International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(1): 2980-2984

Received: 24-11-2019
Accepted: 28-12-2019

Chandini Pradhan
Department of Soil Science and Agricultural Chemistry, Institute of AgriculturalScience, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Kiran Kumar Mohapatra
Department of Soil Science and Agricultural Chemistry, College of Agriculture, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

Subhasis Saren
Assistant Professor, Department of Soil Science and Agricultural Chemistry, College of Agriculture, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

Corresponding Author:
Chandini Pradhan
Department of Soil Science and Agricultural Chemistry, Institute of AgriculturalScience, Banaras Hindu University, Varanasi, Uttar Pradesh, India

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

Chandini Pradhan, Kiran Kumar Mohapatra and Subhasis Saren

DOI: https://doi.org/10.22271/chemi.2020.v8.i1as.8723

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 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 Ghat Agro Climatic Zone of Odisha (Nanda *et al*., 2008) [15]. It is located at at 20.09°N 85.42°E and has an average elevation of 36 metres (118 feet). The soils of khordha 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. pH (1:2) (Jackson, 1973) [10], EC (1:2) (Jackson, 1973) [10], organic carbon (Walkley and Black, 1934) [23], available nitrogen (Subbiah and Asija, 1956) [21], available phosphorus (Bray and Kurtz, 1945) [2], available potassium (Hanway and Heidel, 1952) [8], available sulphur (Chesnin and Yien, 1950) [4].

3. Results and Discussion

3.1 Soil reaction

The soil pH (1:2) as determined by the prescribed method revealed that almost all the surface soil sample of Angarpada village (Table 1) were strongly acidic ranging from 5.02 to 5.62 with mean value of 5.195. Most of land being upland and medium land had low pH due to leaching out of bases during rainfall as these land fall under humid climate zone. The soils of Madanpur village (Table 2) mostly had moderately acidic soils ranging from 5.49 to 6.06 and average of 5.806. Similarly soils of Minchinipatna (Table 3) ranged from 5.43 to 6.47 belonging to moderately acidic soil to slightly acidic soil. The soils of mahula village (Table 4) mostly had slightly acidic soil to neutral soils ranging from 6.53 to 6.99 the reason for higher pH as compared to others can attributed to the fact that most of the lands were lowlands where accumulation of bases takes place. Overall soils of all the villages ranged from strongly acidic to neutral pH. Observation are in line with the findings reported earlier by Priyadarshini *et al*., (2017) [18] and Dash *et al*., (2018) [05].

Electrical conductivity

The electrical conductivity (1:2) for all the samples in the concerned villages(Table 1,2,3,4) were less than 1 ds m^{-1} ranging from 0.011 to 0.164 ds m^{-1} so the soils are safe for the crop production as the soil is non saline and doesn't have toxic concentration of any ions. Prevalence of humid climate featured with high rain fall which contribute to leaching out of salts may be the probable reason of the less salinity of soils which make them fit for cultivation of all types of crop. Similar observations are seen in findings reported by Swain *et al*. (2019) [22].

Table 1: Fertility status of Angarpada 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	5.05	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 Angrapada village(Table 1) ranged from 6.24 g kg^{-1} to 10.83 g kg^{-1} with mean of 6.742 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 Minchnipatna(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) [12], Digal *et al*., (2018) [7].

Available Nitrogen

The available nitrogen in surface soil for the village Angarpada(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*.

(2002) [14] 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) [06].

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	5.99	32.25	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 surface soil of Angarpada village(Table 1) varied from 0.7 P_2O_5 kg ha^{-1} to 14.81 P_2O_5 kg ha^{-1} with a mean of 4.862 P_2O_5 kg ha^{-1}. In case of Madanpur(Table 2) it varied from 0.35 P_2O_5 kg ha^{-1} to 13.75 P_2O_5 kg ha^{-1} with a mean of 3.0115 P_2O_5 kg ha^{-1}, in Minchipatna village(Table 3) it varied from 0.87 P_2O_5 kg ha^{-1} to 34.78 P_2O_5 kg ha^{-1} with an average of 7.908 P_2O_5 kg ha^{-1} and for Mahula(Table 4) it ranged from 3.35 P_2O_5 kg ha^{-1} to 27.89 P_2O_5 kg ha^{-1} with a mean of 9.853 P_2O_5 kg ha^{-1}. It is evident from the observed data that all the villages have low phosphorous content in the surface soil. 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 Pottasium

