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Analysis of physico chemical parameter of soil samples and nematode diversity of seasonal crops from Sakur region, Tal. Sangamner (MS), India

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Abstract
In the present study, an analysis of the physico-chemical parameters of soil samples from different localities of seasonal crops from Sakur region was conducted. The soil samples were collected and analyzed to measure various physical and chemical parameters by standard methods. The soil parameters like pH, temperature, EC, organic carbon, calcium, magnesium, nitrogen, potassium and phosphorus were studied. From the analysis, the variation in physico-chemical parameters observed with respect to crop field pattern. In continuation to our research, study was carried out for nematode diversity of seasonal crops. Nematode diversity showed their interactions with plants and other organisms. The recorded nematode species are *Meloidogyne incognita*, *M. javanica*, *Rotylenchulus* sp., *Heterodera glycines*, and *Paratrichodorus* sp. From these, most dominant species are *M. incognita*, *M. javanica* which found in all seasonal crops.

Keywords: Soil, seasonal crop, physico-chemical parameter, nematodes, Sakur region

Introduction
The soil forms the intermediate zone between the atmosphere and the rock cover of the earth, the lithosphere. It also forms the interface between water bodies (hydrosphere) and the lithosphere and thus forming a part of biosphere. The soil may be defined as the uppermost weathered layer of the earth's crust consist of mixed organisms and products of their death and decay (Dalwadi and Bhatt, 2008) [9]. The soil is a complex organization being made up of six constituents, namely inorganic matter, organic matter, soil organisms, soil moisture, soil solution and soil air. Roughly, the soil contains 50-60% mineral matter, 25-35% water, 15-25% air and little percentage of organic matter (Chatwal and Sharma, 2005) [6].
Physico-chemical analysis of water samples is a very common practice (Verma, 2016 & 2019; Singh and Verma, 2016) [31-34, 26] but that of soil is not so common. Soil quality indicators that directly monitor the soil are grouped into physical, chemical and biological indicators. Major soil chemical properties such as pH, EC, plant nutrient availability, ESP, SAR, CEC etc. are the indicators of soil quality. These chemical properties of soils play an important role in determining the retention and availability of nutrients in soils. The nutrient supply in soil depends on the level of organic matter, CaCO3 content, degree of microbial activity, change in pH, types and amount of clay and status of soil moisture (Gupta and Gupta, 1997; Deshmukh, 2012) [10, 16].
In the study area previous research carried out in the Sangamner by few researchers but current study area was left unexplored. Cropping pattern in Sangamner changed after the establishment of co-operative sugar-mill in 1967 (Deshmukh, 2012) [10], study area is also part of Sangamner taluka. It is necessary to study the physico-chemical parameters of Sakur region soil to know its quality. Five different sites were selected for sampling collection during the seasonal crops. The soil samples were collected and analyzed to measure various physical and chemical parameters by standard methods. The soil parameters like pH, temperature, total hardness, EC, organic carbon, calcium, magnesium, nitrogen, potassium and phosphorus were studied.
The biological diversity is an important aspect of ecological balance and human survival (Verma, 2017 & 2018) [32, 33]. In the light of this fact, author attempted to study the nematode

Diversity in seasonal crops as a part of this research. Moreover, nematode populations can respond in predictable ways to ecosystem disturbance (Freckman and Ettema, 1993) [11]. Basically there are three functional groups of nematodes i.e. saprophytic nematodes, predaceous nematodes and parasitic nematodes. Saprophytic nematodes are most abundant type of nematodes in soil, they are known as decomposers (Shinde *et al*., 2018) [24]. Nematode diversity shows their interactions with plants and other organisms. They play important role in nutrient cycle and as plant parasites (Gade and Hiware, 2017) [12]. The main objectives of this study are to provide primary checklist and information on the diversity, of plant-parasitic nematodes in the seasonal crops of Sakur region Maharashtra state of India.

Material and Methods

The soil samples were collected and analyzed to measure various physical and chemical parameters by standard methods from Sakur region, during the period of August 2018 to February 2019. In the study area farmers cultivate the crop in two seasons. Soil samples collected during particular season of crop, in the first season work carried out in months of August to November and second season samples were collected and analyzed in month of December to February 2019. All the soil samples were collected monthly by standard procedure.

