



Article : A STUDY OF FERTILITY STATUS OF SOIL AND NUTRIENTS RECOMMENDATIONS IN PANCHGANGA BASIN (MAHARASHTRA): A MICRO LEVEL ANALYSIS

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Abstract:

The existence of nutrients in soils and its balance determine the growth of plants. Fertility of soils is determined by various macro and micro nutrients available in the soil. In view of this the present study aims to analyse the fertility level of the soil with the help of N, P, & K, and to recommend essential nutrients wherever necessary in Panchganga Basin of south Maharashtra. The Panchganga Basin, a well watered and agriculturally developed region covers 45752.2 sq.km area and supports 26, 11,547 (2.6 percent of state) population. The index values of N, P & K are collected from government soil survey and soil testing Laboratory, Kolhapur at village level. These index values of N, P, & K, are grouped into six categories and tahsil wise areas in percentage in concern category are computed and shown in tabular form. To recognise the fertility level of the soils composite index is computed with the help of NPK values and is grouped into five categories. Simultaneously village level fertility is shown with the help of choropleth maps prepared by using ARC-GIS software. Deficiency and sufficiency of soil nutrients are identified and specific nutrients are recommended wherever necessary. The analysis reveals that there is large variation in the distribution of macronutrients of the soil. It is observed that most of the areas of the study region are fertile in nature. Low and very low fertility of soil is noted in some pockets only. The physiography, climate and agricultural activities have greatly influenced the nutrients status of soil. Specific fertilizers and addition of organic matters are recommended for nutrients deficient areas which will help to keep the balance of nutrients and to restore the fertility of soils. Moreover, it is observed during the fieldwork that the anthropogenic influences are degrading the soils in the region which needs further investigations.

INTRODUCTION:

The development of agricultural activities is relatively healthy in the areas of high fertile soil. The fertility of the soil is largely influenced by the Physiography, climate and agricultural activities. But with increasing population pressure, low fertile areas are also utilized for agriculture and to get maximum production overexploitation of productive land creates serious problem of lowering the fertility status of soil and it leads to deterioration of soil. The deficiency of nutrients directly affects on the growth of crops and crop response become poor. Hence it is necessary to assess the fertility status of soil with the consideration of available nutrients in soils and to recommend the specific nutrients for the proper management of soil.

OBJECTIVE:

The present study aims to analyse the fertility level of the soil with the help of N. P. & K. status of the soils and to recommend essential nutrients in specific areas of Panchganga Basin.

STUDY REGION:

The selected region for the present investigation is the 'Panchganga Basin' of south Maharashtra state comprising seven tahsils of Kolhapur district namely Shahuwadi, Panhala, Gagan-Bawada, Karveer, Hatkanangle, & Shirol (Fig. 1). The triangular tract region lies between 16° 13" and 17° 11" north latitude, and 73° 41" and 74° 42" east longitudes. It covers about 45752.2sq.km area and supports 26, 11,547 (2.6 % of state) population. The river Panchganga is well- watered and agriculturally developed part of the state (Shinde, 1973). This region is topographically complex, having river valley flood plains to the east and hilly ranges to the west. Climatically this region has temperate climate. The region located in rain shadow zone of Western Ghats receives a decreasing amount of rainfall from the west (6000mm) to east (500mm).

DATABASE AND METHODOLOGY:

Villegaz index data of macronutrients in soils is used for the present investigation, which is collected from government soil survey and soil testing Laboratory, Kolhapur. These index values of N. P. & K. are grouped into six

categories such as VL, L, M, MH, H & VH and tahsil wise areas in percentages in concern category are computed and shown in tabular form. For the assessment fertility level of the soils the composite index of NPK has computed and it categorized into five groups such as VL, L, M, H & VH. Simultaneously village wise level of N. P. K. and status of fertility are indicated through choropleth maps using ARC-GIS software. With the identification of deficiency and sufficiency of soil nutrients specific nutrients are recommended. As per requirement of soil from slight to strong and tahsil wise nutrients required areas are shown in tabular form.

