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AN APPRAISAL OF SOIL FERTILITY STATUS IN THE PANCHAGANGA BASIN

S.D.Shinde and P.B.Patil, Kolhapur

ABSTRACT : Panchaganga basin is agriculturally one of the developed and productive areas in Maharashtra. The region is endowed with rich fertile soils which are well known for sugarcane cultivation. It occupies river plains along the eastern offshoots of Western Ghats in addition to hilly and rugged terrain in rest of the area. Soil fertility is related to number of soil nutrients, the distribution of which vary from place to place. In the present study an attempt is made to examine the spatial pattern of fertility status of the soil at microlevel, the focus being on N,P, and K. This work is largely based on fieldwork wherein 15 to 20 soil samples from selected villages in the study area have been considered in addition to the data made available by Government Soil Testing Laboratory. Average values of each component were derived and were plotted on the map accordingly. As a result distinct micro-regional patterns have emerged depicting spatial variations in NPK status.

INTRODUCTION

A thin layer covering the upper portion of land surface and varying from few centimetres to 2-3 metres in thickness is very significant in terms of plant growth. Plants obtain water and essential nutrients from this layer, which is the source of food, clothing and shelter; and medium for growing plants. But this basic foundation of farming differs in many ways from region to region inviting an attention to understand soils in terms of its fertility and other facets in agricultural studies.

The term fertility is used differently in different contexts as there is no absolute scale of fertility. Soil fertility is, 'the capability of soil of producing a plant yield under defined conditions' (De, 1981). Whereas the capability to produce plant yield more or less depends upon the nutrient availability in the soil, inviting the study of nutrient content in the soil along with other considerations. The factors controlling the fertility of soil are numerous and inter-linked amongst which soil depth, texture, structure, pore space, aeration, compaction, tillage, soil reaction, humus content and nutrient content are some important factors. However this paper focuses attention on the study of nutrient contents in the soil.

A large number of nutrients are available in the soil which are grouped under two categories as 'Macronutrients' and 'Micronutrients'. Oxygen, carbon, hydrogen, nitrogen, phosphorus, potassium, calcium, magnesium and sulphur fall in the first category know as 'macronutrients'; while micronutrients include elements like manganese, zinc, copper, molybdenum, boron, chlorine, cobalt and iron (Thompson,1978). Besides these aluminium, silicon and sodium are abundantly available in the soil but are considered not essential for plant. Elements required by plants in concentration exceeding one part per million (P.P.M.) often ten times or more are called 'macronutrients'; while less than 1 p.p.m are known as 'micronutrients'. But this division varies from plant to plant accordingly to the requirement of particular crop and region. This shows that besides micronutrients which are required by plant in less quantity, macronutrients play pivotal role in plant growth. These are the elements responsible for healthy and steady plant growth. Out of the nine macronutrients carbon, oxygen and hydrogen are obtained by plants from air and water providing energy for plant growth and metabolism of plants. Calcium, magnesium and sulphur are essential for plants but in small quantity. Remaining macronutrients namely nitrogen, phosphorus and potassium are needed by plants in large quantities and are responsible for plant growth and fertility status of the soil in the context of crop production. Keeping this in view an attempt is made to examine the spatial pattern of N,P and K content in the soils of Panchaganga basin of Southern Maharashtra.

THE REGION

Panchaganga basin is one of the developed and productive areas in southern Maharashtra in terms of agriculture having the total geographical area of 2730.40 sq. kms. It covers the parts of Karveer (521.76 sq. kms.), Panhala (399.20 sq. kms.), Bawada (266.24 sq. kms.), Shahuwadi (310.08 sq. kms.), Radhanagri (480.32 sq. kms.), Hatkangale (369.76 sq.kms.) and Shirol (383.04 sq. kms) talukas in Kolhapur district. the Panchaganga - a tributory of Krishna - is formed by its four main tributories namely the Bhogavati, the Tulsi, the Kumbhi and the Kasari (Fig. 1). The rivers drain major part of the district and are the source of enormous amount of sedimentation in the basin region.

