GPS based sampling for determination of fertility status of some villages of Jatani block of Khordha district, Odisha

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Abstract

Precision agriculture is the need of hour and GPS soil sampling is an important tool to achieve it. This as a result helps us to have site specific nutrient management. A GPS based soil sampling was done from some villages of Jatani block, Khordha district of Odisha. The pH ranged from strongly acidic to neutral. Organic carbon was low in most of sample, status of macronutrients like nitrogen, phosphorous, potassium, sulphur were low for most of sample where as calcium and magnesium was found out to be sufficient. Fertilizer dose as per the nutrient status can be recommended and thus suitable crop can be selected for better yield and sustainable agriculture.

Keywords: GPS, Jatani, Khordha, Odisha

1. Introduction

Precision agriculture is trending in the domain of agriculture. As per the definition adopted by The International Society of Precision Agriculture in 2019(https://www.ispag.org/) precision agriculture is a management strategy that gathers, processes and analyzes temporal, spatial and individual data and combines it with other information to support management decisions according to estimated variability for improved resource use efficiency, productivity, quality, profitability and sustainability of agricultural production. Global Positioning System (GPS) is one of most crucial component of precision agriculture. With the advent of the satellite-based Global Positioning System, farmers gained the potential to take account of spatial variability. Global Positioning System (GPS) receivers provide a method for determining location anywhere on the earth. Collection of soil samples by using GPS is very important for preparing thematic soil fertility maps (Pfost et al. 1998) [17]. This instrument helps to know latitude and longitude of that particular place. It has got great significance in agriculture for future monitoring of soil nutrient status of different locations/villages Accurate, automated position tracking with GPS receivers allows farmers and agricultural service providers to automatically record data and apply variable rates of inputs to smaller areas within larger fields.(Dash et al. 2018) [5].

GPS based soil map of any area helps us to formulate the site specific nutrient management (SSNM) practice for that particular area. SSNM is a dynamic concept. It should not mean that every time, a crop is grown, all the nutrients should be applied in a particular proportion. Rather fertilizer application should be tailored according to the crop’s need keeping in view, the capacity of these soils to fulfill various demands (Srivastava et al., 2006; 2009) [19][20]. As its quite evident that in present situation when the land for cultivation in shrinking, pollution due to excessive fertilizer used is increasing and the cost of cultivation creating havoc for poor farmers GPS based soil map can be breakthrough which guides farmers to apply fertilizers in right amount right time and right method.

Work on preparation of soil fertility maps have been done for Khurda district of Odisha, but no such work has been done for the villages under study in the present investigation. Therefore, an attempt has been made in the present investigation to prepare soil fertility maps for three different villages of Jatani block and to find out the soil fertility related production constraints of different crops grown and to suggest remedial measures.
2 Material methods
2.1 Experimental sites
Jatani is a block of khordha district of Odisha, which comes under North Eastern Ghaut Agro Climatic Zone of Odisha (Nanda et al., 2008). It is located at at 20.09°N 85.42°E and has an average elevation of 36 metres (118 feet). The soils of khorhda come under orders such as Alfisols, Inceptisols and Entisols and are mainly of two types which are Laterite soil and coastal saline-alluvial soil. In the present research work 40 samples were collected from five villages which are Angarpada, Madanpur, Minchinipatna, Mahula, along with their GPS location using GPS instrument (Garmin make; model: 76MAPCSx). These areas are mainly dedicated for continuous cultivation of rice along with some seasonal vegetables (chilly, tomato, gourds, brinjal). The fertilizers used by people of these villages are mainly urea, DAP and MOP.

