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Physico-Chemical Properties of Surface Soil in Ashoknagar District of Madhya Pradesh for Agricultural Production

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Looking at the crop production and soil related constraints in different village of Ashoknagar District of Madhya Pradesh we found it important to characterize the soils of the village. For this purpose, one hundred twenty-five GPS-based surface soil samples (0-15 cm) were collected from five blocks (Mungaoli, Chanderi, Ishagarh, Ashoknagar and Sadora) of Ashoknagar district from April to May 2017-2018. Soils were studied for their physical and chemical characteristics - status of sand,silt,clay percent varied from 36.6-56.7%, 3.9-38% and 25.2-42.4%, with the mean value of 47.5%, 17.2% or 35.1%, respectively and soil pH, EC, OC, Calcium carbonate, total Nitrogen or available sulphur were observed in the range of 7.2– 8.6, 0.32 - 0.62dSm^{-1}, 2.14 - 7.06 gkg^{-1}, 0.5 – 3.5 % 0.01-0.24 % and 4.36 – 40.25 mg kg^{-1}under different villages of the investigated area with the average value of 8.0, 0.45dSm^{-1}, 4.35gkg^{-1}, 1.7% and 0.11 %,14.68 mg kg^{-1} respectively. The availability of sulphur increased with an increase in organic carbon and clay content in the soil.

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Keywords: Total nitrogen; calcium carbonate; organic carbon; clay content.

1. INTRODUCTION

Presently, the foremost challenge confronting Indian agriculture lies in the imperative to enhance both food production and productivity while ensuring the sustainability of agriculture as a whole. Several issues act as constraints on these objectives, raising significant concerns about national food security. These challenges encompass the deterioration of soil fertility, escalating production costs, and a limited diversity of production systems. The pressing need for improved crop productivity has become more critical than ever due to the escalating population and the resulting pressures from competing demands for land. This has led to a reduction in the land-man ratio, significantly diminishing the average size of farm land. Consequently, there is a heightened risk of soil fertility depletion through continuous or intensive cropping, coupled with imbalanced fertilization practices. Plants necessitate nutrients in adequate and proper proportions for optimal growth, constituting a pivotal element in determining soil productivity. Effectively managing the fertility of Indian soils requires its augmentation. Soil fertility, in this context, refers to the intrinsic capacity of soil to provide essential nutrients at a high level, supporting the production of sufficient food to feed the burgeoning population.

"Prudent soil fertility management necessitates the careful identification of existing nutrient deficiencies and monitoring changes in soil fertility to predict potential deficiencies. Addressing these deficiencies requires the implementation of sound and proven practices encompassing nutrients, water, crops, and energy in soil management. This approach is essential to sustain food production at a satisfactory level, ensuring continued high productivity in the future.Thus, the management of soil fertility, particularly in terms of nutrient management at an optimum level, stands out as a crucial factor in achieving both high and sustainable productivity. Soil test-based fertility management is an effective tool for increasing productivity of agricultural soils that have high degree of spatial variability resulting from the combined effects of physical, chemical or biological processes" (Goovaerts,1998).

Ramprasad Naik Desavathu (2017)- "82 soil samples were collected randomly at different land use/cover locations, which includes agriculture, forest, built up area, scrubland and plantation at a depth of 0–30 cm, analyzed for soil pH, electrical conductivity (EC) and presence of nitrogen (N), phosphorous (P) and potassium (K). Inverse Distance Weightage method (IDW) was employed for analyzing the spatial distribution of soil fertility through geospatial techniques for sustainable agriculture. It is observed that soil pH varies between 4.8 and 7.5; showing nearly 83% of the study area is acidic in nature. The EC varies from 0.04 to 0.87 $dS^{-1}m$ with a mean of 0.21 dS^{-1}/m and non saline in condition. out of 435 km^2 of total study area,99% of area is less in nitrogen followed by potassium (70%) and phosphorus (42%) respectively".

The increased production per unit area of cereals, pulses and oilseeds crops led to more removal of nutrients and their deficiency of nutrients. The information on micro nutrients and sulphur status in district is inadequate and hence an attempt has been made for the delineation of these nutrients. The soil test results so obtained under study must be translated into digital map at region level for balanced fertilizer application guide. These guidelines will help to the farmers to obtain the balanced fertilizer doses prescribed for different crops and soils.