SOIL TYPES:

The soils in the region are originated mainly from Deccan Trap. The soils in the valleys are mixed in character, varying in colors from brownish to radish. The eastern portion, due to its undulating nature, dipper soils are formed in the low lying parts while ridges are covered by shallow soils. Soil of the study region can divided in five types.

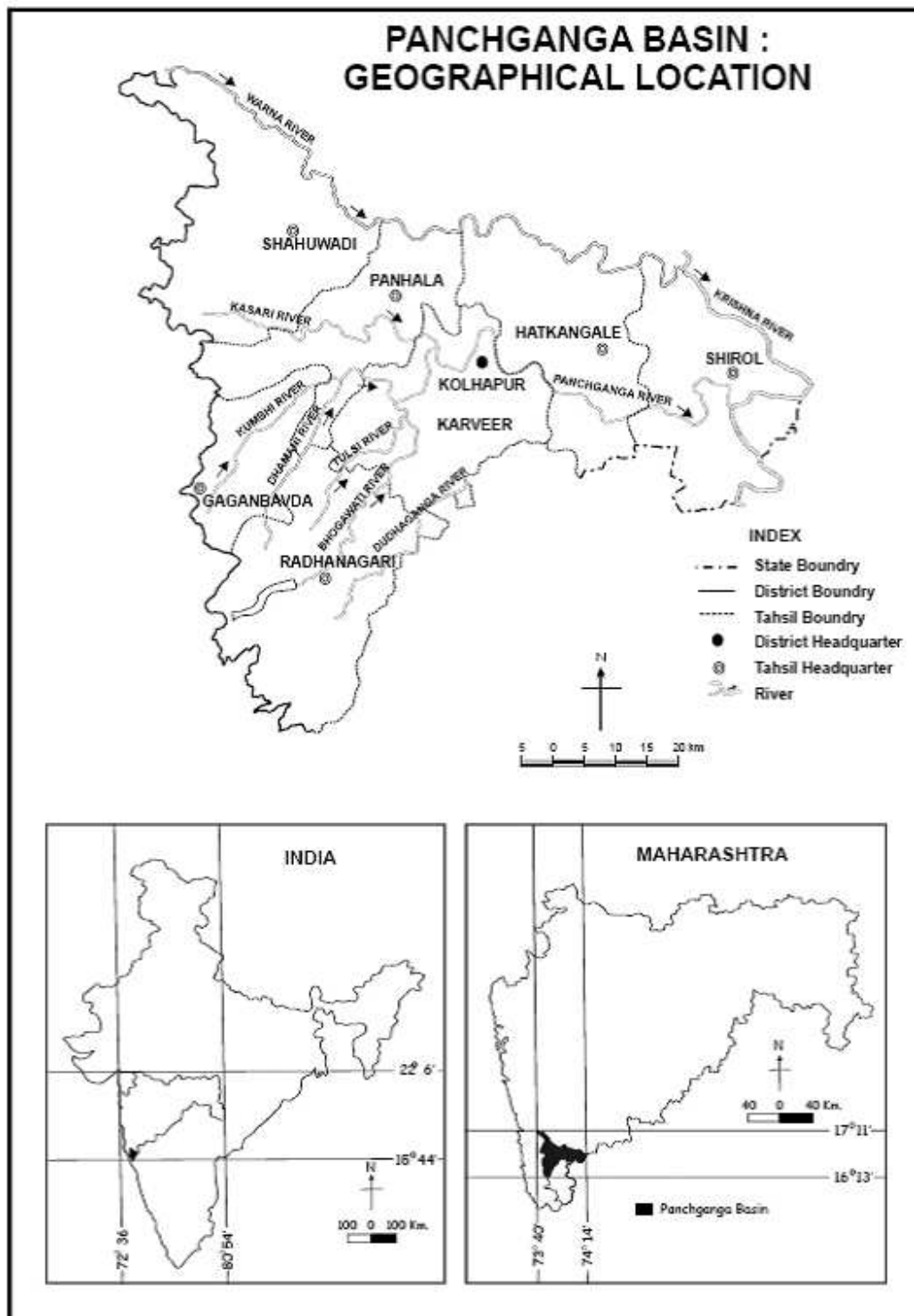


Table 1

Panchganga Basin: Physio-Chemical Characteristics of Soils

Sr. No.	Particulars.	Laterite.	Course shallow & Brown.	Medium and deep black.
1.	Local names.	Tambadi Mati	Halki kali Mati	Madhyam or Bhari kali
2.	Colour	Red to brownish red.	Reddish brown	Gray to deep black.
3.	Depth	1 M	1-1.5 M	1.5 -2.5 M
4.	Drainage	Good.	Excellent.	Moderate to Less
5.	Topography	Undulating.	Undulating.	More or less flat.
6.	Erosion	High	Moderate	Slight
7.	Sand. (%)	35-40	45-50	10-15
8.	Silt (%)	25-30	20-25	30-40
9.	Clay (%)	25-35	20-25	35-50
10.	Lime (CaCo ₃) (%)	Nil.	1-3	1-5
11.	pH	4.50 - 6.50	6.50 - 7.50	7.50 - 8.50

Source: http://kolhapur.nic.in/KolhapurGazetteer/phy_situation.htm

Laterite Soils found mainly in western hilly tracks of heavy rainfall. This soil is red to brownish red in color because of high iron content. This is useful for paddy crops, millets, rice and plantation of fruits. **Radish Brown Soils** is fertile with excellent granular structured this soils mainly derived from traps found in sloppy land of study region. This soil shares 30.77 % area and is useful for growing crops like rice, jowar, groundnut, sugarcane and vegetables. The undulating uplands, foothills and sloppy areas are covered with residual **course shallow soils**. Comprising about 22.10 % area this is useful for the cultivation of groundnuts, jowar, pulses, and sugarcane.