2.2 Sampling and analysis
Soil samples were brought to the laboratory and air dried under shade avoiding contamination with foreign materials and then crushed with a wooden pestle. The sample is then screened through a 2mm sieve and the pebbles, stones and roots were rejected. About 0.5 to 1kg of air dried crushed soil sample was put in the plastic sample bottle, labelled and stacked on the open sample racks for analysis. The analysis of soil samples have been done by using standard methods i.e. 

| Sample No. | pH  | EC ds m$^{-1}$ | OC in g kg$^{-1}$ | N in kg ha$^{-1}$ | P in kg ha$^{-1}$ | K in kg ha$^{-1}$ | Ca meq 100 g$^{-1}$ | Mg meq 100 g$^{-1}$ | S mg kg$^{-1}$ |
|------------|-----|---------------|------------------|-----------------|-----------------|-----------------|------------------|-----------------|---------------|
| 1          | 5.05| 0.011         | 6.24             | 200             | 3.52            | 51.072          | 4.8              | 1.7             | 2.24          |
| 2          | 5.02| 0.032         | 4.37             | 62.5            | 4.21            | 32.256          | 7.4              | 1.6             | 2.57          |
| 3          | 5.05| 0.048         | 4.56             | 187.5           | 3.54            | 81.88           | 8.5              | 4.1             | 2.64          |
| 4          | 5.04| 0.026         | 4.37             | 150             | 4.58            | 55.89           | 6                | 0.9             | 2.8           |
| 5          | 5.02| 0.04          | 8.55             | 137.5           | 2.11            | 44.68           | 6.6              | 0.3             | 3.18          |
| 6          | 5.09| 0.053         | 8.36             | 175             | 0.7             | 67.2            | 6.3              | 0.4             | 3.26          |
| 7          | 5.25| 0.031         | 6.27             | 125             | 2.46            | 75.264          | 3.3              | 3.7             | 3.76          |
| 8          | 5.38| 0.048         | 7.22             | 125             | 0.35            | 60.48           | 2.7              | 0.9             | 4.1           |
| 9          | 5.43| 0.047         | 6.65             | 162.5           | 14.81           | 65.85           | 4.5              | 0.6             | 4.25          |
| 10         | 5.62| 0.079         | 10.83            | 150             | 12.34           | 53.76           | 3.5              | 3               | 4.8           |
| Mean       | 5.195| 0.041        | 6.742            | 147.5           | 4.862           | 58.8332         | 5.36             | 1.72            | 3.36          |

Organic carbon
The organic carbon determined by Walkey and Black method data is illustrated in table. It was observed that the organic carbon in Angerapada village(Table 1) ranged from 6.24 g kg$^{-1}$ to 10.83 g kg$^{-1}$ with mean of 7.642 g kg$^{-1}$, for village of Madanpur(Table 2) it ranged from 2.16 g kg$^{-1}$ to 9.25 g kg$^{-1}$ with mean of 4.605 g kg$^{-1}$ belonging to low organic carbon containing group.Similarly for Minchinipatna(Table 3) and Mahula(Table 4) the organic carbon content ranged from 1.75 g kg$^{-1}$ to 7.8 g kg$^{-1}$ and 2.14 g kg$^{-1}$ to 8.97 g kg$^{-1}$ with average of 3.657 g kg$^{-1}$ and 4.40 g kg$^{-1}$ belonging to low organic carbon containing category. More than 50% of samples were found to have low organic carbon content. Repeated cultivation without incorporation of crop residues into soils may be the major reason of such low carbon content. It was also observed that the lowlands had higher organic carbon content as compared to uplands because higher water table in low lands lead to less oxidation of organic carbon where as in upland due to more exposure to temperature and wind more oxidation of organic matter and thus low carbon content. These findings are in congruence with findings of Mishra (2013) and Digal et al., (2018). 

Available Nitrogen
The available nitrogen in surface soil for the village Angarapada(Table 1) was found to be ranging from 62.5 kg ha$^{-1}$ to 200 kg ha$^{-1}$ with a mean of 147.5 kg ha$^{-1}$ for Madanpur(Table 2) it ranged from 100 kg ha$^{-1}$ to 200 kg ha$^{-1}$ with a mean of 153.75 kg ha$^{-1}$, for Minchinipatna(Table 3) it ranged from 100 kg ha$^{-1}$ to 175 kg ha$^{-1}$ with a mean of 140 kg ha$^{-1}$ and ranged from 162.5 kg ha$^{-1}$ to 175 kg ha$^{-1}$ for Mahula(Table 4) with a mean of 152.5 kg ha$^{-1}$. It can be clearly observed from the obtained results that all the samples are low in available nitrogen content. Earlier, Mitra et al.
reported similar trends. The low nitrogen content in this area could be attributed to continuous growth of rice in submerged soils where the demand for electron acceptors by facultative anaerobic organisms after disappearance of oxygen from submerged soil, results in reduction of nitrate (Dey et al. 2016) [86].

