CHAPTER NO. IV

CHEMICAL ANALYSIS

Fertility of soil in respect of pH, TSS, N, P and K.

INTRODUCTION - Soil is one of the most important fundamental resources in the natural inviornment. It is a gift of nature to man. Soils have provided the energy for life from generations after generations of man. The plants and animals enact in various socio-economic forms including agriculture, forestry, animal husbundary and so on.

Soil may be regarded as the outer mantle of the earth's crust which not only gives ready supply to food material for the plants but also afforts physical strength to the plant for the maintainance of its safe existance on it. The utilization of the soil for the cultivation of crops or plants in general, depends on physical properties and amount of plant food materials present in the soil./ Soils of sangli district are not exception to it. In previous chapter we have considered some physical properties. In this chapter chemical properties are considered to find the fertility of soil in sangli district.

/ Soil contains many chemical elements plants take some of them for their growth. These elements are termed as nutritive elements. The growth of crops or plants depends on the availability of nutritive elements from the soil. In order to soil to be productive and till-

able, it should contain all essential elements in forms readily available to plants in sufficient amount, physically good to support plants and sufficient amount of water and air for proper root growth. All soils are not productive. Some soils are productive and they support luxuriant growth of plants with very little efforts. Whereas others may be unproductive which do not support growth of plants even with large human efforts.

The terms fertile and productive are used in respect of amount of yield of crops from soil. Soil fertility and soil productivity are often used synonymously but most scientists prefer to make a distinction between the two words. Soil fertility may be defined as "the ability of the soil to provide all the assential plant nutrients in available form and in a suitable balance"[1]. But such soil should be free from any toxic substances for eg. The saline soil could otherwise be fertile but the excess of Na salts would be toxic to plants. Na disturbs the balance between Ca, K and other nutrient ions.

In reality adequate supply of nutrients is one of the several factors, which influences crop yields. However while considering the fertility of a soil, it is not enough to take into account only its nutrient status. If other factors such as proper physical