Study area

The study was carried out during August 2018 to February 2019 from different localities of Sakur region Sangamner taluka, District Ahmednagar (M.S.) India. These are Sakur (S1), Mandave Bk (S2), Sindodi (S3), Birewadi (S4) and Hirewadi (S5). The study area lies between 19° 20’58.38’N and 74° 17'54.64’E the climate of the region is influenced by the topography. A rainfall is moderate in the study area. It is a part of northern Maharashtra region and it belongs in Ahmednagar division. It is located 61km towards west from district headquarters Ahmednagar 28 km from Sangamner. Sakur is a main market place for about 15 small nearer villages. It is situated in between the Mula river and Pravara river. Sakur region enter in mountainous area and agriculture of this area are both type like irrigated and non-irrigated.

A. Methodology for soil analysis

Collection of soil sample

The soil samples were collected in the depth of 5 cm to 30 cm from the surface of soil from the different places of Sakur region from August 2018 to February 2019. The instrument used for soil collection is spade. Soil sample was stored in the polythene bag near about 1 kg. The soil samples were collected in zigzag manner in crop field. This soil samples were preserved in polythene bag for further analysis.

Soil analysis

The standard instrumental and non-instrumental methods were used for estimation of soil samples and their parameters**.** It includes texture, colour, pH, temperature, E.C, N, P, K, Carbon, Calcium, using by standard protocols (Dalwadi and Bhatt, 2008; Gupta, 2000; Verma, 2000) [9, 15, 35]. The given soil parameter was estimated by following methods:

Table 1: Methods used for estimation of soil parameter

Sr. No.	Parameter	Methods
1	Texture	Qualitative
2	Colour	By viewing (Observation)
3	pH	pH meter
4	Temperature	Thermometer
5	Electric conductivity	Condoctometry
6	Nitrogen (N)	Volumetric method
7	Phosphate (P)	Spectrophotometry
8	Potassium(K)	Flamephotometry
9	Carbon	Volumetric method
10	Calcium	Volumetric method
11	Magnesium	Volumetric method

B. Methodology for nematode extraction and identification from soil

For nematode extraction 25gm of soil sample was taken by Baermann funnel technique (Southey, 1970) [28]. The soil is taken into muslin cloth. The muslin cloth was wrapped around these soils and tide with help of thread. Then soils with muslin cloth kept into the funnel. The one end of the funnel was packed with pinch-cock and funnel filled with distilled water until up to the deep muslin cloth within the water and soil becomes wet and kept in to the safe place for 24hours. After that the pinch-cock removed and the nematode suspension was poured into a collection bottle and allow settle. Then the supernatant liquid were removed and also the remaining suspension that contains nematodes. Then these suspensions were poured into the nematode investigating dish for nematodes investigation and examined under the light microscope for identification and photography. Nematodes were identified by using different identification keys (Goodey, 1963; Andrássy, 1983; Maggenti, 1983; Bongers, 1987; Nickle, 1991; Hunt *et al*., 1987; and State Fauna Series, ZSI, 2012) [1, 4, 13, 17, 20, 22].

Table 2: Physico-chemical analysis of soil samples from month of August 2018 to October 2018

Parameters	August					September					October				
	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5
Texture	Sandy loam	Silt loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Silt loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Silt loam	Sandy loam	Sandy loam	Sandy loam
Colour	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light
pH	7.76	7.18	7.20	7.60	8.12	8.12	7.98	7.57	7.68	7.52	7.31	7.39	7.47	7.41	7.51
Temp (^{0}C)	27	25.2	24.2	24.7	24.1	24.2	23.9	24.6	24.3	25.2	23.2	23.6	24.3	24.1	23.8
E.C(mhos) dsm-1	0.95	1.05	1.12	1.00	0.8	1.02	0.9	1.22	1.12	1.0	1.09	1.06	1.17	1.21	1.05
N (%)	0.034	0.029	0.031	0.042	0.039	0.044	0.036	0.039	0.052	0.047	0.040	0.042	0.041	0.049	0.053
P (%)	0.024	0.032	0.067	0.040	0.051	0.036	0.038	0.045	0.052	0.048	0.042	0.043	0.051	0.049	0.055
K (%)	0.70	1.02	1.01	0.89	1.22	0.82	0.90	1.10	0.96	1.18	0.91	0.96	1.11	1.04	1.24
C (%)	0.315	0.256	0.368	0.375	0.51	0.280	0.295	0.324	0.360	0.350	0.310	0.308	0.339	0.354	0.366
Cal (mg/l)	44.08	50.5	46.09	42.08	45.08	41.08	53.3	49.2	45.8	46.32	43.20	51.4	48.08	44.5	44.32
Mg (mg/l)	25.92	14.5	18.91	32.92	24.92	23.92	14.7	20.8	21.2	25.68	23.8	17.6	21.92	23.5	20.68