Physiographically the region represents diversity ranging from hilly and rugged western part to relatively leveled, broad and plain eastern tract. The western portion is dominated by hill ranges and crests of Sanhyadari elevating from 516 to 914 metres, whereas eastward offshoots of Western Ghats restrict the expansion of flood plains in the east. the rivers separate theses ranges and deposit vast amount of sediments along the banks which help to boost agricultural activities. The soils are characterised by variations from west to east. The western hilly part is dominated by lateritic soils while eastern plain portion has medium to deep black soils. The brown soils of low depth are found in the central transitional zone. Climatically the region experiences moderate type of climate with very little extremes of heat and cold. (Shinde, 1973). The region has mild summers and winters in the west whereas hot summers and cold winters in the east. The amount of rainfall decreases from west to east ranging from 3,500 mm to 750 mm. respectively.

In recent years development of lift irrigations, development of sugar factories in co-operative sector and co-operative societies and units have accelerated the pace of agricultural production, thereby directly affecting the quality of soils in the basin. In particular, excess use of irrigation and overdose of chemical fertilizers have directly affected the soil quality which invited the authors to examine the fertility status of the soils in the basin.

SOURCES OF DATA AND METHODOLOGY

The present study is based on fieldwork in which thirty villages were selected on the basis of selective sampling, representing almost entire region. While selecting the villages care has been taken to cover the soils from different topographical tracts. Field traverses were undertaken to collect soil samples from each village. Samples were collected dividing the field in parts according to soil colour, rockiness, nature of irrigation, slope and crop taken and further extracted soil was mixed together. This mixture was again divided in four equal parts out of which one was taken as soil sample. These soil samples were obtained from each selected plot, representing the surrounding fields; at plough level (0 - 30 cms.) with a screw auger systematically. While taking samples care was taken to avoid the locations affected by waterlogging, manure pits, tree shades and old compost pits. The soil samples thus collected were taken to the soil laboratory and were dried, ground and screened through a sieve to obtain suitable soil sample for laboratory examinations. About 15 to 20 soil samples were collected from each sample village and chemical characteristics of those were obtained in terms of nutrient content. Nitrogen content in terms of organic carbon was derived with 'Walker and Black method'; phosphorus content from Photo Electric Calorimeter and potassium availability from Flame Photometer. The results in connection with N,P and K content thus obtained from laboratory were taken as the data for further study. This data was processed, classified, tabulated and average values were worked out