Table 2

Panchganga Basin: Soils types (Area in %)

Sr. No.	Tahsils	Laterite	Radish Brown	Course Shallow	Medium Black	Deep Black
1	Shahuwadi	3.92	92.47	1.16	1.25	1.20
2	Panhala	7.13	51.54	25.94	15.39	0.00
3	Gagan Bawada	88.64	9.22	2.14	0.00	0.00
4	Radhanagri	21.25	57.30	21.25	0.20	0.00
5	Karveer	1.30	6.80	39.04	36.06	16.80
6	Hatkanangle	0.00	0.00	45.82	28.56	25.62
7	Shirol	0.00	0.00	0.00	47.33	52.67
	Region	13.41	30.77	22.10	19.65	14.07

Source: Based on Government Soil Survey and Soil testing Laboratory, Kolhapur.

Medium Black Soils: It is developed on middle part of the study region and nearer to river. This soil is useful for paddy, sugarcane soyabean and vegetable cultivation. It covers about 19.65 % of total geographical area. **Deep Black Soils** has been formed from deposition of eroded materials mostly found on eastern plain topography. It has high proportion of clay and organic matter. This is useful for jowar, groundnuts, pulses, cotton, wheat, sugarcane, and soyabean. It shares only 14 % area.

NPK STATUS:

1. Nitrogen (N): Nitrogen is the most critical element in plant growth (Donahue et. al, 1958). It materialised in soils from nitrogen fixation, microbial activity and addition through manures and fertilizers. It is essential constituent of proteins and chlorophyll and present in many other compounds of great physiological importance in plant metabolism such as nucleotides, phosphatides, alkaloids, enzymes, hormones, vitamins etc (Sabale, 2000). It increases protein content, improve quality and produces rapid early growth of plant.

