50-163 | 108 | 10-32 | 23 | 120-463 | 305 |
| Kandhara | 125-225 | 169 | 7-15 | 11 | 116-254 | 180 |
| Dangapal | 100-225 | 165 | 7-16 | 11 | 130-330 | 236 |
| Kankadahad | 25-175 | 124 | 7-36 | 21 | 122-509 | 307 |

the higher SOC content in the low land (Digal *et al.* 2019). 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 yields for various crops.

### Available phosphorus

Available soil phosphorus contents of Kantapal village were found to vary in between 10 to 32 kg $ha^{-1}$ with a mean value of 23 kg $ha^{-1}$; that of Kandhara village varied between 7 to 15 kg $ha^{-1}$ with a mean value of 11 kg $ha^{-1}$; that of Dangapal varied between 7 to 16 kg $ha^{-1}$ with a mean value of 11 kg $ha^{-1}$; that of Kankadahad village varied between 7 to 36 kg $ha^{-1}$ with a mean value of 21 kg $ha^{-1}$ (Table 4). Soil phosphorus was found to be in low (75% of total) to medium range (25% of total). Similar spatial variations of available P were also observed by Barik *et al.* (2017). Since most soils are low 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.

### Available potassium

The available soil potassium contents of Kantapal village were found to vary in between 120 to 463 kg $ha^{-1}$ with a mean value of 305 kg $ha^{-1}$; that of Kandhara village varied between 116 to 254 kg $ha^{-1}$ with a mean value of 180 kg $ha^{-1}$; that of Dangapal varied between 130 to 330 kg $ha^{-1}$ with a mean value of 236 kg $ha^{-1}$; that of Kankadahad village varied widely between 122 to 509 kg $ha^{-1}$ with a mean value of 307 kg $ha^{-1}$ (Table 4). Soils showed a medium (52%) to high (48%) range of soil potassium status. Hence, soil potassium, status is adequate in the soils of Kankadahad block, which is feasible for a wide range of crops (Mishra *et al.* 2017, Dash *et al.* 2018).

## CONCLUSION

From the above region-specific small experiment, it was clear that the soils of Kankadahad block of Odisha are acidic in soil reaction, safe concerning soluble salt content. Soils are of medium 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 to high for soil potassium. Soil acidity was found to be the major soil-related crop production constraint, which can be efficiently managed by applying feasible recommended doses of liming materials in the soils. 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 Odisha, 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. Besides all, the addition of sufficient organic matter is always recommended to maintain soil health as a whole. Judicious management of soil nutrients maintains soil health and crop productivity besides curtailing the cost of production.

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