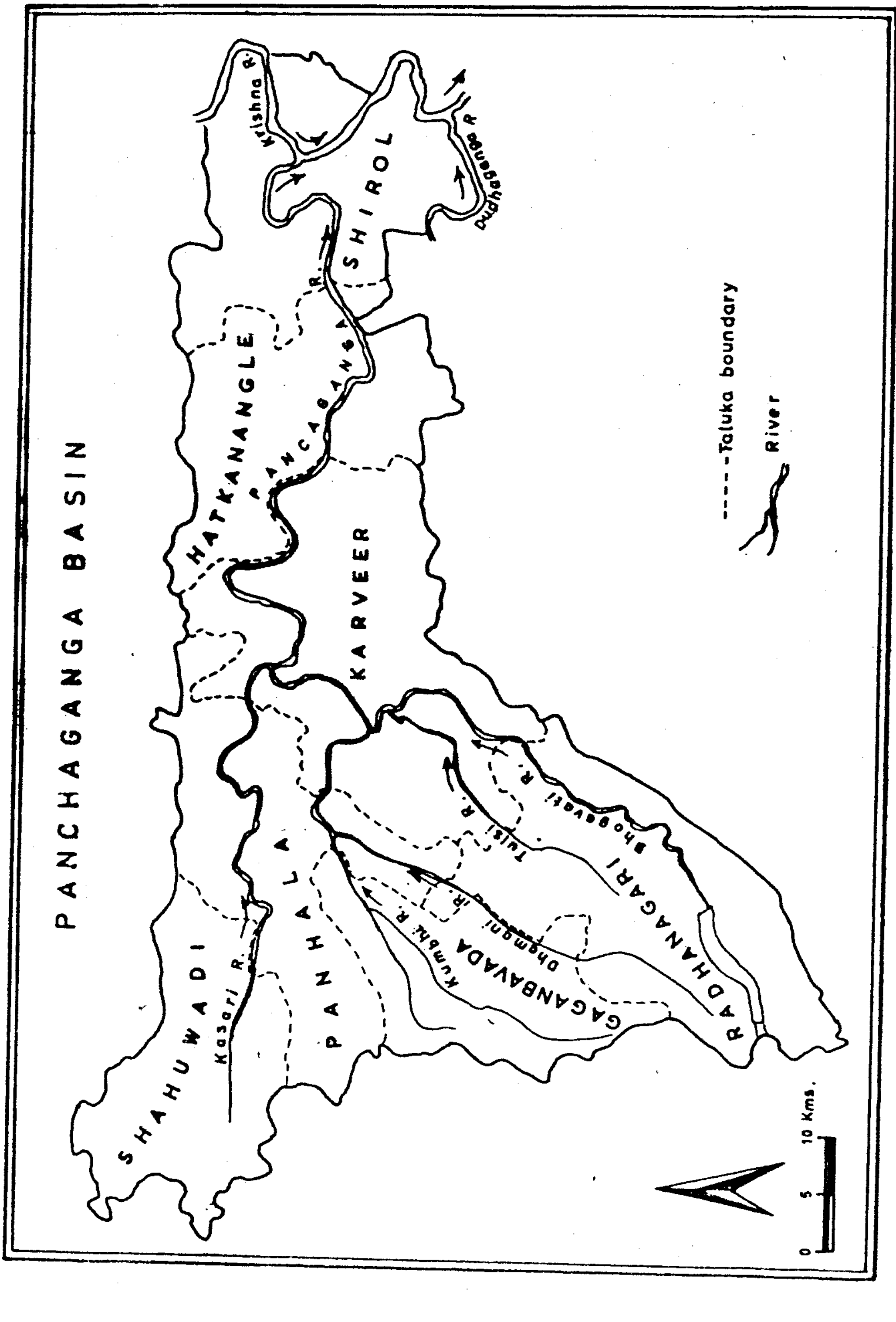
PANCHAGANGA BASIN
SHAHUWADI
PANHALA
KARVEER
HATKANANGLE
SHIROL
GAGANBAVADA
RADHANAGARI
Krishna R.
Dudhaganga R.
PANCAGANGA R.
Kasari R.
Kumbhi R.
Dhamani R.
Tulsi R.
Bhogavati R.
Taluka boundary
River
0
5
10 Kms.

Fig.1

to find out spatial pattern of nutrient content in the region. In addition to this data on nutrient content was also collected from Government soil Testing Laboratory for remaining villages excluding sample villages to study the pattern at micro-level. The average values of nutrients were plotted accordingly on the map and isopleth lines were drawn using interpolation technique at selective interval. The spatial variations in each component is represented through cartographic technique.

FERTILITY STATUS (N,P,K STATUS) OF SOIL

The fertility status of the soil is largely related to the nutrient availability in the soil which varies from place to place. An attempt is made henceforward to focus an attention on the spatial pattern of N,P and K content in the soil.

A)Nitrogen (N) content

Moderate to high nitrogen content in the soil is observed in the basin region showing the spatial distribution as follows :-

I)High Nitrogen content

The soils containing more than 0.61 percent organic carbon are included in this category. These soils dominate the spatial distribution with 68.75 percent area (Fig. 2) scattered in Karveer (13.41%), Panhala (12.82%), Bawada (9.63%), Shahuwadi (11.35%), Radhanagri (12:45%), Hatkangale (6.21%) and Shirol (2.88%) talukas (Table 2). These soils are largely confined to the vicinity of streams and rivers which happen to be the sugarcane cultivation areas having overdoses of chemical fertilizers and heavy sedimentation.