Table 3

Panchganga Basin: Nitrogen (N) Cotenant in Soil Tahsil wise (Area in %)

Sr. No.	Tahsils	Categories					
		VL	L	M	MH	H	VH

		Below 0.75	0.75- 1.25	1.25- 1.75	1.75- 2.25	2.25- 2.75	Above 2.75
1	Gagan Bawada	0.00	0.00	7.89	42.11	36.84	13.16
2	Hatkanangle	0.00	16.98	62.26	18.87	1.89	0.00
3	Karveer	0.00	4.67	15.89	38.32	34.58	6.54
4	Panhala	0.00	12.26	29.25	41.51	16.98	0.00
5	Radhanagri	2.17	95.65	2.17	0.00	0.00	0.00
6	Shahuwadi	2.80	8.41	31.78	33.64	18.69	4.67
7	Shirol	4.26	6.38	72.34	14.89	2.13	0.00
	Region	1.27	23.09	28.00	28.00	16.55	3.09

Source: Compiled & computed by the researchers.

In the Panchganga basin, about three fourth areas are having good status of nitrogen content. It includes having moderate (28.00%), moderately high (28.00%) and high (16.66%), status of Nitrogen. Only 24.36% area has deficiency of the nitrogen. It consist barren and sloppy land of Radhanagri, Panhala, and Shahuwadi tahsils and saline patches from Hatkanangle and Shirol tahsils (Table 3). The Gagan Bawada, Panhala and Shahuwadi have well forested areas which help to enrich nitrogen content in soil (Fig. 2.A). The Radhanagri tahsil has also lot of forested area but nitrogen in these soils is leached out with the flowing water. Karveer, Hatkanangle and Shirol tahsils have well developed flood plains due to which these tahsils have satisfactory amount of nitrogen content except saline areas.