The available potassium content in the surface soil in Angarpada village(Table 1) was found to be low ranging from 32.25 K_2O kg ha^{-1} to 81.88 K_2O kg ha^{-1} with mean of 58.83 K_2O kg ha^{-1}, for Madanpur(Table 2) it ranged from 32.25 K_2O kg ha^{-1} to 287.61 K_2O kg ha^{-1} with a low average of 105.88 K_2O kg ha^{-1}, for Minchinipatna(Table 3) it ranged from 88.88 K_2O kg ha^{-1} to 250.97 K_2O kg ha^{-1} with a medium average of 143.315 K_2O kg ha^{-1}, for Mahula(Table 4) it varied from low value of 96.76 K_2O kg ha^{-1} to as high as 686.78 K_2O kg ha^{-1} with a medium average of 216.30 K_2O 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 Minchnipatna 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	3.4	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	5.46	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} respectivley, 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.

Table 4: Fertility status of Mahula 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	6.53	0.034	3.9	162.5	14.58	96.76	6	3.9	2.41
2	6.05	0.061	5.26	162.5	3.52	131.71	4	2.8	2.74
3	6.66	0.047	4.87	175	3.35	98.11	5	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	2.1	4.56
8	6.99	0.154	7.21	162.5	27.89	686.78	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

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 Minchinipatna (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 suphur content. The findings are in line with finding of Nahak *et al.*, (2016) [16]. The low sulphur content may be attribute to the ignorance of application of sulphur containing fertilizers.

4. Recommendation and suggestion

It can be concluded from the above study that 35% of sample were found to be strongly acidic,22.5% of sample were moderately acidic, 22.5% sample were slightly acidic, 20% of sample were neutral. As majority of samples were found to be in acidic range application of lime is recommended. As stromatolyte is a cheap and abundant liming material available in Odisha it can be used as liming source. The organic carbon was found to be low for 60% of samples, 25% samples had medium organic carbon content and 15% had low organic carbon content. Incorporation of crop residue and application of organic manures along with inorganic fertilizers can enhance organic matter content and thus the soil fertility and quality. All the samples(100%) were low in available nitrogen content. 99% of samples had low available phosphorus and 67.5% samples were low in potassium content, 25% medium potassium content and 7.5% had high potassium content. Sulphur was also found to be low for all the samples (100%) whereas calcium and magnesium were sufficient in all the samples. Hence, 25 per cent more fertilizers than that of the recommended dose should be applied in the plots having lower range of nutrients. In case of the plots of the farm having higher status of nutrients, 25 per cent less fertilizers than that of the recommended dose should be applied and recommended dose should be applied. In the rest of the plots having medium range, recommended dose of fertilizers should be applied. Along with this incorporation of crop residue to field will not only improve organic carbon status but also increase the nutrient status of soil and help to avoid nutrient mining. Use of control release nitrogen fertilizer or slow release nitrogen fertilizer instead of conventional urea, incorporation of urea into soil to avoid volatisation loss, band application of phosphatic fertilizer and applying appropriate dose of potasic and sulphuric fertilizers is the key for sustainable production system.

5. Conclusion

It can be concluded that this study on GPS based soil sample collected from some viilage 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.