II)Moderate Nitrogen content

The. soils containing 0.41 to 0.60 percent organic carbon are known as moderately nitrogen content soils, which cover 29.91% of the basin area (Fig. 2) mostly in the eastern part, in addition to the patches in the central and western tract. These soils are observed in Shirol (11.03%), Hatkangale (6.62%), Karveer (5.48%), Radhanagari (4.93%), Panhala (1.73%) and Bawada (0.12%) talukas (Table 2).

III)Areas of deficient Nitrogen content

The soils containing less than 0.40 percent organic carbon are grouped in this category covering 1.34% area (Table 1) in isolated patches throughout the region (Fig.2). The soils from Karveer (0.22%), Panhala ().07%), Radhanagari (0.21%), Shirol (0.12%) and Hatkangale (0.72%) talukas belong to this category (Table 2).

B)Phosphorus (P) content

Phosphorus plays an important role in energy transformations and metabolic process of plants (De, 1981). It is a structural component of cell constituent and metabolically active compound. Soils contain phosphorus in both organic and inorganic forms but the availability is often low in most of the soils.

The soils of Panchaganga basin are poor in P content covering almost four fifth (79.35%) area of the basin (Fig.3). The distribution of these soils is as following :-

I)Rich soils

The soils containing more than 50 kilograms of phosphorus per hectare are known as rich phosphorus containing soils, covering 2.78 percent basin area (Table 1). These soils are observed in northern part of Karveer (2.54%) talukas (Fig.3). The soils from northern part of Karveer show very high phosphorus content.

TABLE 1 : N, P, AND K STATUS IN THE BASIN.

Sr. No.	Category (Concentration)	Percentage of area covered N.	P.	K
1.	High	68.75	02.78	40.68
2.	Medium	29.91	17.87	43.43
3.	Low	01.34	79.35	15.89