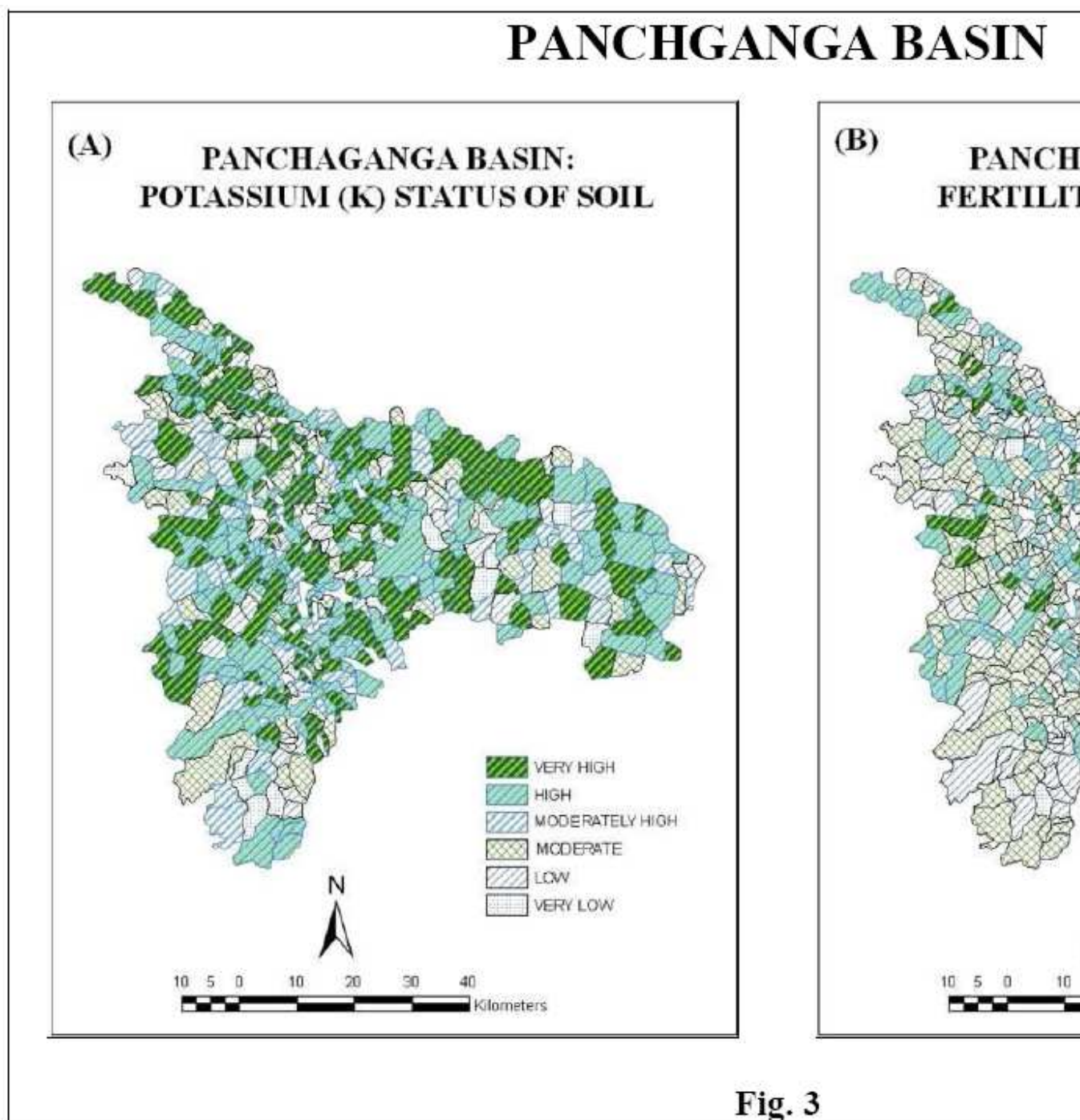


Fig. 3

2. Phosphorus (P): It performs significant functions in energy transformations and metabolic processes of plant. It is closely related to cell division and development. It helps the root development and growth, gives rapid and vigorous start to plant, strengthen straw and decreases loading tendency and improves the

quality of crops. It is produced in soils from phosphate fixation and phosphate released during organic matter decomposition in the soils.

The table no. 4 reveals that most of the areas have Phosphorus deficiency in Panchganga basin. Out of total area 43.63% area is facing acute problem of Phosphorus deficiency and 15.82% of areas has moderate problem of Phosphorus deficiency (Table 4). Aggregate 59.45 % areas, means more than half of total areas of the region is facing problem of Phosphorus deficiency.

Table 4

Panchganga Basin: Phosphorus (P) Content in Soil Tahsil wise (Area in %)

Sr. No.	Tahsils	Categories					
		VL	L	M	MH	H	VH
		Below 0.75	0.75-1.25	1.25-1.75	1.75-2.25	2.25-2.75	Above 2.75
1	Gagan Bawada	2.63	18.42	23.68	34.21	13.16	7.89
2	Hatkangale	28.30	30.19	0.00	32.08	9.43	0.00
3	Karveer	8.41	23.36	20.56	21.50	23.36	2.80
4	Panhala	14.15	31.13	16.98	15.09	20.75	1.89
5	Radhanagri	38.04	27.17	9.78	23.91	1.09	0.00
6	Shahuwadi	14.95	20.56	17.76	23.36	18.69	4.67
7	Shirol	21.28	23.40	21.28	21.28	8.51	4.26
	Region	18.36	25.27	15.82	22.91	14.91	2.73

Source: Compiled & computed by the researchers.

The distribution of phosphorus nutrients in soils are seen in scattered manner (Fig. 2.B). Drainage network, slope, flood plain, distance from river, vegetation, cropping pattern are the factors affecting on concentration and existence of phosphorus nutrients in soils.