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STRATA

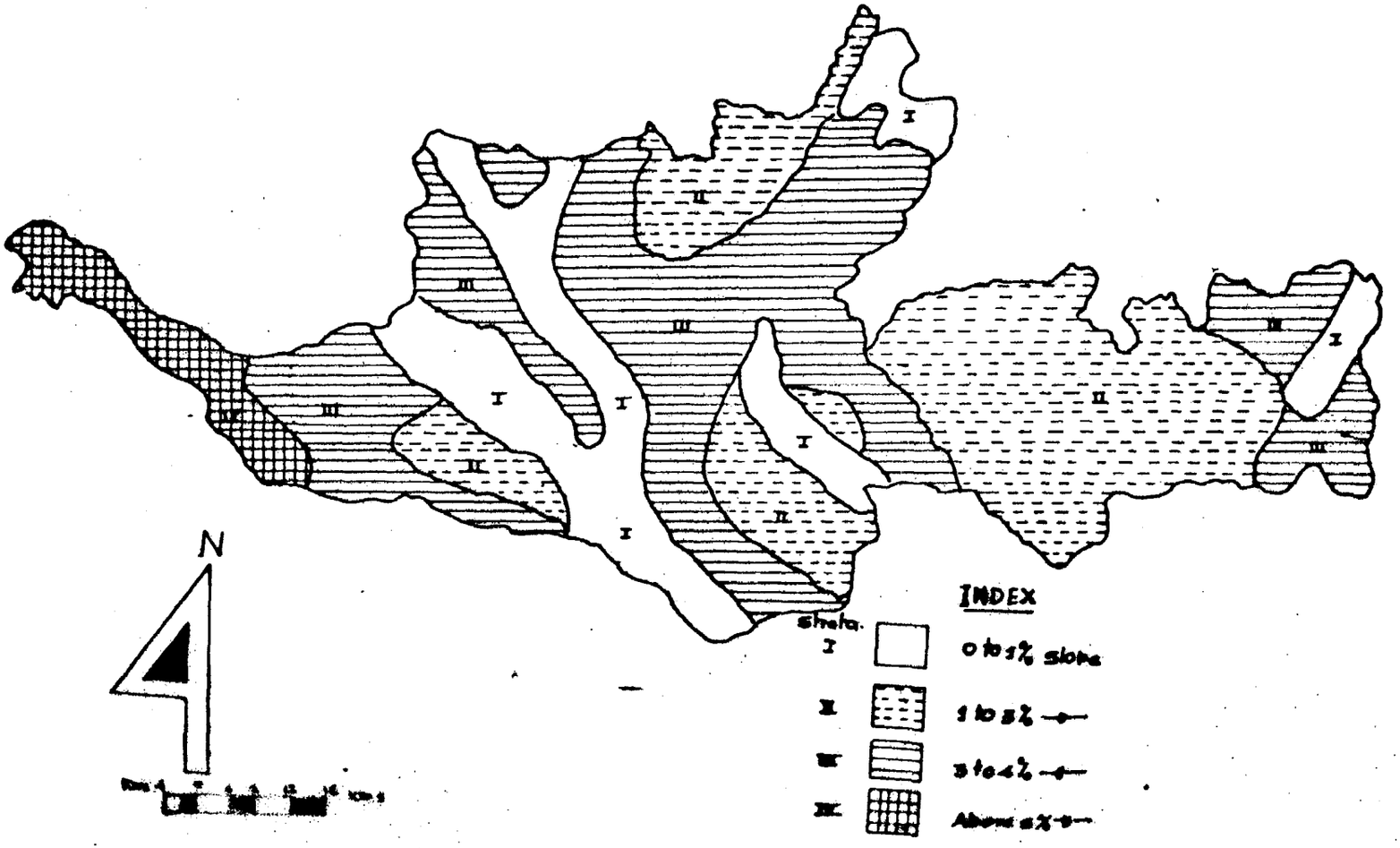

Fig. No. 9

condition, freedom from alkalinity, salinity and toxic accumulation of certain elements are disregarded. Otherwise in a fertile soil plant growth will be adversely affected if it contain metalic ions. However under normal conditions the growth of crops is mainly governed by the supply of adequate quantities of nutrients and water.

"Soil productivity on the other hand is the ability of the soil to produce crops."[2] Thus fertile character of soil develops productive soils. Soil fertility, good management practices, availability of sufficient amount of water and air, and a suitable climate increases soil productivity. Thus soil fertility denotes the status of plant nutrients in the soil, while soil productivity denotes the result of various factors influencing crop production, both within and beyond the soil.

Need for study of soil fertility -

The continued prosperity and well being of the people of any nation is dependent upon several factors. One of them is production from agriculture. Agricultural production depends on productivity and productivity of soil depends on fertility. Therefore one of the most important factor of productivity being the level of soil fertility. There are a number of limitations in horizontal extension of agricultural land. Because there is every day experience that the problem of increasing agricultural land has been made further acute due to the land grabbing tendancy of the industrialist and brick field workers who prefer the best agricultural land for

their non agricultural activities. Hence to face the situation not only intensification of agriculture is required but also search for newer areas are to be made. To maintain soil fertility is one of them.

Soil must always be kept in a fertile condition if high yields are to be produced and people are to prosper. If any essential nutrient is deficient it should be supplied because deficiency of nutrient limits the crop yield. Higher and higher crop yields are essential for feeding the increasing population. The soil fertility therefore, should not only be mentioned but constantly improved to keep rich harvests. Fertilizers and manures are necessary for maintaining the soil in a high state of fertility and productivity. Before correct fertilizer recommendation can be made it is important to know the relative level of nutrients and which plant nutrients are deficient in the soil.

Due to enviornmental factors and wrong use by cultivaters all soils lack fertility to some extent. In order to ensure adequate return the soil should be made to recoup this loss by the application of the right doseges of the appropriate fertilizers.

Soil fertility differs greatly from field to field. The proper understanding of fertility variations in a farm serves as an effective tool in an economic and judicious use of the agricultural lands. So that optimum crops is ensured. This is indeed a district which have adverse man-land ratio and adverse climatic conditions in part where maximum output