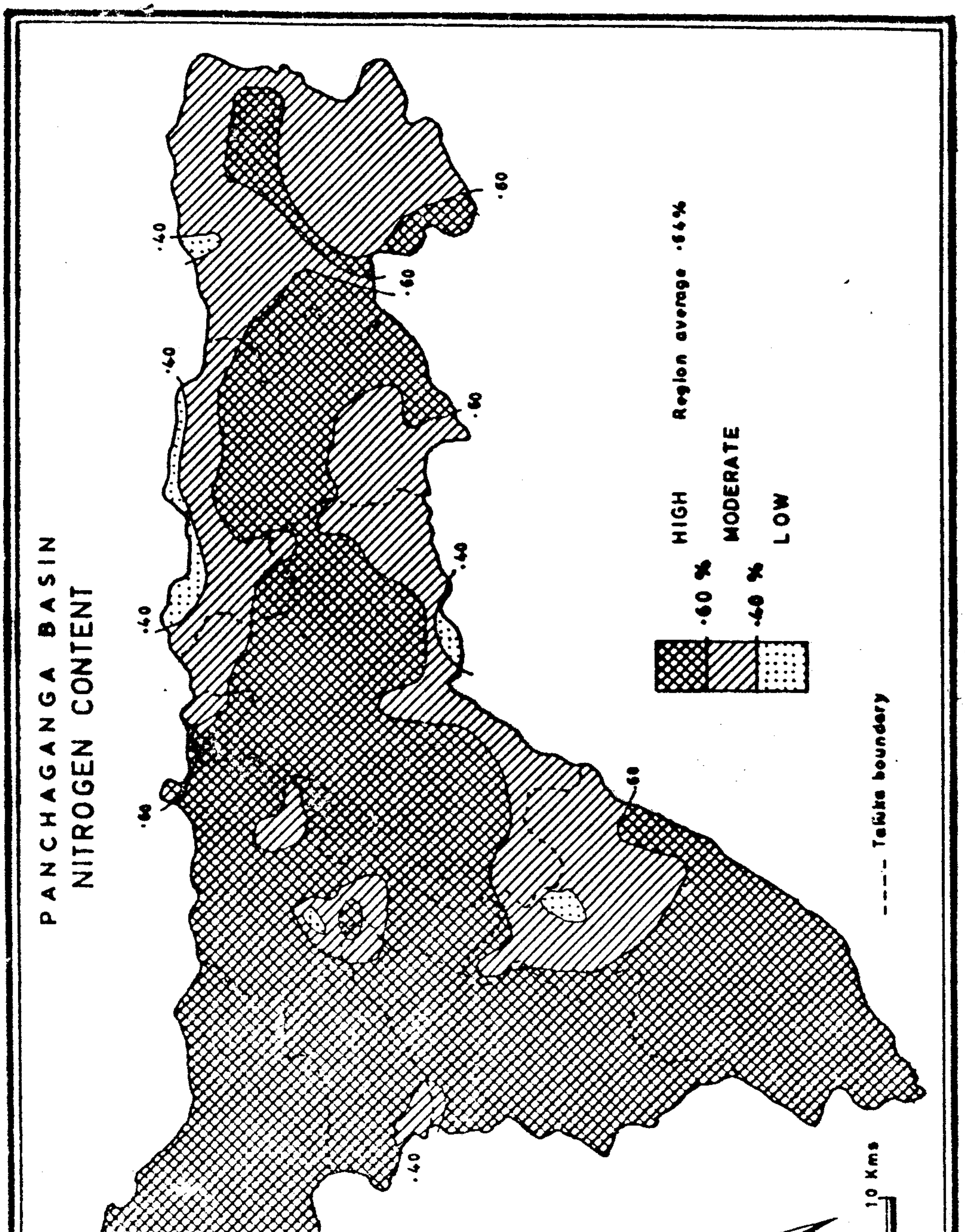
PANCHAGANGA BASIN
NITROGEN CONTENT
·60 %
·40 %
HIGH
MODERATE
LOW
Region average ·64%
Taluka boundary
0
5
10 Kms