This study presents The present study entitled "Status of different forms of sulphur in soils of Ashoknagar district of Madhya Pradesh". The information generated will be useful for managing soil resources of the village on sustainable basis. . The basic objectives of the study are as follows:

- To study the distribution of different forms of sulphur in surface soil.
- To determine the physico-chemical properties of the soils.
- To determine the correlation between different forms of sulphur.
- To find out the relationship of forms of S with total N and other soil properties.

2. MATERIALS AND METHODS

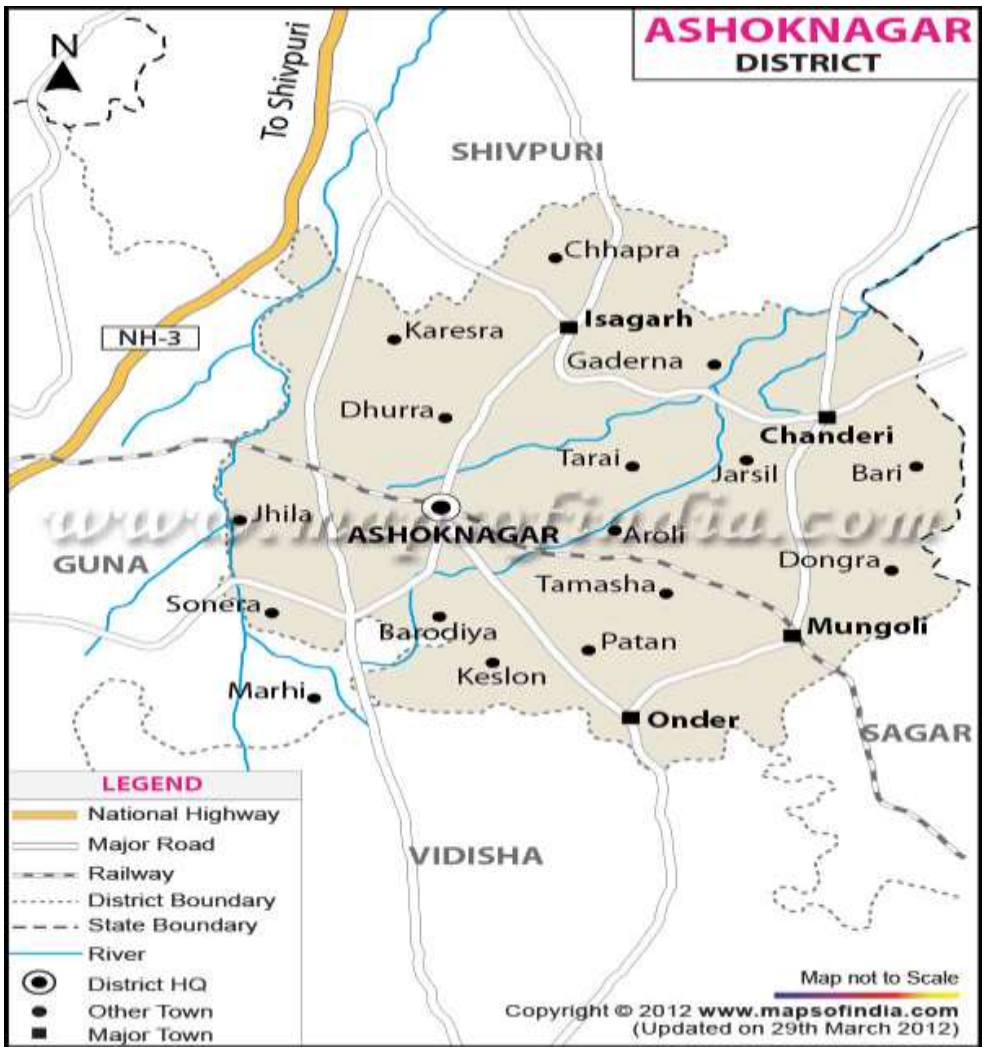
The study was carried out during 2017-18 in the Department of Soil Science, College of Agriculture, Gwalior (M.P.).

(a) Location and extent: Ashoknagar is located in the northern part of Madhya Pradesh, between

the rivers Sindh and the Betwa. It comes under the northern part of the Malwa plateau, though the main part of its district lies in the Bundelkhand Plateau. The Coordinates of the district are 24°34′ 48″ N and 77°43′ 48″E with an average elevation of 507 meters (1640 ft) above sea level.

