Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(1): 1223-1225
Received: 04-11-2018
Accepted: 06-12-2018

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GPS-GIS based soil fertility maps of Akole tahsil of Ahmednagar district (M.S.)

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Abstract
Plant nutrients supply from chemical fertilizers plays a vital role in increasing agricultural production by enhancing the soil quality and productivity. The GPS and GIS techniques i.e. (Global Position System and Geographical Information System) are widely utilized for delineating fertility maps of macro and micronutrients. The study entitled GPS-GIS based soil fertility maps of Akole tahsil of Ahmednagar District (M.S) was conducted during the year 2013-2014 and 2014-2015 at Department Soil Science and Agriculture Chemistry, Post Graduate Institute MPKV, Rahuri to assess the macro nutrient status of Akole tahsils of Ahmednagar district based on GPS and delineation of fertility maps.

Keywords: Akole tehsil, GIS, GPS and soil fertility maps

Introduction
The GPS and GIS techniques i.e. (Global Position System and Geographical Information System) are widely utilized for delineating fertility maps of macro. Global Position System is used in agriculture for land survey, development of dams and canal, animal behavior study and marine organism. It is also used for obtaining digital road maps in vehicles when GPS and GIS are integrated. Soil samples collected with GPS data can help in making critical decisions on nutrients management. The fertilizer required is to be established, for calculating exact amount of straight fertilizer rather than a ready mixed complex, compound fertilizer. Fertilizer used can be better optimized by utilizing knowledge of fertility maps prepared with the help of GPS-GIS techniques. Money spends on fertilizers can be modified to the amount actually needed to supply nutrients in soil for cropping systems. Fertilizer use can be customized to area and quantities needed on various parts of fields for better nutrients management. Collection of soil samples by using GPS is very important for preparing thematic soil fertility maps. 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. It also helps to know elevation, road map, nearest city/town and speed of movement.

Ahmednagar district is located between 18.20 to 19.90 North Latitude and 73.90 to 75.50 East Longitudes. The geographical area of the district is 17, 41, 271 ha. Its annual rainfall is 769 mm. The maximum and minimum temperature of this district is 43.3^0C and 11.9^0C, respectively. Ahmednagar district comprises 14 tahsils out of this Akole is considered for the study. Global positioning system (GPS) is a space based navigation and positioning system administered by U.S. military, which helps to determine the exact position of an object on the earth surface in terms of geographical coordinates (French, 1996) [2]. Geographical information system (GIS) is a computer system for capturing, storing, querying and displaying geographical data, Chang (2002) [1]. Once the soil fertility maps are created, it is possible to transform the information about the fertility status of the area. Such maps provide site specific recommendation and validation for soil fertility over the following years. Adoption of high yielding varieties and intensive cropping together with shift towards use of high NPK fertilizers has caused decline in the level of micronutrients in soil below normal at which productivity of crop cannot be sustained. The deficiency of micronutrients has become major constraint for productivity and sustainability of soil (Yadav and Meena, 2009) [8]. The average rainfall of Akole tahsil is 1058 mm. Main crops grown in Main crops grown in Akole tahsil are Paddy, sugarcane sorghum, pearlmillet, Vegetables, onion, pomegranate and. tomato.

Materials and Methods
Akole is well surrounded with the mountains of Sahyadri, and extends between $73^0$46’29.773’’E and $19^0$33’56.171’ N. It is situated 140 km away in the South-East direction of Ahmednagar district.

There are 191 Villages and four Revenue Circles *viz*., Rajur, Akole, Samsherpur and Kotul. The total population is 2, 71,719 according to Census 2001 (No. of Male 1,37,617 and No. of Female 1,34,102) and literacy is 59.15 per cent. The Akole tahsil of Ahmednagar district was selected for carrying out the study to prepare GPS and GIS based thematic soil fertility maps. Latitude (Lat) and Longitude (Long) were recorded by GPS instrument from soil sampling places of Akole areas. The soils were collected at a depth of 0-22.5 cm from farmer's fields. The samples collected from Akole tahsil were 321. Soil samples collected from Akole tahsil of Ahmednagar district were brought to the laboratory, thoroughly mixed, air dried in shade, ground with wooden mortar and pestle and passed through two mm sieve for analysis. The sieved soil samples were stored in cloth bags with proper labeling for subsequent analysis. All the precautions were followed while processing the soil samples in the laboratory. The analysis of soil samples have been done by using standard methods i.e. Soil available nitrogen (Alkaline permanganate), Soil available phosphorus ($NaHCO_3$ 0.5 *M* pH 8.5 ascorbic acid) and Soil available potassium (Flame photometer).

Results and Discussion

The GPS-GIS based fertility maps of Akole tahsil of Ahmednagar district (M.S.) was prepared by using Arc-4 software The data on available revealed that major portion of the study area in Akole tahsil of Maharashtra registered low status of available nitrogen as per the three tier system. A large variation in the results of available phosphorus from 2.83 to 72.01 kg ha^{-1} in Akole tahsil. In general, the values of available K in the cultivated soils of Akole was higher.