Sampling sites: Sakur (S1), Mandave Bk (S2), Sindodi (S3), Birewadi (S4) and Hirewadi (S5)

Table 3: Physico-chemical analysis of soil samples from month of December 2018 to February 2019

Parameters	December					January					February				
	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5
Texture	Sandy loam	Silt loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Silt loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Silt loam	Sandy loam	Sandy loam	Sandy loam
Colour	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light
pH	8.02	7.43	7.46	7.49	7.68	8.22	8.18	7.92	7.98	8.76	8.15	8.32	8.00	8.09	8.44
Temp (^{0}C)	23.87	23.92	24.1	24.5	24.2	24	24.12	24.32	24.62	24.68	26.12	26.18	25.22	26.00	26.29
E.C(mhos) dsm-1	1.01	1.12	1.15	1.19	1.20	1.09	1.14	1.13	1.22	1.24	0.96	1.10	1.12	1.22	1.08
N (%)	0.052	0.049	0.047	0.042	0.052	0.064	0.056	0.059	0.067	0.049	0.068	0.060	0.062	0.058	0.061
P (%)	0.040	0.045	0.049	0.049	0.051	0.039	0.047	0.056	0.052	0.059	0.032	0.038	0.044	0.036	0.047
K (%)	1.11	1.07	1.14	1.10	1.22	1.09	1.12	1.17	1.14	1.23	1.12	1.17	1.08	1.14	1.18
C (%)	0.344	0.329	0.356	0.377	0.371	0.349	0.336	0.360	0.382	0.380	0.360	0.358	0.345	0.362	0.372
Cal (mg/l)	41.22	46.00	49.08	43.02	41.00	40.31	46.12	46.08	44.12	42.22	41.18	46.44	47.12	46.36	41.68
Mg (mg/l)	24.78	21.00	19.92	25.98	26.00	26.69	22.88	21.92	23.88	26.78	27.82	21.56	23.88	23.64	25.32

Sampling sites: Sakur (S1), Mandave Bk (S2), Sindodi (S3), Birewadi (S4) and Hirewadi (S5)

Results and Discussion

A. Soil analysis

For soil analysis was done for the parameters including texture, colour, pH, temperature, E.C, N, P, K, Carbon, Calcium, from the collected soil samples and the observations of physicochemical parameters are tabulated in table 2 and 3.

1) Colour and texture

Collected soil samples are the light (pale or bleached) in colour and the texture of all soil samples are sandy loam except the soil sample no-2 is silt loam in texture in all the sampling sites. Colour of the soil is an overall indicator of soil properties. Superficially texture indicates the fertility of soil.

2) Soil temperature

Soil temperature is one of the most important properties of soil that affect crop growth and production. The main source of heat is sun and heat generate by the chemical and biological activity of the soil is negligible. The temperature of soil in study area is ranged between 24.1^{0}C to 28^{0}C. It is in a normal range to increase crop productivity. Soil temperature fluctuates with season wise, time of day and climatic conditions of that area. The major source of soil heating is solar radiation and heat generated by the biochemical activities of the soil (Jain *et al*., 2014) [18]. A rise in temperature of soil accelerates chemical reaction, reduces solubility of gases and decrease pH of soil. Soil temperature varies in response to exchange processes that take place primarily through the soil surface (Shirbhate and Malode, 2012) [25]. Soil temperature plays a significant role in seed germination, helpful to plants growth and activity of other microorganisms and their growth.