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LOCATION OF SAMPLE VILLAGES

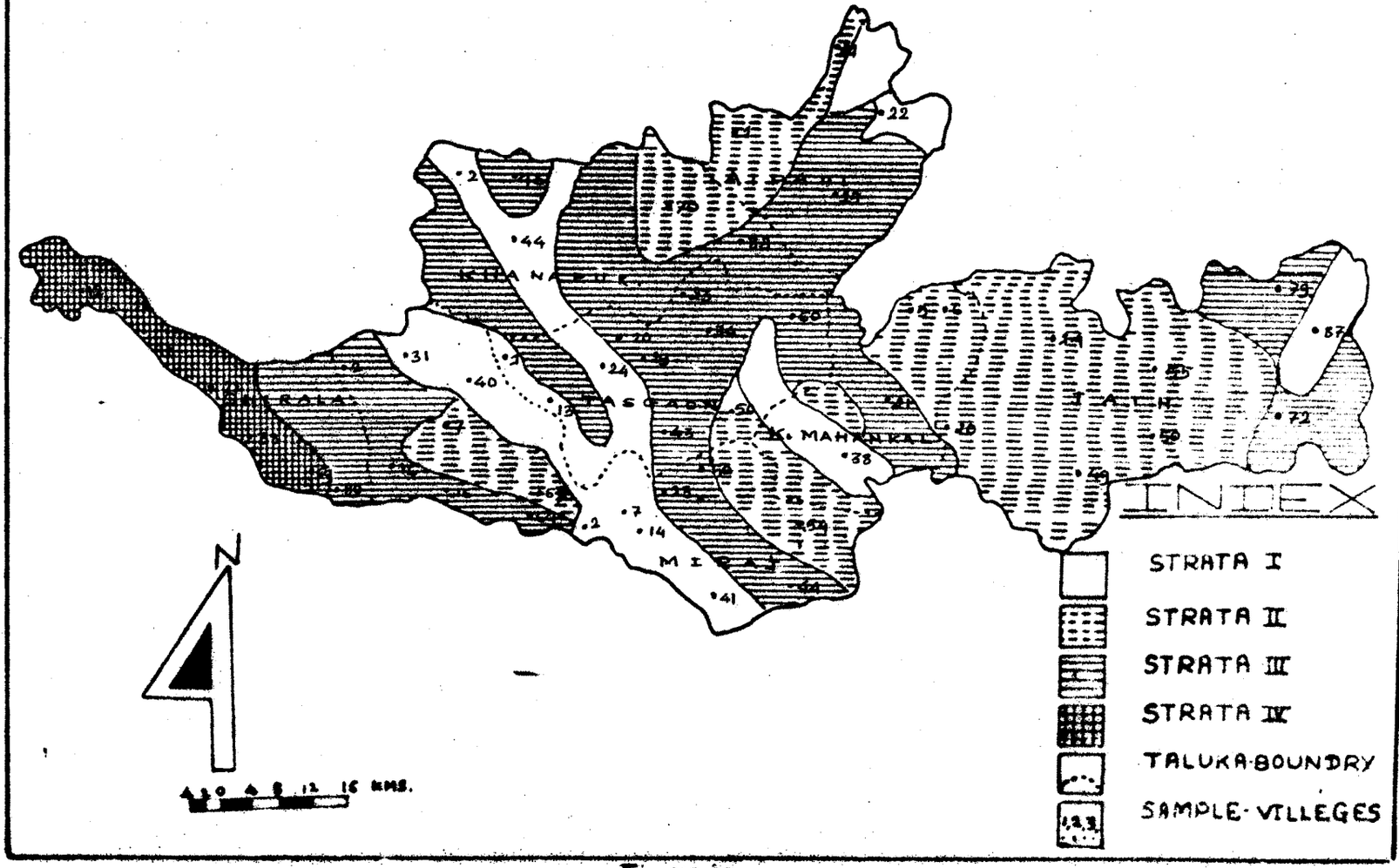

Fig No. 10

is the only way to offset the adverse man-land ratio. With all these in view an attempt has been made in this chapter to find the the fertility of soil inrespect of N,P,K main plant nutrient and pH and TSS which affects availability of N,P and K.

Approach:

Even though climate, specially rainfall and temparature plays active role in the soil forming process, water is most active agent. Entire soil forming process is connected with water. It acts both, mechanically and chemically by acting as solvent. The amount of N,P,K, TSS and soil pH in natural condition depends on the runoff and depth of soil. And amount of runoff depends on the slope, texture, structure and depth of soil. Runoff is greater in sandy, granular, shallow and steep soils, while it is less in blocky, deep and gentle soils. Runoff washes the different salts and chemical compounds of NPK. Greater the runoff greater is the washing of all salts and compounds of NPK. It ultimately decreases the amount of TSS and plant nutrients. Therefore there is a possibility of decreasing pH of soil. In the same way less the runoff less is the washing of salts and compounds of nutritive elements. It ultimately may increase the amount of TSS and plant nutrients. But there may be a possibility of increasing pH of soil. Increase in pH make soils saline or alkali. Both low and high pH are responsible for availability of plant nutrients. Therefore runoff must be in a balanced state. By considering effect of slope and depth of soil on availability of plant nutrients, the study region is divided

in four strata as mentioned before in the first chapter.(fig no 9)

It is impossible to collect large number of soil samples from all sample villages because it is a very time and money consuming process. Considering the large spatial uniformity such a number of samples seem to be unnecessary. Therefore data about pH, TSS, N, P and K for number of soil samples ~~has~~ have been collected from Rashtriya Chemical Fertilizer Corporation at Kolhapur and from soil testing laboratory of Department of Soil Survey at Sangli. Very few i.e. 1 to 2 soil samples from some villages have been collected personally from farms and analysed chemically for pH, TSS, N, P and K. Thus the figures obtained for pH, TSS, N, P and K and data collected for other soil samples has been first arranged in different strata and then tabulated in different tables as shown in appendix.

Soil Reaction or pH of soil -

Different soils show different reactions. It may be acidic, neutral, or alkaline in reaction. The soil reaction is presented in the form pH. pH is defined as hydrogen ion concentration. In order to understand soil reaction, the knowledge of pH is very necessary. Acidic, neutral or alkali nature of soil is described in terms of H^+ ion concentration. Acidity is caused by H^+ ions. Basicity which is opposite of acidity is caused by OH^- ions. All aqueous solutions contain both H^+ and OH^- ions. When there are more H^+ ions than OH^- ions. the solution is acidic and soil is also acidic. When OH^- ions

are in excess the solution is basic and soil is also basic. And when there is equal amount of H^+ and OH^- ions then the solution is said to be neutral and soil is also neutral in reaction. Therefore pH is scale for measuring acidity or basicity of soil.