Table 2: Fertility status of Madanpur Village

| Sample No. | pH  | EC ds m⁻¹ | OC in g kg⁻¹ | N in kg ha⁻¹ | P in kg ha⁻¹ | K in kg ha⁻¹ | Ca meq 100 g⁻¹ | Mg meq 100 g⁻¹ | S mg kg⁻¹ |
|------------|-----|-----------|--------------|--------------|--------------|--------------|---------------|---------------|-----------|
| 1          | 6.04| 0.032     | 4.13         | 150          | 0.88         | 134.4        | 3.8           | 1.9           | 3.54      |
| 2          | 5.62| 0.047     | 3.74         | 162.5        | 2.29         | 95.42        | 4             | 1             | 2.54      |
| 3          | 5.88| 0.143     | 6.3          | 175          | 2.46         | 237.88       | 5.7           | 1.2           | 2.56      |
| 4          | 5.83| 0.141     | 5.91         | 200          | 13.75        | 287.616      | 4.5           | 2.6           | 2.66      |
| 5          | 5.99| 0.164     | 9.25         | 162.5        | 1.58         | 108.86       | 5             | 3             | 2.95      |
| 6          | 5.57| 0.046     | 4.72         | 162.5        | 0.35         | 43           | 6.1           | 0.2           | 3.58      |
| 7          | 5.49| 0.042     | 2.56         | 150          | 0.35         | 33.6         | 6.5           | 0.9           | 3.67      |
| 8          | 6.03| 0.031     | 4.72         | 137.5        | 1.76         | 49.56        | 2.5           | 0.6           | 4.11      |
| 9          | 6.06| 0.044     | 2.16         | 137.5        | 0.69         | 23.22        | 3.5           | 0.1           | 4.12      |
| 10         | 5.55| 0.039     | 2.56         | 100          | 0.705        | 36.28        | 3             | 0.5           | 4.56      |
| Mean       | 5.806| 0.072    | 4.605       | 153.75       | 3.0115       | 105.8866     | 4.46          | 1.2           | 3.429     |

Available Phosphorous
The value of available phosphorous in the soil of Angarpada village(Table 1) varied from 0.7 P₂O₅ kg ha⁻¹ to 14.81 P₂O₅ kg ha⁻¹ with a mean of 4.862 P₂O₅ kg ha⁻¹. In case of Madanpur(Table 2) it varied from 0.35 P₂O₅ kg ha⁻¹ to 13.75 P₂O₅ kg ha⁻¹ with a mean of 3.0115 P₂O₅ kg ha⁻¹, in Minchinipatna village(Table 3) it varied from 0.87 P₂O₅ kg ha⁻¹ to 34.78 P₂O₅ kg ha⁻¹ and for Mahula(Table 4) it ranged from 3.35 P₂O₅ kg ha⁻¹ to 27.89 P₂O₅ kg ha⁻¹ with a mean of 9.853 P₂O₅ kg ha⁻¹. It is evident from the observed data that all the villages have low phosphorous content in the soil surface. Similar observation were also reported by Mishra et al. (2013) [12]. The reason for low available phosphorous can be ascribed to the low pH of the soil due to which most of the available phosphorous are being fixed as aluminum and iron phosphates(Ch’ng et al. 2014 [3], Ara et al. 2018) [1].