3) pH

Soil is naturally acidic or alkaline, and this can be measured by testing their pH value. In the present study lowest value of pH is 7.18 and highest value of pH is 8.44. The limit of pH value for soil Acidic < 6.5, Normal 6.5-7.8, Alkaline 7.8- 8.5, Alkali > 8.5. It indicted the soil is neutral. PH is a most important physical property of soil and encouraging the plant nutrient accessibility. It affects on solute concentration and absorption in soil (Daji, 1996) [8].

4) EC

Electric conductivity (EC) is especially rapid, simple and inexpensive method to check the health of soil. It is measure of ions present in solution. The EC increases when increased concentration of ions in soil. EC varies with depth, slope of land surface, high permeability, high rain fall, responsible for leach out alkali and alkaline base (Chik, 2011) [7].

Total soluble salts are estimated from electrical conductivity (EC) of aqueous soil extracts. Standard value of EC in soil-Normal < 0.8 dsm-1, critical for salt sensitive crops, critical for salt tolerant crops 1.6 -2.5 dsm-1, Injurious to most crops > 2.5 dsm-1. During the study period EC value is ranges between 0.8 dsm-1 to 1.24 dsm-1. The EC of soils totally depends on the amount of moisture held by soil particles.

5) Soil nitrogen

Nitrogen is a mobile nutrient in the soil and nitrogen as a fertilizer required for the growth of plant. Due to the importance of nitrogen for the growth of plants, try to estimate available nitrogen from the soils in the study area. In the present analysis the value of nitrogen level in soil of Sakur and around region is between 0.029% and 0.072%. The sewage water significantly increased the nitrogen in the soil (Baddesha *et al*., 1997) [2]. Nitrogen as a fertilizer required for the growth of plant.

6) Phosphate

Phosphate is found in the range of low, medium and high. Inorganic phosphorus as orthophosphate plays an important role in aquatic ecosystem. The percentage of phosphate in soil of study area is the range from 0.024 to 0.059%. Most soil P is tightly bound to soil particles or contained in relatively insoluble complexes. The P-containing complexes in alkaline soils are very different than those in neutral or acidic soils. The amount of P removed during soil extraction is very much dependent on the nature of P complexes (Olsen *et al*., 1954) [23].

7) Potassium

The presence of potassium (K) in the soil is in the form of bonded potassium between the layers of soil. The range of potassium in the study area is between 0.70 % and 1.23%. Potassium is not an integral part of any major plant component but it plays a significant role in plant growth, protein synthesis and maintenance of plant water balance (Sumithra, 2013) [30]. It involves in many plant metabolism reactions, ranging from lignin and cellulose used for formation of cellular structural components, to regulation of photosynthesis and production of plant sugars. The high content of available potassium on surface soil may be attributed to the application of potassium fertilizers and

manures addition (Solanki *et al*., 1989).

8) Organic carbon

Organic carbon is the index for nitrogen content in the soil. In present investigation organic carbon values are ranges from 0.25% to 0.37%. The source of organic carbon in the cultivated soil included crop residue, animal manure, cover crops, green manure and organic fertilizer etc. (Gupta and Varsshaney, 1994) [14].

9) Calcium

Calcium ranges from 41.00 ml/100gm to 53.3 ml/100gm. Calcium (Ca) is present in sufficient quantity in most of the soil. Calcium is a component of several primary and secondary minerals in the soil. These minerals are the original source of available forms of calcium. In agriculture Ca is essential for soil porosity, plant cell growth, neutralized the excess acid of alkaline, inflexible cell wall structure generally avoiding the breaking of fruit covering (Kiran, 2013) [19].

10) Magnesium

Magnesium available to plants as the ions Mg+2. Magnesium content in the soil samples ranges from 14.05 mg/ml to 32.92 mg/ml. Magnesium is important for photosynthesis. It also plays the role in the activation of many plant enzymes needed for growth and protein synthesis.

B. Nematode diversity of seasonal crops in Sakur region

Nematodes are found in both aquatic and terrestrial ecosystems, some adopting a parasitic habitat in vertebrates, invertebrates and plants. Nematode diversity shows their interactions with plants and other organisms. They play important role in nutrient cycle and as plant parasites. In the present investigation the recorded nematode species are *Meloidogyne incognita, M. javanica, Rotylenchulus sp., Heterodera glycines, and Paratrichodorus sp.* From these, most dominant species are *M. incognita, M. javanica* which found in all seasonal crops.