Water dissociates into H^+ ions and OH^- ions. Hence ionic constant of water can be prescribed by $[H^+]\,[OH^-]$. The ionization constant of water is 10^{-14} at 25^{o}c. and therefore in any aqueous system products of H^+ and OH^- ion concentration is 10^{-14}. Therefore ionic constant = $[H^+]\,[OH^-] = 10^{-14}$. pH and pOH are indices of the acidity and alkalinity respectively. When the aqueous soil solution or system is neutral, pH will be equal to pOH. And as ionic constant is 10^{-14} the value of pH and pOH at neutral point will be 7 for each. When pH value is less than 7 the soil is acidic and value above 7 indicates alkalinity. The pOH can be determined from pH value. Therefore in general the notation pH is used to show soil reaction.

pH is the most important single property identifying the chemical character of a soil. It controls the absorption and distribution of the various cations by soil colloids. The pH of a soil controls the release of bases from the exchange complex. The solubility of many soil constituents depends on pH. Since the various minerals of the soil dissolve at different pH levels.

There is a close relation between soil pH and availability of plant nutrients. The maximum availability of

the primary i.e. N, P, K and secondary nutrients i.e. S, Ca, and Mg is at a pH range of 6.5 to 7.5. The minor elements like Fe, Mn, B, Cl, and Zn are more in acid range than in the neutral or alkaline range. Since requirement of plants of these minor nutrients is small. The quantities available at pH 6.5 to 7.5 are usually enough for satisfactory plant growth.[3] A pH 6.5 to 7.5 is therefore considered to be the pH range in which most soil nutrients are available to plants. Therefore soils with this pH are fertile soils.

The attempt has been made in this chapter to find the soil reaction and in its turn the fertility of soil in study area. Three groups of soil reaction are made with limits suggested by Tamhane, Motiramani, Beli, and Donahue for soil fertility evaluation. Those groups are as follows:

S.No.	Character of soil	pH range	Fertility
1	Acid soils	below 6.5	low fertility
2	Neutral	6.5 to 7.5	high ,,
3	Basic	above 7.5	low ,,

Acid soils - These soils have pH less than 7. It is important chemical property. This property of soil exerts various effects on plant growth. They may be direct or indirect. Acidic soils whose pH is below 6.5 pose a problem of i) toxic effect of high proportion of exchangeable Al, Fe and Mn ii) high phosphate fixation iii) low rate of nitrification iv) low water holding capacity of soils v) deficiency of elements like Mo, Si, K, Ca and Mg.[4] These

problems ultimately badly affects the germination of seed, growth of crops and amount of production from agriculture.

Very low pH of acid soils attack clay minerals. This may result in the release of Fe and Al, both are toxic to plants. In addition hydrated oxides of Fe and Al serve as cementing materials for hardpan and concretion formation.

Bhaumik and Roy (1964), Chakraborthy and others (1961), Roy Choudhury and Anantharaman (1960) and Roy Choudhury (1966) have discussed the influence of soil acidity. According to them also "the acid character of the soils makes, them less suitable for agriculture as most of plant nutrients become poorly available, of the major nutrients N and P tend to become available in lesser amount below pH 6. And without sufficient supply of these plant nutrients, plants can not thrive well".[5]

Basic soils - It is second important character of all soils. The soils with pH above 7.5 are considered to be alkali soils. Like acid reaction basic reaction of soil exerts adverse effects on plant growth and crop yield. High pH of soil is injurious to the activities of friendly micro-organisms like nitrogen fixing bacteria. These soils may be saline, alkali or saline-alkali (which are discussed later). Saline soils dom not support plant growth primarily, because of excessive salts in the soil solution creates high osmotic pressure. The high osmotic pressure prevents absorption of moisture and nutrients in adequate amounts. The high pH of alkali soils cause a reduction in the solubility

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SOIL FERTILITY IN RESPECT OF PH.