6. References

1. Ara I, Islam M, Kashem M, Osman KT. A comparative study of phosphorus availability in an acidic soil and an alkaline soil amended with organic and inorganic phosphorus sources. Journal of soil science and plant nutrition. 2018; 18(2):466-478.
2. Bray RH, Kurtz Lt. Determination of total, organic and available forms of phosphorus in soils. Soil Science. 1945; 59:39-45
3. Ch'ng HY, Ahmed OH, Majid NMA. Improving phosphorus availability in an acid soil using organic amendments produced from agroindustrial wastes. The Scientific World Journal, 2014.
4. Chesnin L, Yien CH. Turbidimetric determination of available sulphates. Proceedings of Soil Science Society of America. 1950; 14:149-51.
5. Dash PK, Mishra A, Saren S, Revathi B, Sethy SK. Preparation of GPS and GIS Based Soil Fertility Maps and Identification of Soil Related Crop Production Constraints of RRTTS and KVK Farm, Dhenkanal Located in the Mid-Central Table Land Agro Climatic Zone of Odisha, India. International Journal of Chemical Studies. 2018; 6(5):934-943.
6. Dey P, Sekhon BS. Nitrogen Fertility Status of the Indian Soils vis-a-vis the World Soils. Indian Journal of Fertilisers, 2016, 36.
7. Digal M, Saren S, Mishra A, Dash PK, Swain N, Acharya BP. Soil Fertility Status of Some Villages in Phiringia Block of Kandhamal District under North-Eastern Ghat Agro Climatic Zone of Odisha, India. Journal of Pharmacognosy and Phytochemistry. 2018; 7(6):659-662.
8. Hanway JJ, Heidel H. Soil analysis methods as used in Iowa State College Soil Testing Laboratory. Iowa State College Bulletin. 1952; 57:1-31
9. IFFCO, Kolkata. maps for Khurda district, Odisha. Indian Agriculturist. 2013; 57(1):11-20.

10. Jackson ML. Soil Chemical Analysis. Prentice Hall of India. Private limited, New Delhi, 1973.
11. Mishra A, Das D, Saren S, Dey P. GPS & GIS based soil fertility maps of Nayagarh district Odisha, Annals of plant & soil research. 2016; 18(1):23-28.
12. Mishra A, Das D, Saren S. Preparation of GPS and GIS Based Soil Fertility maps for Khurda district of Odisha. Indian Agriculturist. 2013; 57(1):l 1-20.
13. Mishra A, Das D, Saren S, Dey P. GPS and GIS based soil fertility maps of Bhadrak District of Odisha. Ecology Environment and Conservation. 2017; 23(1):207-213.
14. Mitra GN, Mishra UK, Sahu SK. Macro and micronutrient status of the soils of Orissa, 2017.
15. Nanda SK, Mishra A, Pradhan NK, Muralidharudu Y. Soil testing and fertilizer recommendation in Odisha. AICRP on Soil Test Crop Response, Department of Soil Science and Agricultural Chemistry, OUAT, BBSR, 2008.
16. Nayak SR, Saren S, Mishra A, Acharya BP. Soil Fertility Status of Some Villages in Chilika Block of North Eastern Ghat Agroclimatic Zone of Odisha. International Journal of Environmental and Agriculture Research. 2014; 1(2):1-5.
17. Pfost DL, Casady WW, Shannon K. Precision agriculture: global positioning system (GPS). Extension publications (MU).
18. Priyadarshini P, Saren S, Mishra A, Acharya BP. Soil fertility status of some villages under North-Eastern Coastal Plain Agro climatic Zone of Odisha. Journal of Indian Society of Coastal Agricultural Research. 2017; 35(2):42-47.
19. Srivastava AK, Shyam S, Diware VS, Haramandeep S. Site-specific nutrient management in ‘Mosambi’ sweet orange. Better Crops India. 2009; 3(1):10-11
20. Srivastava AK, Shyam S, Tiwari KN. Site specific nutrient management for Nagpur mandarin (Citrus reticulata Blanco) Better Crops. 2006; 88(2):22-25.
21. Subbiah BV, Asija GL. A rapid procedure for the determination of available nitrogen in soils. Current Science. 1956, 25259-25260.
22. Swain N, Mishra A, Saren S, Dash PK, Digal M, Mishra BB. Soil Fertility Status of Some Villages in Khordha and Bhubaneswar Block of Khordha District under North Eastern Ghat Agro Climatic Zone of Odisha, India. Journal homepage*: http://www. ijcmas. com*, 8(01), 2019.
23. Walkley AJ, Black IA. Estimation of soil organic carbon by the chromic acid titration method. Soil Science. 1934; 37:29-38.