(b) Soils: Soils of the investigated area are generally variable in colour, depending on the timing period and sources of the irrigation system. In this region, the main classes of soil are black, brown and bhakti (stony) soil. The volcanic, clay-like soil of the region owes its black colour to the high iron content of the basalt from which it is formed. The soil requires less irrigation because of its high capacity for moisture retention. The other two soil types are lighter and have a higher proportion of sand. The major crops of the investigated area are Soybean, Paddy, Blackgram, Greengram, Jowar, and Pearlmillet in *Kharif* and Mustard, Gram and Wheat in *Rabi.*

(c) Collection and preparation of soil samples: For the present study, 125 surface (0-15 cm) soil samples (GPS based, detail given in tables) collected from cultivar's fields of five blocks (namely; Mungaoli, Chanderi, Ishagarh, Ashoknagar and Sadora) of Ashoknagar district. The representative soil samples were collected with the help of soil auger. The soil samples were put in the polythene bags properly, labelled and carried to the laboratory. After collection, the samples were brought to the Soil Science Laboratory, College of Agriculture, Gwalior and samples were air dried, crushed and sieved through a 2 mm plastic sieve.



Map 1. Study location
Source: www.mapsofindia.com

List 1. Determination method of soil constituents

S.No.	Soil constituents	Method of determination
1.	Particle size analysis (mechanical analysis of Soil) Sand (%) Silt (%) Clay (%)	Hydrometer method described by Buoyoucos (1962) using 5%sodium hexameta phosphate as dispersing agent
2.	Soil pH (1:2 soil- water ratio)	pH meter Jackson, [1]
3.	Electrical conductivity (ds/m)	Conductivity meter at 25ºC (Jackson, 1967)
4.	Organic carbon (g/kg)	Walkley and Black method [2]
5.	Total nitrogen (%)	sulfuric salicylic acid modification method Chapman and Pratt, [3]
6.	Calcium carbonate $CaCO_3$ (%)	Titration method Piper [4]
7.	Available Sulphur ($mgkg^{-1}$)	Turbidity metric method (Bardsleyand Lancaster [5]

(d). Soil analysis:

We have used different methods for determine physico-chemical properties of soil.

3. RESULTS AND DISCUSSION

3.1 Physical and Chemical Characteristics of Soils

3.1.1 Mechanical composition of soils

Mechanical composition (sand, silt and clay) of soils of different blocks of Ashoknagar district are presented in (Fig-1).

In the study area of Ashoknagar district sand, silt and clay percent varied from 36.6-56.7%, 3.9-38 % and 25.2-42.4%, with the mean value of 47.5%, 17.2% and 35.1%, respectively (Fig 1), “However, maximum average content of sand (49.4%), silt (24.9%) and clay (38.0%) were observed recorded in Chanderi, Sadora, Isagarh block, respectively, whereas minimum content of sand (44.1%), silt (12.8%) and clay (31.4%) were observed in Sadora, Isagarh and Sadora block, respectively”. Similar result recorded by Santra et al., [6].