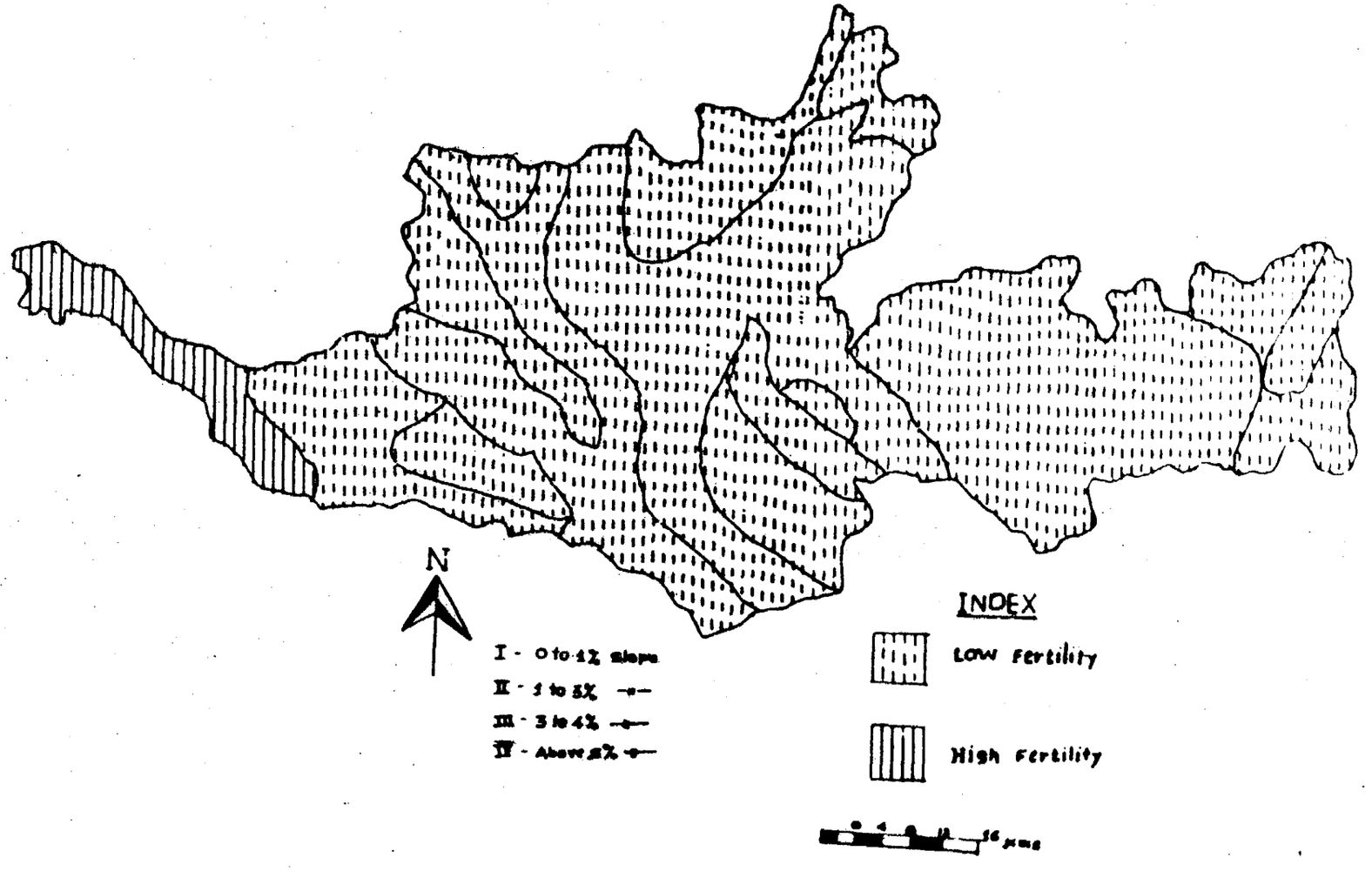

Fig.No.11

and availability of Fe, Cu, Mn and Zn to plants.

The pH values for soil samples from district have been presented in table No. 4.1, 4.2, 4.3 and 4.4. The tables in appendix are prepared separately for strata No.I, II,III & IV respectively. The column 5 of all these tables shows that the pH of soil is high in strata No.I,II and III while it is low in strata No.IV.

The table No.4.1 shows that 19 out of 102 soil samples i.e. 18.6% soils from strata I have pH in between 6.5 to 7.5. This range of pH makes available maximum amount of primary and secondary plant nutrients. So these soils are fertile in respect of pH. All other i.e. 83 out of 102 soil samples i.e. 81.4% soils from this strata have pH above 7.5. It is clear from pH that the soils are saline, alkali or saline alkali. As all these soils are harmful to plant growth, these are infertile in respect of pH. The soil condition in respect of fertility is worst in this strata, because 33 out of 102 soil samples i.e. 32.4% of soils have pH above 8.2. The soil sample number 23, 24 33 and 71 have pH 9, 8.9, 8.8 and 8.7 respectively. These are highly alkaline soils and are not suitable for crop production.

The soils from Borgaon, Dhamgaon, Haripur and Kasabe-Digraj villages have higher pH values. The soils from these villages are less fertile compaired to soils from other villages from same strata.

Table No. 4.2 shows that there are no acidic soils in strata No.II. Only 4 out of 133 soil samples i.e. only 3% of

soils have favourable pH which ranges between 6.5 to 7.5. Therefore very few (negligible) soils are fertile. While 129 out of 133 soil samples i.e. 97% of soils have pH above 7.5. So most of soils from strata No.II are infertile, not only this but 78 out of 133 soil samples i.e. 58.6% of soils have pH above 8.2 and soil sample number 2, 51,61, 66, 79, 91, 92, & 126 have pH value above 8.7. So condition of most of soils worst, in respect of fertility. The pH of soil sample umber 2,51,61,66,79, 91,92 and 126 shows the formation of alkali soils in strata No.II.

The soils from Belunki, Dudebhavi, Ghorpadi,Kognoli, Vibhutwadi and walwan villages from this strata have higher pH values. The soils from these villages are less fertile compaired to soils, from other villages.

Table No.4.3 also shows that like strata No. I & II, not single soil is acidic in reaction in strata No.III. And only 11 out of 181 soil samples i.e. 6.1% of soils have favourable pH between 6.5 to 7.5. That means only few soils are fertile in respect of pH. While 170 out of 181 soil samples i.e. 93.9% of soils have pH more than 7.5. Therefore like strata No. I & II the most of soils are infertile in respect of pH. Table No.4.3 also show that 60 out of 181 soil samples i.e. 33.1% soils have pH more than 8.2. The soil sample number 15,46,49,51,115,116, 118,120,123,147,165,170 and 171 from different villages show very high pH i.e. above 8.6. It shows 7.2% of soils from strata No.III have been turned to alkali soils.