3. Potassium (K): Potassium also plays an important role in the maintenance of cellular organization by regulating the permeability of cellular membranes and keeping the protoplasm in a proper degree of hydration by stabilizing the emulsions of highly colloidal particles (De & Sarkar, 1993). It also helps to vigor and disease resistance to plant, regulate water condition within the plant cells, helps to formation of proteins and chlorophyll, increase plumpness of grains and seeds and counteracts of excess nitrogen.

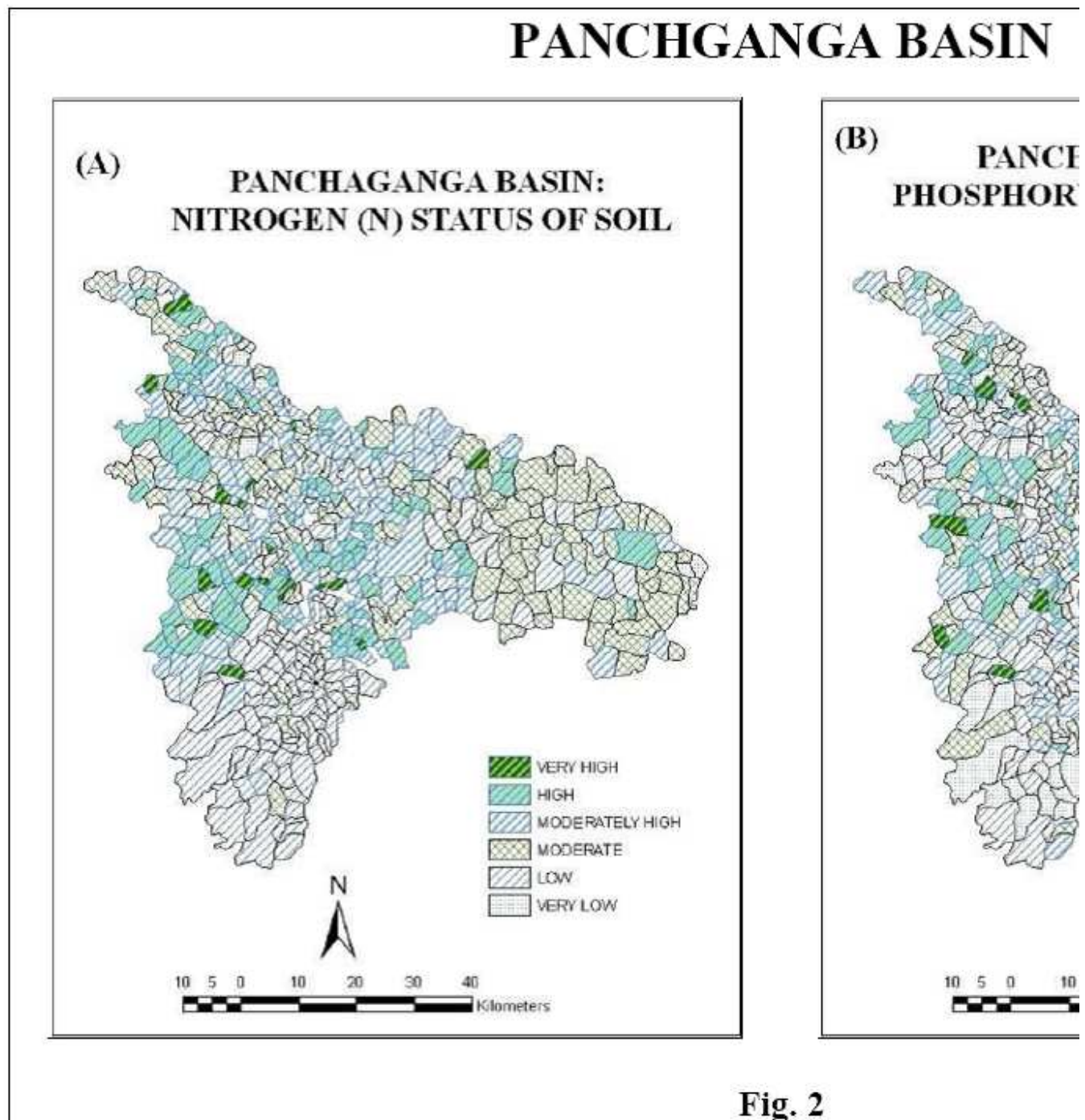
Table 5

Panchganga Basin : Potassium (K) Content in Soil Tahsil wise (Area in %)