Fig. 2

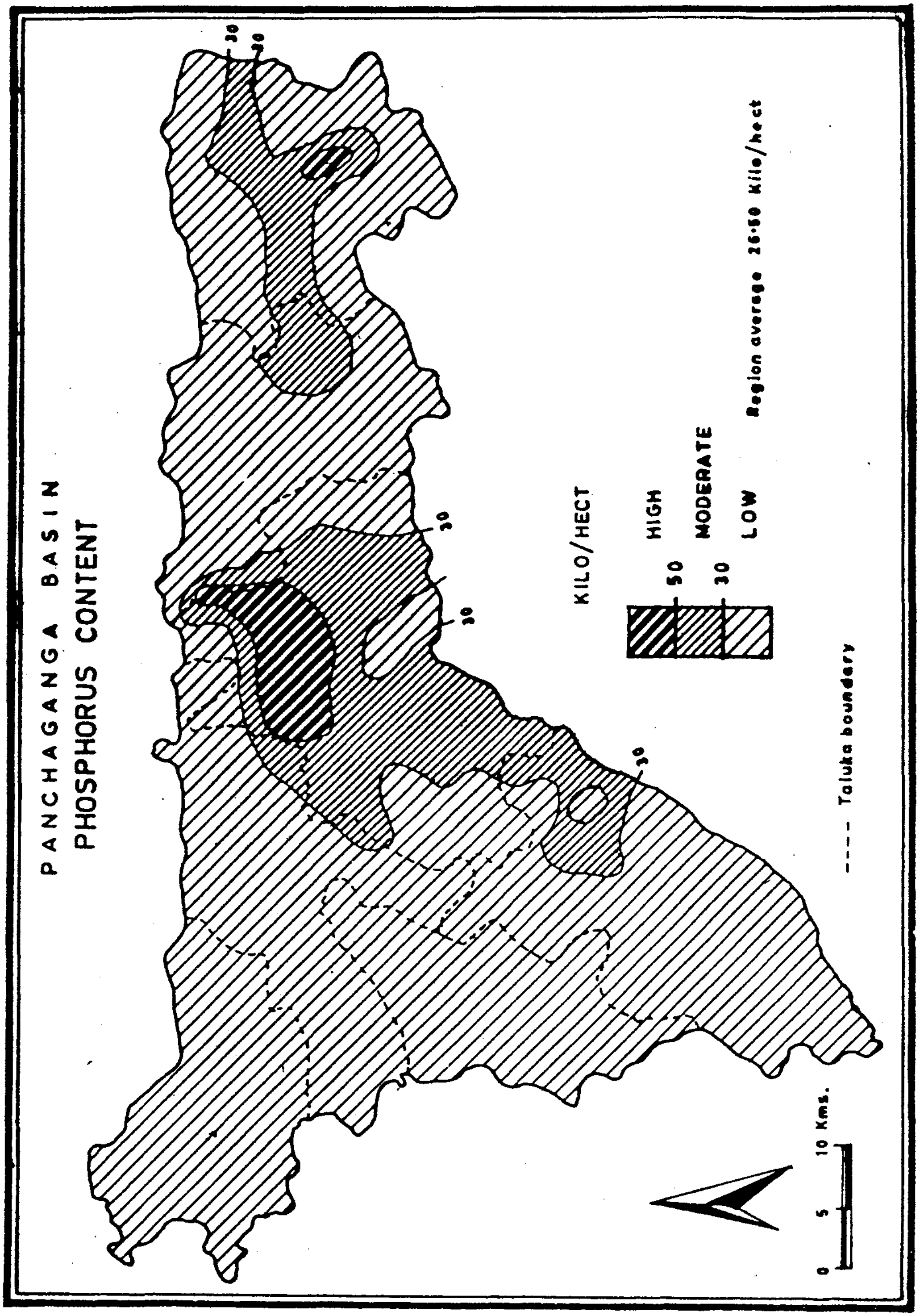
PANCHAGANGA BASIN
PHOSPHORUS CONTENT
KILO/HECT
50 HIGH
30 MODERATE
LOW
Region average 26·50 Kilo/hect
30
---- Taluka boundary
0 5 10 Kms.

Fig. 3

TABLE 2 : TALUKAWISE N,P,K CONTENT

Sr. no.	Name of Taluka	Percentage of area covered								
		N			P			K		
		H	M	L	H	M	L	H	M	L
1.	Karveer	13.41	05.48	00.22	02.54	09.15	08.36	0.90	08.72	09.48
2.	Panhala	12.82	01.73	00.07	-	00.72	13.90	03.30	10.16	01.17
3.	Bawada	09.63	00.12	-	-	-	09.68	09.64	00.12	-
4.	Shahuwadi	11.35	-	-	-	-	10.78	06.23	02.88	02.24
5.	Radhanagari	12.45	04.93	00.21	-	02.22	15 26	10.50	06.95	00.94
6.	Hatkangale	06.21	06.62	00.72	00.05	02.07	11.38	01.17	10.42	01.94
7.	Shirol	02.88	11.03	00.12	00.19	03.71	09.99	09.77	04.18	00.08
8.	Basin Total	68.75	29.91	01.34	02.78	17.87	79.35	40.68	43.43	15.89

II)Moderately Phosphorus containing soils

The soils containing 30 to 50 kilograms of phosphorus per hectare are regarded as moderately phosphorus containing soils. These soils occupy 17.87% area (Table 1) in the basin with the distribution in Shirol (3.71%), Hatkangale (2.07%), Radhanagari (2.22%), Panhala (0.72%) and Karveer (9.15%) talukas (Fig.3). These soils cover nearly one half (47.90%) portion of Karveer taluka alone.