The soils from Dahivadi, Irali, Manjarde, Rasulwadi Rayewadi, Tadavale and Yelur villages show higher pH values. The

soils from these villages are less fertile compaired to soils from other villages of same strata.

Table No. 4.4 shows that 12 out of 46 soil samples i.e. 26.1% of soils have pH below 6.5 and are acidic in reaction. The acidic soils of strata IV are confined to western part of shirala taluka. 30 out of 46 soil samples i.e. 65.2% of soils from same strata have favourable pH between 6.5 to 7.5. It indicates larger number of soils are fertile in respect of pH. And only 4 out of 46 soil samples i.e. 8.7% of soils have pH value above 7.5. Even though the pH of these soils is above 7.5 the values are near to the neutral. So these soils may be considered as moderate in fertility. The most of soils from Arala and Natoli villages have favourable pH while most of soils from Kokrud and Petlond villages have not favourable pH.

In short the soils from strata No.I,II and III which are confined to eastern part of Shirala, walwa, Tasgaon, Khanapur, Atpadi, Miraj, Kavathe-Mahankal and Jath talukas have more pH than required for proper growth of plants and more yield from agriculture. Therefore above areas, as shown in the fig.No.11, have less fertile soils in respect of pH.

The high pH in above mentioned strata would be due to the flat topography (low slope), deep soils, clay structure poor drainage, periodical rain and high temperature. The arid region like in strata No.I,II and III, where there is low rainfall and high temperature, there is always a tendancy for the accumulation of soil salts near the surface and

resulting high pH in soil.

Most of soils from strata IV have favourable pH. This strata have low pH compaired to pH of soils from above three strata. Therefore the soils from this strata are more fertile than strata No.I,II & III (fig. No.11)

The low pH in strata No.IV which is confined to western part of shirala taluka, may be due to washing of lime and Ca, Mg, etc. Salts by periodical heavy rainfall and making saturation of H^+ ions, more use of ammonium sulphate and ammonium chloride fertilizers.

Total soluble salts (TSS)

Different soluble salts like chlorides, sulphates and carobonates of Na, Ca and Mg are found in the soil. These salts may occur in soil through parent material, encroaching sea water, and supply of salt water through irrigation. Amount of salts in the soil depends on the leaching of salts through drainage, clay content, water table, addition of salts through irrigation and sea water, temperature and amount of rainfall. Amount of salts in soil are more in poorly drained soils, because it prevents leaching of salts through soil. The high water table brings salts near to the surface and supply of salty waters through irrigation increase the amount of salts in soil.

In arid and semi-arid regions where there is low periodic rainfall and high temperature there is always a tendancy for the accumulation of soil salts near the surface. During the rainy season these salts may go downward to the lower soil layers, decreasing the amount of salts in surface soil. But after

the rainy season the intense evaporation brings the salts back to the surface by capillary action and it increases the amount of salts in surface soils.

The soluble salts contain different types of salts like Nacl, Na_2SO_4, $Cacl_2$, $CaSO_4$, $MgSO_4$ etc. Soluble salts can have two types of effects on the growing plants. Specific effects which are due to particular ions being harmful to crop can be operative at low or high concentration. The general effects of salinity are due to rise in osmotic pressure of the soil solution around the roots of the crop and this results in dwarf and stunted growth of the crop. Besides these effects high concentration of salts effects absorption of water and its translocation in the plant system; root activity, and the activity of soil micro-organisms. The salinity and alkalinity of soils depends on the amount and type of salts.

Salts, pH, and saline - alkali soils -

There is close relation between pH the amount of salts in soil and formation of saline alkali and saline-alkali soils. Fairly high concentration of salts converts productive soils into unproductive saline, alkali or saline-alkali soils. These are due either to the presence of an excess of Na salts or to the predominance of Na among the exchangeable bases. In some cases K salts may be present in appreciable amounts but it is of unusal occurrence. Formation of saline alkali and saline-alkali soils takes place under different conditions of Na and other salts.

Saline soils - Saline soils were originally called 'white alkali' soils. If the amount of exchangable Na in soil is low i.e. less than 15% then these soils are supposed to be saline soils. The pH of these soils is generally below 8.5.

Saline soils usually have a surface crust of white salts, especially in the dry season when the net movement of soil water is upward. The salts dissolved in the soil water move to the surface, where they are left as a crust when the water evaporates. The white salts are mostly chlorides, sulphates and carbonates of Ca, Mg and Na.

Alkali soils - The soils with high Na content are alkali soils. These are also called 'black alkali' soils, because they are black, owing to the effect of the high Na content which causes the dispersion of the organic matter. The amount of exchangable Na saturation in alkali soils is greater than 15%. The pH of these soils is generally between than 8.5 to 10. Locally in many areas these soils are also termed as 'slick spots' because, when the soil is ploughed slightly wet it turns over in slick, rubbory furrow slices.