Sr. No.	Tahsils	Categories					
		VL	L	M	MH	H	VH
		Below 0.75	0.75-1.25	1.25-1.75	1.75-2.25	2.25-2.75	Above 2.75
1	Gagan Bawada	0.00	5.26	2.63	18.42	34.21	39.47
2	Hatkangale	7.55	13.21	13.21	15.09	22.64	28.30
3	Karveer	2.80	5.61	4.67	6.54	29.91	50.47
4	Panhala	1.89	5.66	12.26	7.55	31.13	41.51
5	Radhanagri	8.70	9.78	11.96	15.22	31.52	22.83
6	Shahuwadi	1.87	6.54	16.82	8.41	21.50	44.86
7	Shirol	4.26	6.38	8.51	19.15	34.04	27.66
	Region	3.82	7.27	10.73	11.27	28.73	38.18

Source: Compiled & computed by the researchers.

The analysis reveals that most of the areas in Panchganga basin have moderately high, high and very high potassium containing soils (Table 5). Out of total region 78.18 % area



has potassium rich soils and only 11.09 % areas have potassium deficiency. Part of Hatkanangle (20.76%), Radhanagri (18.48%), Shirol (10.64%), Shahuwadi

(8.41%) & Karveer (8.41%) tahsils fall in below the moderate level (Fig. 3.A). In all the tahsil 70 to 90 percent areas have above moderately high level of the potassium content in soils.

FERTILITY STATUS:

With the help of composite index of the village wise fertility index data, the fertility level of the villages is determined by classifying data into five groups. The figure no. 3.B indicates level of soil fertility at village level.

- 1. Very Low fertile areas:** Out of the total region only 2.36 % area belongs to this category. It includes Radhanagri (5.43 %), Hatkanangle (3.77 %), Shirol (2.13 %), Panhala (1.89%), Shahuwadi (1.87%) and Karveer (0.93%) tahsils. The hilly barren lands of Radhanagri, Shahuwadi, Panhala, and some part of Karveer and lowlands which are saline and waterlogged in Hatkanangle and Shirol tahsil fall in this category. It is a negligible area as compare area as to total geographical area.
- 2. Low fertile areas:** The low fertile region covers 18.18 % of the total regional areas. It includes Hatkanangle (28.30%), Radhanagri (25.00 %), Shahuwadi (21.50 %), Shirol (17.02 %), Panhala (15.09 %), Karveer (11.21 %) and Gagan Bawada (7.89 %) tahsils. The hilly and sloppy lands with immature soils in high drainage density and high rainfall areas of Radhanagri, Shahuwadi, Panhala, and some part of Karveer belongs to this category. The saline and waterlogged and overexploited areas in Hatkanangle and Shirol tahsil have low soil fertility.
- 3. Moderate fertile areas:** Most of the areas in the region (43.45%) fall in the moderate soil fertility zone. It includes Gagan Bawada (55.26%), Shirol (53.19%), Radhanagri (50.00%), Panhala (44.34%), Hatkanangle (41.51%), Karveer (39.25%) and Shahuwadi (33.64%) tahsils. The common agricultural land derived in this category and it receives average agricultural production.
- 4. High fertile areas:** Next to the moderate fertile soil area, high fertile soil area in the region covers 30.00% area. It exists in Karveer (40.19%), Shahuwadi (34.58%), Gagan Bawada (31.58%), Panhala (29.25%), Shirol (25.53%), Hatkanangle (22.64%) and Radhanagri (19.57%), tahsils. It is relatively high fertile and well supported for agriculture.
- 5. Very High fertile areas:** Very insignificant (6.00%) area belongs to this category. It is found in Panhala (9.43%), Karveer (8.41%), Shahuwadi (8.41%),

Gagan Bawada (5.26%), Hatkanangle (3.77%) and Shirol (2.13%) tahsils. It is highly suitable for crop production and agricultural development because of well crop response.