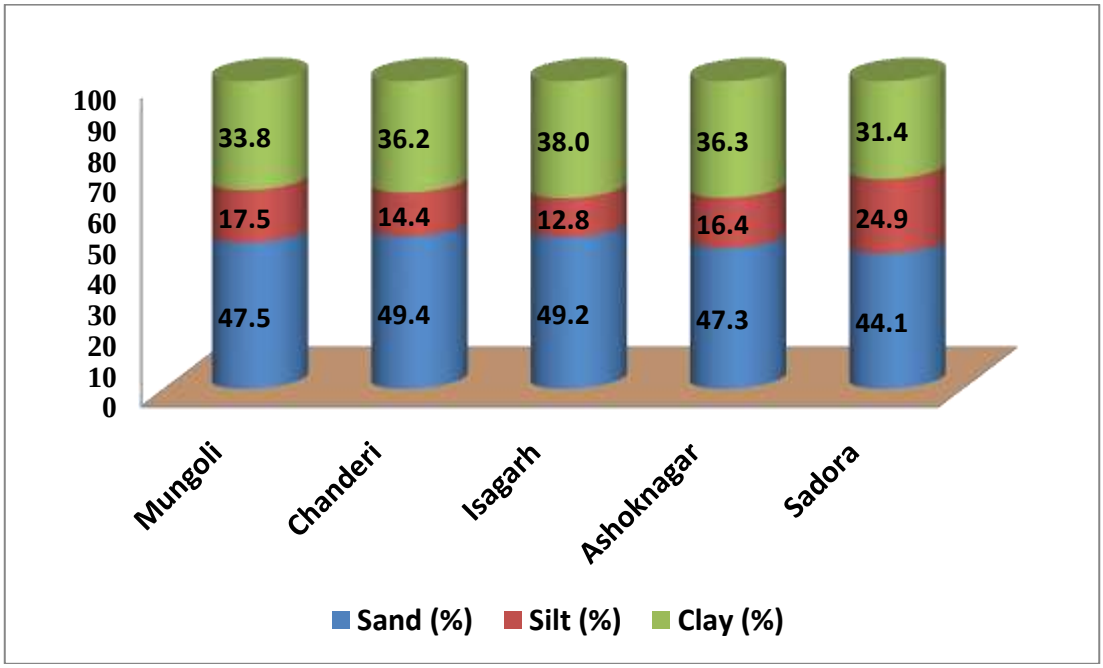


Fig. 1 .Mechanical composition of soils in different blocks of Ashoknagar district

3.1.2 Soil pH

Soil pH of studied area was found in the range of 7.2 - 8.6 under different villages with the average value of 8.0 (Table 1). However, pH value in different villages of Mungaoli, Chanderi, Isagarh, Ashoknagar, and Sadora block varied from 7.2 – 8.6, 7.2 – 8.6, 7.5 – 8.4, 7.6 – 8.5, and 7.3 – 8.4 with an average value of 8.0, 8.0, 8.0, 8.1 and 7.9 respectively. Maximum average value of soil pH (8.1) was observed in Ashoknagar block whereas minimum value (7.9) noted in Sadora block of Ashoknagar district. Higher pH (>8.5) in some of the samples of Ashoknagar district indicate towards the fact that the soils are infested with alkalinity. Similar, result were recorded Ravikumar and Somashekar, [7] Shukla et al., [8] and Subhash et al., [9] indicating the existence of a variety of soils that are slightly natural to slightly alkaline nature.

3.1.3 Electrical conductivity (dSm^{-1})

Value of electrical conductivityin Ashoknagar district varied from 0.32 - 0.62 with the average value of 0.45dSm^{-1} (Table 1). However, EC value in different villages of Mungaoli, Chanderi, Isagarh, Ashoknagar, and Sadorablock varied from 0.32 - 0.61, 0.37- 0.56, 0.38–0.62, 0.38-0.61 and 0.38 - 0.59 dSm^{-1}, with an average value of 0.44, 0.45, 0.45, 0.44, and 0.45dSm^{-1} respectively.

Highest value of electrical conductivity (0.62 dSm^{-1}) was observed in Korwas village of Isagarh block whereas minimum value (0.32 dSm^{-1}) was found in Shyampur village of Mungaoli block of Ashoknagar district. similar findings were reported Bharteey et al., [10].

Table 1. Soil pH and EC in various villages of different blocks of Ashoknagar district