III)Poor soils

The soils containing less than 30 kilograms of phosphorus per hectare are known as poor soils in terms of of phosphorus content. This category dominates the phosphorous content scene covering almost entire region (79.35%) excluding central part of Shirol and middle part of basin (Fig. 3). These soils are found in Karveer (8.36%), Panhala (13.90%), Bawada (9.68%), Shahuwadi (10.78%), Radhanagari (15.26%), Hatkangale (11.38%) and Shirol (9.99%) talukas (Table 2).

C)Potassium (K) content

Potassium is an important macronutrient essential for plant growth which helps to maintain a cellular organisation of plant. Whereas its deficiency results in producing water imbalances in the plant. It helps 'to increase the resistance of plants to the stress of moisture, to heat and to diseases' (De,1981). It is found in the soil within the crystal lattices of silicate minerals.

Medium to high potassium content is found in most of the areas of the basin. (Fig. 4), the distribution of the same is as follows:-

I)High content

The soils containing more than 240 kilograms of potassium per hectare fall in this category covering 40.68% area in the basin (Table 1) dominating almost eastern, western and southwestern parts of the region (Fig. 4). These soils are distributed in Shirol (9.77%), Bawada (9.64%), Radhanagari (9.67%), Shahuwadi (6.23%) talukas while remaining talukas share the rest (Table 2).

II)Moderate content

The soils containing 181 to 240 kilograms of potassium per hectare are included in this category enjoying a vast distribution in the region. They cover 43.43% area (table 1) including major parts of Radhanagari (6.95%), Panhala (10.16%), Hatkangale (10.42%) and Karveer (8.72%) talukas (fig. 4) in addition to the northwest part of Shirol (4.18%) and central tract of Shahuwadi (2.88%) talukas (Table 2).

III)Potassium Deficiency areas

The soils containing less than 180 kilograms of potassium per hectare are know as potassium deficient soils - covering only 15.89% areas in the basin (Table 1). These soils cover almost all parts of Karveer (9.48%) excluding northern and western tracts (Fig. 4) in addition to the isolated patches in Shahuwadi (2.24%), Panhala (1.17%), Hatkangale (1.94%), and Shirol (0.08%) talukas (Table 2).

In general upper and lower parts of the basin enjoy rich to moderate potassium containing soils (Fig.4) while central part has poor soils.

CONCLUSIONS

The following conclusions can be drawn from foregoing study :

1) The soils of Panchaganga basin have moderate to high nitrogen content but deficient in phosphorus and potassium availability.

2) The areas with high N,P and K content are confined to the western hilly tracts which happen to be the rugged terrain and so not developed in terms of agriculture.

3) The soils rich in nitrogen content are confined to the vicinity of rivers and streams which happen to be sugarcane cultivation belt with high chemical fertilizer doses, whereas unirrigated farming zones have the soils with poor nitrogen content.

4) The spatial pattern of phosphorus content in the soil shows that the hilly areas and areas adjoining the ridges are poor in phosphorous content, whereas comparatively level lands in the central and eastern part have moderate phosphorus content.

5) The spatial distribution in potassium availability in the soil shows that the hilly tracts and depositional eastern parts of flood plains are rich in potassium while the central tract is deficient in the same.