Table 1: Range and average values of Available nutrients of Akole tehsil

Available Nutrients		Akole
Nitrogen (kg ha^{-1})	Range	53.76 to 598.08
	Average	239.01
	SD ±	118.93
Phosphorus (kg ha^{-1})	Range	2.83 to 72.01
	Average	21.17
	SD ±	14.59
Potassium (kg ha^{-1})	Range	82.88 to 997.02
	Average	518.12
	SD ±	254.95

Table 2: Per cent distribution of available nutrients in different category

Available Nutrients	Category	Value	Akole		
			No. of Samples	No. of Samples	Per cent distribution
Nitrogen (kg ha^{-1})	Low	<280	242	211	65.7
	Medium	280 to 560	93	109	34
	High	>560	00	1	0.3
Phosphorus (kg ha^{-1})	Low	<10	144	95	29.6
	Medium	10 to 24.5	191	108	33.6
	High	>24.5	00	118	36.8
Potassium (kg ha^{-1})	Low	<108	00	2	0.6
	Medium	108 to 280	56	36	11.2
	High	>280	279	283	88.2

Muhr (1965)

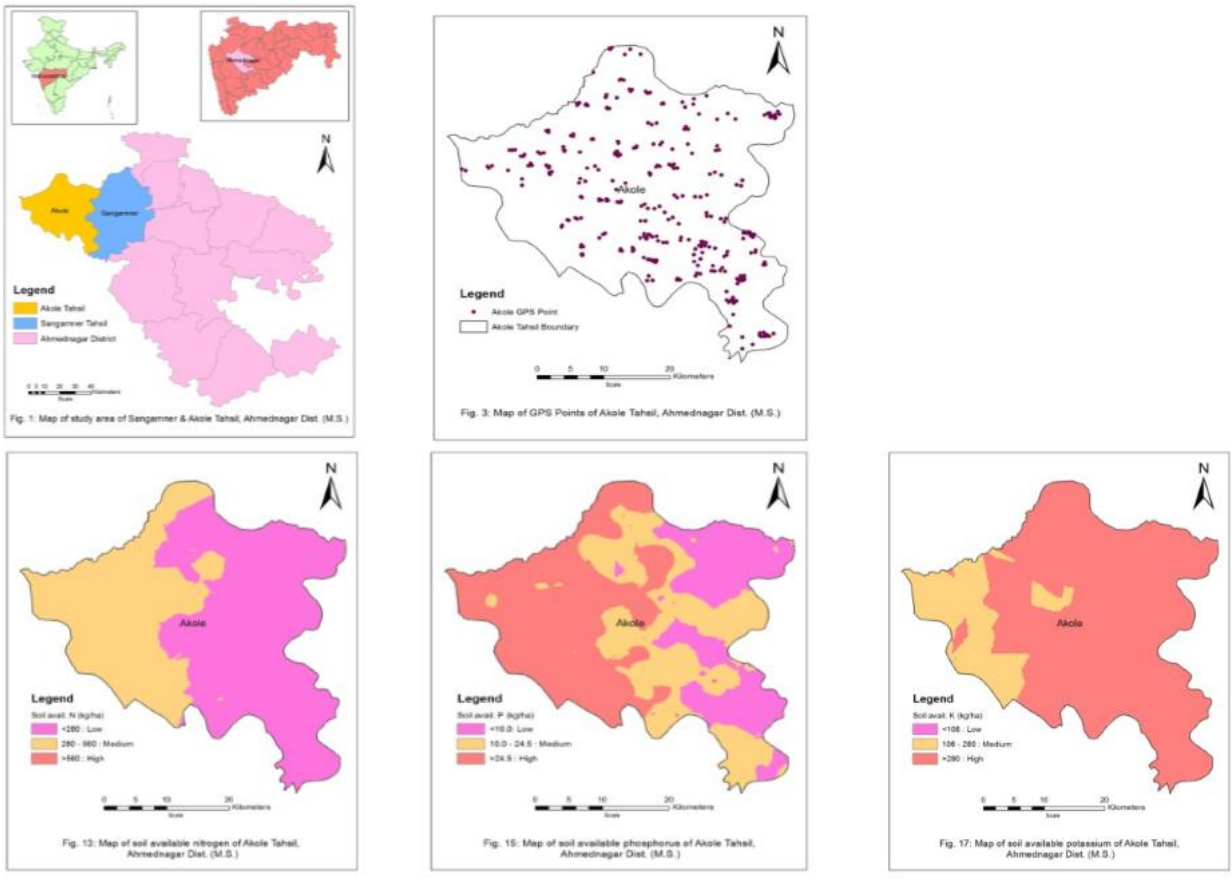

Fig 1: The GPS-GIS based fertility maps of Akole tahsil of Ahmednagar district (M.S.)

Conclusion

It was observed from the maps that all the soil samples collected from Akole tahsil the available nitrogen in cultivated soils of Akole tahsil ranged from 53.76 to 598.08 kg ha^{-1} with an average of 239.01 kg ha^{-1}. Akole soils recorded the large variation in the available nitrogen content.

Among the soil samples collected from Akole tahsil recorded the 29.6, 33.6 and 36.8 per cent samples were in low, medium and high phosphorus category as per three tier system.

The available potassium in cultivated soils of Akole tahsil ranged from 82.88 to 997.02 kg ha^{-1} with an average of 518.12 kg ha^{-1}. All the soil samples were in low (11.5 %) to high (88.5 %) category of available potassium content (11.5 and 88.5 per cent).

This approach is proposed as a method for the evaluation of sustainable soil management. The fertility maps could be used to predict potentials and constraints of land for specific crop production. The soil test values have further been utilized for prescribing fertilizer recommendations for optimum crop production in order to maintain the soil fertility, productivity, sustainability and better crop quality in the studied area. This data and fertility maps will be helped in planning, maintaining the fertility, productivity and quality of growing crops *viz*., Paddy, pomegranate, sugarcane, onion, cabbage, tomato, cauliflower, *chilli*, *brinjal* and particularly in forage crop *Lucerne* etc. in the soils of Akole tahsil.

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