			pH		EC	
S. No.	**Block**	**Village name**	**Range**	**Mean**	**Range**	**Mean**
1.	Mungaoli (25)	Aathaikheda	7.9 – 8.3	8.1	0.39 – 0.51	0.47
		Bilakhedi	8.0 – 8.6	8.2	0.37 – 0.51	0.44
		Mudrakhana	7.6 – 8.1	8.0	0.38 – 0.48	0.41
		Chamrai	7.9 – 8.2	8.0	0.39 - 0.61	0.49
		Shyampur	7.2 – 8.4	7.8	0.32 – 0.50	0.41
		Overall Block	7.2 - 8.6	8.0	0.32 – 0.61	0.44
2.	Chanderi (25)	Barodiya	7.2 – 8.6	7.8	0.37 – 0.43	0.41
		Sangampur	7.8 - 8.6	8.2	0.39 – 0.53	0.46
		Tarai	7.9 – 8.3	8.1	0.41 – 0.53	0.45
		Mohalichak	7.6 – 8.4	8.0	0.38 – 0.56	0.46
		Salona	7.2 - 8.4	7.9	0.38 - 0.50	0.44
		Overall Block	7.2 – 8.6	8.0	0.37 – 0.56	0.45
3.	Isagarh (25)	Korwas	7.8 – 8.4	8.1	0.41 – 0.62	0.46
		Kotharkhedi	7.9 – 8.3	8.1	0.39 – 0.49	0.43
		Vijaypura	8.0 – 8.4	8.1	0.39 – 0.52	0.45
		Pachlana	7.5 – 8.2	7.9	0.38 – 0.47	0.43
		Bamnawar	7.6 – 7.9	7.8	0.43 – 0.61	0.50
		Overall Block	7.5 – 8.4	8.0	0.38 – 0.62	0.45
4.	Ashoknagar (25)	Mau	8.0 – 8.3	8.1	0.42 – 0.46	0.44
		Banyga	8.0 - 8.2	8.1	0.38 – 0.51	0.45
		Diyadhari	8.0 – 8.4	8.1	0.38 – 0.45	0.41
		Ratikheda	7.6 – 8.5	8.0	0.39 – 0.53	0.45
		Ashoknagar	7.8 – 8.4	8.1	0.39 – 0.61	0.45
		Overall Block	7.6 – 8.5	8.1	0.38 – 0.61	0.44
5.	Sadora (25)	Kherai	7.7 – 8.4	8.0	0.42 – 0.59	0.47
		Bamuria	7.3 – 8.1	7.8	0.38 – 0.52	0.44
		Parwai	7.6 – 8.3	8.0	0.39 – 0.47	0.43
		Gugor	7.4 – 8.2	7.9	0.41 – 0.46	0.44
		Bagulya	7.6 – 8.3	7.9	0.43 – 0.52	0.46
		Overall Block	7.3 – 8.4	7.9	0.38-0.59	0.45
Whole district			7.2- 8.6	8.0	0.32-0.62	0.45

3.1.4 Organic carbon

Status of organic carbon understudied area was in the range of 2.14 - 7.06gkg^{-1}under different villages with the average value of 4.35g kg^{-1}(Fig. 2). However, organic carbon status in different villages of Mungaoli, Chanderi, Isagarh, Ashoknagar, and Sadorablock varied from 2.58 – 6.19, 2.14 – 6.15, 2.88 – 5.85, 3.48 – 5.88 and 2.25 – 7.06 g kg^{-1}, with an average value of 3.98, 4.37, 4.47, 4.79 and 4.12 g kg^{-1},respectively.

Maximum average organic carbon content (4.79g kg^{-1}) was obtainedin Ashoknagar whereas minimum value (3.98g kg^{-1}) in Mungaoli block of Ashoknagar district. Similar results were also reported by Das et al., [11] and Setia and Sharma, [12].

3.1.5 Calcium carbonate

Calcium carbonateof studied area of Ashoknagar district was found in the range of 0.5 –3.5 % under different villages with an average value of 1.7% (Table 2). However, calcium carbonatestatus in different villages of Mungaoli, Chanderi, Isagarh, Ashoknagar, and Sadora block varied from 0.5 – 2.5, 0.5 – 3.5, 0.5 – 2.5, 0.5 – 3.0 and 0.5 – 2.5 %, with a mean value of 1.6, 1.8, 1.8,1.9 and1.7 %respectively. Highestcontent ofcalcium carbonate(3.5%) was noted in Barodiya village of Chanderi block of Ashoknagar district. Similar result has been recorded by Sharmaet at al. [13].

3.1.6 Total nitrogen (%)

Status of Total Nitrogenunderstudy area of Ashoknagar district was observed in the range of 0.01-0.24 % under different villages with an average value of 0.11 % (Table 2). However, total N status in different villages of Mungaoli, Chanderi, Isagarh, Ashoknagar and Sdora block varied from 0.03-0.24, 0.06-0.14, 0.01-0.16, 0.04-0.24and 0.05-0.19% with an average value of 0.10, 0.10, 0.10, 0.12 and 0.10 %respectively. Highest content of total N (0.24%) was noted in Mudrakhana and Diyadhari villages of Mungaoli and Ashoknagar block of Asoknagar district. Similar result has been recorded by Paul and Mukopadhyay [14].

3.1.7 Available-S

Status of available -S (mg kg^{-1}) under different villages of Ashoknagar district are presented in Fig. 3. It has observed in the range of 4.36 – 40.25mg kg^{-1} with the mean value of 14.68 mg kg^{-1} . However, status of available sulphur in Mungoali, Chanderi, Isagarh, Ashoknagar and Sadora block were4.36-22.56, 6.95-24.51, 6.95-27.44, 5.27-40.25 and 4.62-26.55 mgkg^{1} with an average value of 13.52, 14.47, 15.02, 17.08, and 13.32 mg kg^{-1},respectively.The average maximum (20.43 mg kg^{-1}) and minimum (8.17 mg kg^{-1})values of available-S was noted in Ashoknagar and Shyampur village of Ashoknagar and Mungoali block, respectively. Similar result has been recorded by Ghodke *et al.* (2016) [15,16].