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Address of the Authors

Dr.S.D.Shinde
Professor and Head
Department of Geography,
Shivaji University
Kolhapur 416 004

Shri P.B.Patil
U.G.C teacher Fellow
Department of Geography
Shivaji University,
Kolhapur 416 004

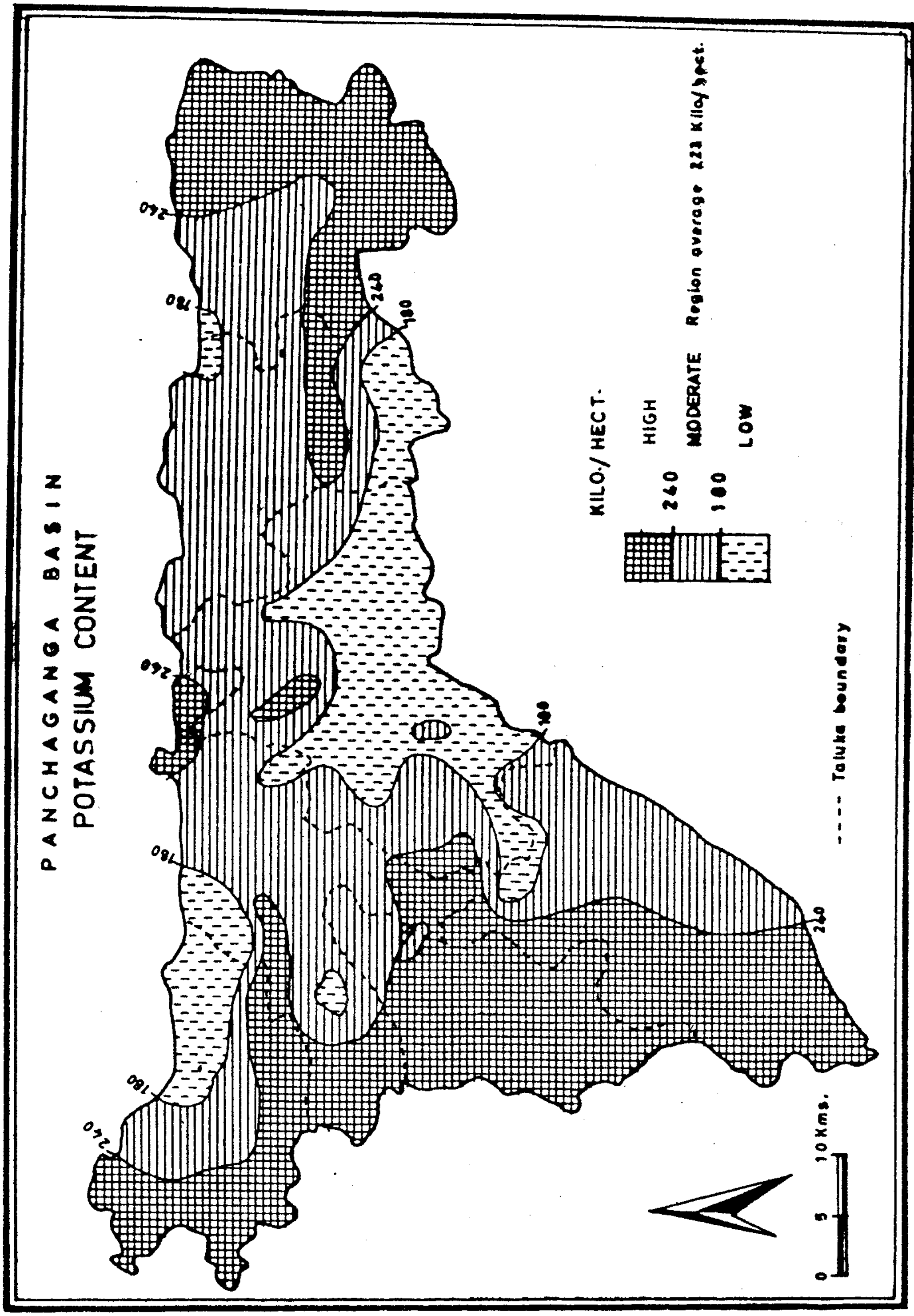
PANCHAGANGA BASIN
POTASSIUM CONTENT
KILO./HECT.
240 HIGH
180 MODERATE
LOW
Region average
---- Taluka boundary
0 5 10 Kms.
240
180

Fig. 4