NUTRIENTS RECOMMENDATIONS:

In view of the above analysis the nutrients are recommended for the betterment of soil status. With consideration of the existing nutrients, moderate high level of nutrients is selected as an ideal nutrients level. Deficiency of the particular nutrients and its acuteness determines the requirement of nutrients. As per the requirement, the soil nutrients are recommended (Table 6).

Table 6
Indexing for Nutrient Recommendations

Nutrients	VL	N.R.	L	N.R.	M	N.R.	MH	Ideal
Index	< 0.75	Strong	0.75-1.25	High	1.25-1.75	Slight	1.75-2.25	
Organic Carbon (OC) (%)	< 0.20	< 0.6	0.21-0.40	0.4-06	0.41-0.60	0.2-0.4	0.61-0.80	Satisfactory
Potassium (P) (Kg/H)	< 15	< 50	16-30	35-50	31-50	15-35	51-65	Satisfactory
Phosphorus (K) (Kg/H)	< 120	< 180	121-180	120-180	181-240	60-120	241-300	Satisfactory

Source: Recommended by the researchers on the basis of “Government soil survey and soil testing Laboratory, Kolhapur”.

Based on table no. 6 tahsil wise nutrients are recommended in table no. 7 for the nutrients balance and soil management in Panchganga basin.

Table 7

Tahsil wise areas of recommended soil nutrients (Area in %)

Nutrient Recommendation		Parameter	Gagan Bawada	Hatkangale	Karveer	Panhala	Radhanagri	S
N	Strong	(%)	0.00	0.00	0.00	0.00	2.17	
	High	(%)	0.00	16.98	4.67	12.26	95.65	
	Slight	(%)	7.89	62.26	15.89	29.25	2.17	
P	Strong	(Kg/H)	2.63	28.30	8.41	14.15	38.04	
	High	(Kg/H)	18.42	30.19	23.36	31.13	27.17	
	Slight	(Kg/H)	23.68	0.00	20.56	16.98	9.78	
K	Strong	(Kg/H)	0.00	7.55	2.80	1.89	8.70	
	High	(Kg/H)	5.26	13.21	5.61	5.66	9.78	
	Slight	(Kg/H)	2.63	13.21	4.67	12.26	11.96	

Source: Compiled & computed by the researchers.

CONCLUSION:

The soils in the region are originated from Deccan trap; however it varies spatially. The western hilly and woody part with heavy rainfall is corers shallow and medium black soils with brownish colour are well drained; whereas eastern dry part with uncertain rainfall is covered with medium to deep black soils. So far fertility status is concerned most of the areas are fertile in nature in Panchganga basin. There are few areas as compression fertile areas derived in very low and low fertile category. Physiographic nature of the region, climate and agricultural activities greatly affects on the nutrients availability in the region. Slope, forested areas, cropping pattern and fertilizers used for crops also determined the fertility status of soils. The macronutrients are distributed in to the scattered forms. The nutrients deficient areas needs to use specific fertilizers and addition of organic matter. Its amount is depending upon requirements. Low nutrient containing soil needs high nutrients. Thus the increasing acuteness of the nutrient deficiency,

increases nutrients recommendations from slight to strong. Tahsil wise nutrients recommendations are varied due to the variation of existing nutrients. To keep the balance of nutrients and manage fertility of soils the recommended nutrients need be applied on priority basis. Further the soil degradation in lower reaches of Panchganga basin is emerging fastly which needs further micro level investigation.

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