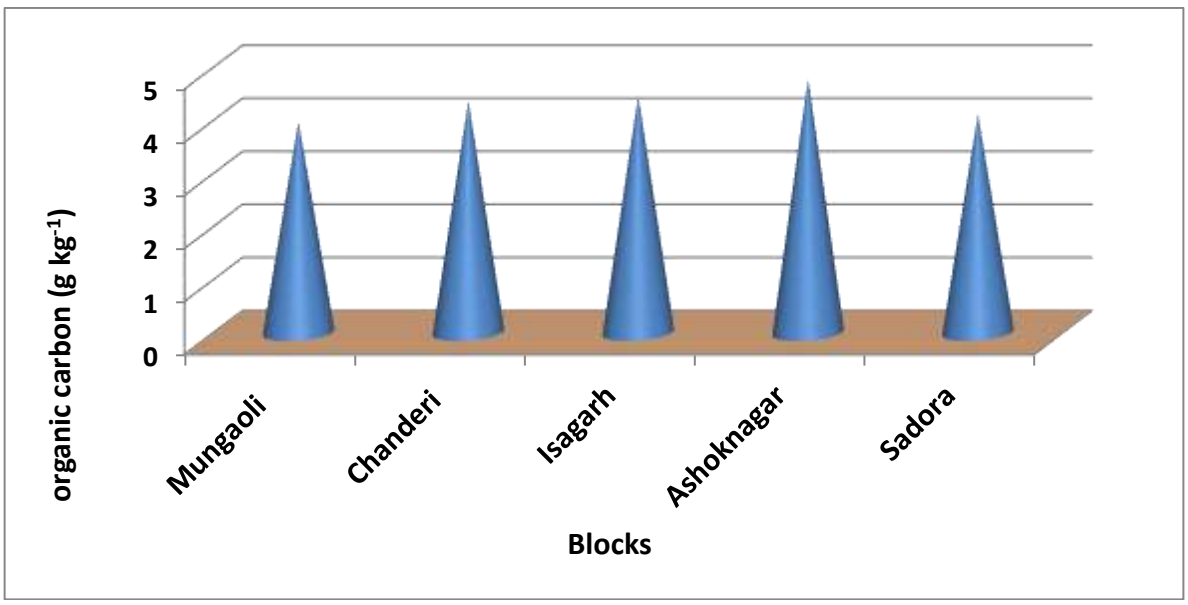


Fig. 2. Status of organic carbon (g kg^{-1}) in different blocks of Ashoknagar district

Table 2. Status of $CaCO_3$ (%) and Total N(%) in soils of different blocks of Ashoknagar district

			$CaCO_3$ (%)		Total N (%)	
S. No.	**Block**	**Village name**	**Range**	**Mean**	**Range**	**Mean**
1.	Mungaoli (25)	Aathaikheda	1.5 – 2.5	2.1	0.08-0.16	0.10
		Bilakhedi	1.5 – 2.5	2.0	0.03-0.13	0.07
		Mudrakhana	1.0 – 1.5	1.2	0.10-0.24	0.16
		Chamrai	0.5 – 1.5	1.2	0.09-0.22	0.14
		Shyampur	0.5 – 2.5	1.6	0.08-0.18	0.12
		Overall Block	0.5 – 2.5	1.6	0.03-0.24	0.10
2.	Chanderi (25)	Barodiya	0.5 – 3.5	1.7	0.08-0.14	0.11
		Sangampur	1.5 – 2.5	1.8	0.06-0.13	0.07
		Tarai	1.5 - 2.5	1.9	0.09-0.12	0.10
		Mohalichak	1.0 – 2.5	1.9	0.07-0.13	0.09
		Salona	0.5 - 2.5	1.8	0.08-0.14	0.11
		Overall Block	0.5 – 3.5	1.8	0.06-0.14	0.10
3.	Isagarh (25)	Korwas	1.5 – 2.5	1.8	0.12-0.16	0.14
		Kotharkhedi	1.0 – 2.5	1.7	0.07-0.16	0.10
		Vijaypura	1.5 – 2.5	2.0	0.04-0.12	0.08
		Pachlana	0.5 – 2.5	1.6	0.01-0.12	0.05
		Bamnawar	1.5 – 2.0	1.7	0.08-0.16	0.11
		Overall Block	0.5 – 2.5	1.8	0.01-0.16	0.10
4.	Ashoknagar (25)	Mau	2.0 – 2.5	2.3	0.05-0.19	0.12
		Banyga	1.5 – 2.0	1.8	0.08-0.19	0.11
		Diyadhari	1.5 – 3.0	2.1	0.05-0.24	0.14
		Ratikheda	0.5 – 2.5	1.8	0.04-0.10	0.08
		Ashoknagar	1.0 – 2.5	1.7	0.06-0.20	0.12
		Overall Block	0.5 – 3.0	1.9	0.04-0.24	0.12
5.	Sadora (25)	Kherai	1.5 – 2.5	1.9	0.08-0.19	0.12
		Bamuria	0.5 – 2.5	1.7	0.07-0.13	0.09
		Parwai	1.5 – 2.5	2.0	0.05-0.14	0.09
		Gugor	1.0 – 2.0	1.5	0.06-0.18	0.11
		Bagulya	1.0 – 2.5	1.5	0.06-0.14	0.09
		Overall Block	0.5 – 2.5	1.7	0.05-0.19	0.10
Whole district			0.5 – 3.5	1.7	0.01-0.24	0.11