Available Potassium
The available potassium content in the soil in Angarpada village(Table 1) was found to be low ranging from 32.25 K₂O kg ha⁻¹ to 81.88 K₂O kg ha⁻¹ with mean of 58.83 K₂O kg ha⁻¹, for Madanpur(Table 2) it ranged from 32.25 K₂O kg ha⁻¹ to 287.61 K₂O kg ha⁻¹ with a low average of 105.88 K₂O kg ha⁻¹, for Minchinipatna(Table 3) it ranged from 88.88 K₂O kg ha⁻¹ to 250.97 K₂O kg ha⁻¹ with a medium average of 143.315 K₂O kg ha⁻¹, for Mahula(Table 4) it varied from low value of 96.76 K₂O kg ha⁻¹ to as high as 686.78 K₂O kg ha⁻¹ with a medium average of 216.30 K₂O kg ha⁻¹. In the entire study area available potassium was found within the range of low to medium. This was similar to the findings of Mishra et al. (2013) [12] and Mishra et al. (2017) [13]. The lower content of potassium in these villages may be attributed to lack of incorporation of crop residues to field post harvest and continuous cropping without application of appropriate dose of K fertilizers leading to nutrient mining.

Table 3: Fertility status of Minchinipatna Village

| Sample No. | pH  | EC ds m⁻¹ | OC in g kg⁻¹ | N in kg ha⁻¹ | P in kg ha⁻¹ | K in kg ha⁻¹ | Ca meq 100 g⁻¹ | Mg meq 100 g⁻¹ | S mg kg⁻¹ |
|------------|-----|-----------|--------------|--------------|--------------|--------------|---------------|---------------|-----------|
| 1          | 5.43| 0.045     | 2.75         | 175          | 9.58         | 111.99       | 4.3           | 0.7           | 2.48      |
| 2          | 5.4  | 0.039     | 2.56         | 150          | 0.87         | 96.88        | 4.1           | 0.2           | 2.54      |
| 3          | 6.39| 0.041     | 2.75         | 112.5        | 4.57         | 120.88       | 9             | 3             | 2.55      |
| 4          | 5.13| 0.028     | 2.75         | 100          | 1.58         | 180.81       | 1.5           | 0.4           | 2.63      |
| 5          | 6.02| 0.041     | 3.74         | 137.5        | 8.44         | 88.88        | 4.4           | 0.4           | 2.7       |
| 6          | 3.46| 0.042     | 1.75         | 100          | 2.35         | 95.68        | 3.7           | 0.7           | 2.88      |
| 7          | 5.52| 0.066     | 2.73         | 125          | 3.17         | 157.79       | 3             | 0.4           | 3.08      |
| 8          | 6.47| 0.155     | 7.8          | 162.5        | 34.78        | 250.97       | 7.5           | 0.4           | 3.15      |
| 9          | 6.43| 0.114     | 6.82         | 162.5        | 8.28         | 204.28       | 5.1           | 1.2           | 3.25      |
| 10         | 6.13| 0.041     | 2.92         | 175          | 5.46         | 124.99       | 5             | 3.8           | 3.5       |
| Mean       | 5.838| 0.061    | 3.657        | 140          | 7.908        | 143.315      | 4.76          | 1.16          | 2.876     |

Available Calcium and Magnesium:
Available calcium and magnesium for the village of Angarpada (Table 1) varied from 2.7 meq 100 g⁻¹ to 8.5 meq 100 g⁻¹ with an average of 5.36 meq 100 g⁻¹ and from 0.3 meq 100 g⁻¹ to 4.1 meq 100 g⁻¹ with an average of 1.72 meq 100 g⁻¹ respectively, for Madanpur (Table 2) available Ca and Mg varied from 2.5 meq 100 g⁻¹ to 6.5 meq 100 g⁻¹ with average of 4.46 meq 100 g⁻¹ and from 0.1 meq 100 g⁻¹ to 3 meq 100 g⁻¹ with mean of 1.2 meq 100 g⁻¹ respectively, for Minchinipatna (Table 3) it varied from 1.5 meq 100 g⁻¹ to 9 meq 100 g⁻¹ with mean of 4.76 meq 100 g⁻¹ and from 0.2 meq 100 g⁻¹ to 3.8 meq 100 g⁻¹ with mean of 1.16 meq 100 g⁻¹ respectively, in Mahula (Table 4) it ranged from 4 meq 100 g⁻¹ to 6 meq 100 g⁻¹ with mean of 4.74 meq 100 g⁻¹ and 0.8 meq 100 g⁻¹ to 4.6 meq 100 g⁻¹ with average of 1.87 meq 100 g⁻¹. It can be inferred from the data that the average of all the villages had sufficiency of Ca and Mg. As calcium and magnesium are required in less amount mostly they were being found to be sufficient.