Because of high Na content in alkali soils, both the clay and organic matter are dispersed and the result is a close packing of the soil particles. The close packing of the particles reduces the size and the amount of pore spaces and as a consequence water and air will not move through the soil readily. Poor aeration and high Na content which is often toxic. These soils are formed by accumulation of salts

at low lying soils from the surrounding catchment area.

Saline - alkali soils - Some times soils may be saline alkali. The term saline - alkali is used to the soils which are both saline and alkali. These soils have generally exchangeable Na in excess of 15% and variable pH usually above 8.5. The variable pH depend upon the relative amount of exchangable Na and soluble salts. When soluble salts are leached downward, the pH of soil raises above 8.5 forming saline- alkali soils. These soils are also harmful to crop growth.

It is clear from the above information that the certain amount of soluble salts in a soils are favourable for crop growth and yield. Very low and excess amount of salts creates adverse effect on crop growth and yield. Therefore total salts in a soil is another factor which determines the fertility of soil. Many scholars have tried to suggest the ranges for low, medium and high amount of total soluble salts in the soil.

The TSS values obtained and collected in percentage for soil samples from sangli district have been presented in column No. 6 of table No. 4.1, 4.2, 4.3 and 4.4. in appendix. These tables are prepared for strata No. I, II, III and IV respectively. TSS values in column No. 6 are used to show soil fertility of the sangli district. Ranges of TSS for groups suggested by USDA (1951) and mentioned by S.N.Mukharjee for fertile and infertile soils have been used to show soil fertility of study area. The ranges and groups suggested

by USDA are as follow:-

S.No.	Group	Range of TSS in %
1	Low	below 0.15%
2	Medium	0.15 to 0.65%
3	High	Above 0.65%

According to the salinity survey under the united states Department of Agriculture (USDA 1951) the presence of less than 0.15% of salts in soil has got no influence on crop production but above 0.65% strongly affects crop production. In between these two limits, crop growth is affected slightly or moderately.[6]

The column 6 in table No. 4.1 show that only 8 out of 102 soil samples i.e. 7.8% soils have TSS value below 0.15%. So only few soils are fertile in respect of TSS. 77 out of 102 soil samples i.e. 75.5% of soils have TSS value between 0.15 to 0.65% while 17 out of 102 soil samples i.e. 16.7% of soils have TSS value above 0.65%. It is clear that most of soils are moderate and less fertile in respect of TSS, and very few are more fertile in respect of TSS in strata No.I.

The column No.6 in table No.4.2 for strata II shows that 38 out of 133 soil samples i.e. 28.6% of soils have TSS value below 0.15%, 83 out of 133 soil samples i.e. 62.4% soils have TSS value between 0.15 to 0.65% and 11 out of 133 soil samples i.e. 8.3% soils have TSS value above 0.65%. It is clear from these figures that 28.6% of soils from strata No.II are more fertile, 62.4% of soils are moderate fertile and 8.3% of soils

are less fertile in respect of TSS. The table also shows that the sample number 2, 19, 22, 27, 105 and 106 have very high amount of TSS. So these soils are more infertile.

The soils from Belunki, Kognoli, Shegaon, Uplavi, Vibhutwadi and walwan have more amount of TSS than other villages from same strata.

The column 6 in table No. 4.3 for strata No.III shows that 32 out of 181 soil samples i.e. 17.7% of soils have TSS value below 0.15% , 139 out of 181 soil samples i.e. 76.8% soils have TSS value between 0.15 to 0.65% and 10 out of 181 soils samples i.e. 5.5% ~~soil~~ soil have TSS value more than 0.65%. It is clear from the above figures that only 17.7% of soils are fertile in respect of TSS. While most of others are moderate and less fertile. The soil sample number 3, 72, 73, 76, 117, 119, 167, 171 have very high amount of TSS. So these soils are very infertile.

The soils from Kambali, Manjarde, Narwad, Rasulwadi, Shigaon, Umadi, Tadvale and Yelur have more amount of TSS than TSS values of soils in other villages. Therefore soils are comparatively less fertile in these villages. Sugar-cane is important crop in all above mentioned villages. The sugar-cane cultivation is not suitable to the soils of these villages. Because the supply of irrigation water to sugar-cane will further increase the TSS in the soils of these villages.

The column 6 in table No.4.4 for strata No.IV shows that 18 out of 46 soil samples i.e. 39.1% of soils have TSS below 0.15%, 28 out of 46 soil samples i.e. 60.9% of soils have

TSS, in between 0.15 to 0.65% and there is no soil in strata IV whose TSS value is more than 0.65%. It shows that soils of strata No.IV are moderate to high fertile in respect of TSS. The soils from Natoli and petalond have comparatively more TSS than soils from Arale and Kokrud villages. Even though the values are not much higher.

In short most of the soils from the strata No. I,II and III which are confined to eastern part of shirala, walwa, Tasgaon, khanapur, Atpadi, miraj, kavathe.mahankal and Jath taluka have more TSS than required for proper growth of crops and more yield from agriculture. Therefore most of soils from talukas mentioned above are infertile in respect of TSS. While most of soils from strata No.IV which is confined to western part of Shirala taluka have less and medium i.e. favourable TSS. So soils of this strata are more fertile in respect of TSS.