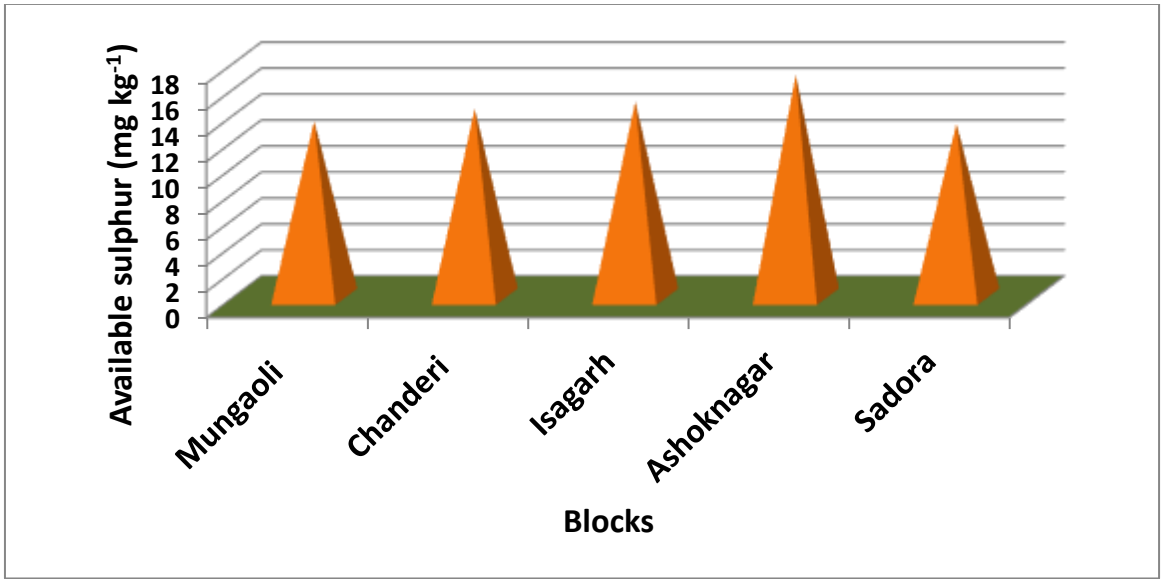


Fig. 3. Status of available Sulphur (mg kg^{-1}) in different blocks of Ashoknagardistrict

4. CONCLUSION

From the study, it can be concluded that, soils of Ashoknagar District Agro climatic zone of northwestern Madhya Pradesh are Higher pH (>8.5) in some of the samples of Ashoknagar district indicate towards the fact that the soils are infested with alkalinity. Surface soil samples were non calcareous with low organic carbon content, total nitrogen, available sulphur content in soil. Soil organic carbon, Total N and S are important soil fertility constraints indicating their immediate attention for sustained crop production. Soil nutrient management holds the key for sustainable soil fertility management.

It can be concluded from the available data that the soils were deficient in some nutrients while others were very high due to imbalanced fertilization coupled with intensive cultivation of nutritive exhaustive crops.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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