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Available Sulphur
The available sulphur content for the village of Angarpada (Table 1) was found to be ranging from 2.24 mg kg\(^{-1}\) to 4.8 mg kg\(^{-1}\) with an average of 3.36 mg kg\(^{-1}\); for Madanpur (Table 2) it ranged from 3.54 mg kg\(^{-1}\) to 4.56 mg kg\(^{-1}\) with an average of 3.429 mg kg\(^{-1}\); for Minchipatna (Table 3) it ranged from 2.48 mg kg\(^{-1}\) to 3.5 mg kg\(^{-1}\) with a mean of 2.876 mg kg\(^{-1}\); for Mahula (Table 4) it varied from 2.41 mg kg\(^{-1}\) to 4.89 mg kg\(^{-1}\) with mean of 3.67 mg kg\(^{-1}\). It was observed that the entire study area had low to medium sulphur content. The findings are in line with finding of Nahak et al., (2016)\(^{10}\). The low sulphur content may be attribute to the ignorance of application of sulphur containing fertilizers.

### Table 4: Fertility status of Mahula Village

| Sample No. | pH  | EC  | OC in | N in | P in | K in | Ca     | Mg     | S     |
|------------|-----|-----|-------|------|------|------|--------|--------|-------|
|            | ds m\(^{-1}\) | g kg\(^{-1}\) | kg ha\(^{-1}\) | kg ha\(^{-1}\) | meq 100 g\(^{-1}\) | meq 100 g\(^{-1}\) | mg kg\(^{-1}\) |
| 1          | 6.53 | 0.034 | 3.9  | 162.5 | 14.58 | 96.76 | 6.04 | 3.9     | 2.41   |
| 2          | 6.05 | 0.061 | 5.26 | 162.5 | 3.52  | 131.71| 4.00 | 2.8     | 2.74   |
| 3          | 6.66 | 0.047 | 4.87 | 175   | 3.35  | 98.11 | 5.00 | 2.6     | 2.99   |
| 4          | 6.67 | 0.055 | 4.29 | 162.5 | 6.35  | 180.09| 5.5  | 4.3     | 3.42   |
| 5          | 6.62 | 0.055 | 4.29 | 162.5 | 4.76  | 151.87| 5.2  | 0.8     | 3.54   |
| 6          | 6.59 | 0.067 | 3.7  | 175   | 11.1  | 149.18| 4.1  | 1.8     | 3.87   |
| 7          | 6.83 | 0.156 | 2.14 | 162.5 | 4.05  | 573.88| 4.00 | 2.1     | 4.56   |
| 8          | 6.99 | 0.154 | 7.21 | 162.5 | 27.89 | 668.78| 4.3  | 2.3     | 4.63   |
| 9          | 6.65 | 0.117 | 8.97 | 175   | 19.92 | 607.48| 4.4  | 4.6     | 4.89   |
| 10         | 6.99 | 0.132 | 7.6  | 162.5 | 24.15 | 162.62| 4.7  | 1.4     | 4.56   |
| Mean       | 6.23 | 0.07  | 4.40 | 152.50| 9.84  | 210.24| 4.74 | 1.87    | 3.76   |

5. Conclusion
It can be concluded that this study on GPS based soil sample collected from some village of jatani block of khordha district could help to determine nutrient status of specific sites and thus helps in site specific nutrient management by balanced recommendation of fertilizer for various crops. Site specific nutrient management not only reduces environmental pollution due to excessive fertilizers but also cut short the expenditure of farmer. This will help to increase the production of different food crops like paddy, maize, groundnut, sesame, black gram, green gram, papaya, arhar, coriander, garlic, brinjal, tomato, beans, banana, bottle gourd, fibre crops etc which are grown in these villages.

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