In the study area major crops cultivated by farmers in two seasons are the cotton, soybean, jawar, onion, tomato. When analyzed the diversity of phyto nematodes among the seasonal crops species, it was found to be diversified with various nematodes species. The *Meloidogyne incognito* is the common species of nematodes on the Cotton, Soybean, Jawar, Onion and Tomato. The species are found all over the world and also found in the seasonal crops of study area. It is also called root-knot nematodes.

There are two types of nematodes present in the soil. Some are parasitic and some are beneficial to plant growth (Andrássy, 1983) [1]. Most of the quantity of nematodes present in soil is parasitic. The plant parasitic nematodes are slender, unsegmented usually shorter than 2mm in length with twisting mode of locomotion. The *Meloidogyne* sp. of nematodes is wide spread throughout India (Yeates, 1980) [37].

In the present investigation *M. incognita* and *M. javanica* are known to parasitize crops of cotton, soybean, onion, tomato and jawar. It is also called as root-knot nematodes. Most common symptom of root-knot nematodes infection was appearances of knot like galls on the roots. In India *M.incognita* is widespread in Panjab and Maharastra (Andrássy, 1983) [1]. Other plant parasitic nematodes are the *Rotylenchulus* sp. nematode (may be R*otylenchulus renoformis)* is found in cotton crop. It is also found in all over India (Andrássy, 1983) [1]. Damage of Cotton by *Rotylenchulus reniformis* estimated at 5.6% due to direct reduction in yield, lint percentages and reduced fiber elongation. The nematode also causes delay in boll maturity as well as reduction in boll size and lint quantity (Yeates, 1980) [37] but in study area no any serious cause of this species. Other plant parasitic nematodes *Heterodera glycine* found in soybean crop. It is also known as soybean cyst nematodes. Basically *M. incognita* is common and dominant species in this area and it is widely distributed. Various workers stated that this species loss soybean yield globally (Wrather and Shannon, 2010) [36]. *M. incognita* and *H. glycine* are reported last year in Godavari basin of Jalna district Maharashtra, India (Shinde *et al*., 2018) [24]. In study area onion and tomato cultivated in both seasons by farmers. In onion crop *Paratrichodorus sp.* is reported it is commonly known as stubby root knot nematode. The present study of nematode diversity provides a primary data base for researchers in future. There is no any significant cause of plant parasitic nematodes.

Table 4: Nematode diversity of seasonal crops in Sakur region

Crop plant	Cultivation season of crop	Common name	Scientific name	Family
Cotton	August to February	Root-knot nematode	*Meloidogyne incognita*	Meloidogynidae
		Reniform nematode	*Rotylenchulus sp.*	
Soybean	August to October	Soybean cyst nematode	*Heterodera glycines*	Meloidogynidae
			Meloidogyne incognita	
Jawar	November to February	Root knot nematode	*Meloidogyne incognita*	Meloidogynidae
Onion	August to February	Root knot nematode	*Meloidogyne incognita*	Meloidogynidae
			Meloidogyne javanica	
		Stubby root knot nematode	*Paratrichodorus sp.*	
Tomato	August to February	Root knot nematode	*Meloidogyne incognita*	Meloidogynidae
			Meloidogyne javanica	

Conclusion

In the present study, we analyze the physico-chemical parameters of soil samples from different localities of seasonal crops from Sakur region. All the soil parameter such as EC, pH, and %N, %P, %K, %C, Ca, Mg are in normal range. This study gives information about nature of soil and present nutrients in soil. This analysis is helpful to farmers of that area to arrange the amount as well as which fertilizers and nutrient needed for soil increase the percentage yield of crop. The present study indicates that the given soil is more suitable for crops like sugarcane, wheat, cotton, soybeans, onion, and tomato and fruit plant.

The most of the nematode species recorded in the present study are highly plant pathogenic. Their occurrence may cause a serious threat to the affected crop plant species but no any significant loss in study area. For control the nematode

population various methods can be used by farmers like the crop rotation, chemical control, biological control etc.

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