The more TSS in soils of strata No.I,II and III would be due to, absence of leaching of salts due to poor soil drainage, flat topography clay texture of soil, and semiarid climate of the region. The semi-arid climate of the region has brought the soluble salts to the surface of soil by capillary action.

The medium and less amount of TSS in soils of strata IV which is confined to western part of Shirala taluka would be due to leaching of salts from steep slope by periodical heavy rainfall of the region.

The column 6 in tables in appendix also shows that

there is decrease in amount of TSS in group third (High group) from strata No.I to IV. It is because of leaching of more and more salts with increase in slope from strata No.I to IV. and also increase in rainfall from eastern part to western part of the district.

The soils of strata I are situated along the banks of Krishna, Warna, Yerala Bor etc. river. These soils are very flat and they have highly clay texture. It has resulted in increase in salts due to poor drainage and absence of leaching of salts from the soils.

Soils from strata II and III are though away from river valleys have also flat topography more soil depth, and clay texture like strata No.I. So these strata have also infertile soils due to more accumulation of salts near the surface.

The strata IV which is confined to western part of shirala has more slope and shallow soils, some soils have granular structure, and it has high periodical rainfall. The leaching of salts due to above reasons has decreased amount of TSS in soil.

Main plant Nutrients -

Primary plant Nutrients -

Adequate supply of nutrients is one of the several factors which influence crop yields. It is However while considering the fertility of a soil, it is not enough to take into account only its nutrient status if other factors such as proper physical condition, freedom from salinity, alkalinity,

and toxic accumulation of certain elements are disregarded. Otherwise in a fertile soil plant growth will be adversely affected if it contains excess of soluble salts or toxic accumulation of certain metalic ions. However under normal conditions, the growth of crops is mainly governed by the supply of adequate quantities of main plant nutrients and water.

Several chemical elements have formed the earth's crust. Of the several elements 16 are known to be essential for plant growth and reproduction. Out of that seven elements are needed in more quantities. Those are Hydrogen (H_2), Oxygen (O_2), Nitrogen (N), Carbon (C), Water (H_2O), Phosphorus (P), Potassium (K) and calcium (Ca). While other nine elements needed only in small amount are, magnesium (Mg), sulpher (S), boron (B), Copper (Cu) Iron (Fe) Manganese (Mn), Zinc (Zn), Molybdenum (Mo) and chlorine (Cl). First seven are called macro-nutrients while later nine are micro-nutrients. Out of seven macro-nutrients H_2O_2, C are taken from air and water. While others i.e. N, P, K and Ca are available in the form of mineral particles in the soil.

Of the elements known to be essential for plant growth, N, P and K are required in large amount by plants. Therefore they are designated as major or primary nutrients, are they may be called as 'big three'. While Ca, Mg, and S are secondary nutrients. Fe, Mn, B, Mo, Cu, Zn, and Cl are required in trace amount and hence they are called micro-nutrients. All these act as catalyser.

The three i.e. N P and K are great source of plant food. Therefore they influence the crop production. It has been accepted from the time of Liebig (1861) that the presence of nutrient elements chiefly N, P and K in the soil are responsible for the productivity of land. The report of Rice Commission, food and Agricultural Organisation under United Nations Organisation also admit their importance. Number of scholars also have proved that there is a strong positive co-rrelation between the yield and the soil nutrients.

The single nutritive element even though supplied sufficiently is not enough for proper growth of crop or plants. But all of them are required in different amount by different crops. Therefore here first attempt is made to find fertility of soil in respect of N, P and K separately and lastly fertility of soil in respect of N, P and K in combination.

It is now know that deficiency and also excess of N, P and K is harmful to crop growth and yield from agriculture. Therefore suitable amount of N, P and K are required for optimum yield. Many scholars have tried to suggest suitable ranges of N, P and K for optimum yield of most of crops. To suggest low, medium and high amount of N, P and K Rating chart given below is prepared by Indian Agricultural Research Institute. The Index values for the same are obtained by Azziz method and the index values thus obtained are used to show low medium and high amount of N, P and K in soils of the sangli district.

IARI Rating chart for soil Testing data[7]

Sr. No	Nutrient	Low	Medium	High
1	Available Nitrogen in percentage	Below 0.5%	0.5-0.75%	Above 0.75%
2	Available Phosphrous Kg/ha	below 10	10-25	Above 25
3	Available Potassium Kg/ha	below 120	120-280	Above 280

In present study, the soils containing low amount of N, P and K as per given range in rating chart have been treated as less fertile. While soils containing medium and high amount of N, P and K have been treated as medium and more fertile soils respectively.

Nitrogen -

Nitrogen is one of the important nutritive element from 'Big Three'. Of the various plant nutrients, it has subjected to greatest No.of studies. Many scholars have proved its importance in plant growth and agricultural production. Also it is found that amount of N in the soil is small, while the quantity withdrawn annually by crops is comparatively large. The response to N is of the higher order under assured water supply. "Experiments conducted on the field of cultivators over a period of three years have shown that per kg of N supplied, there is an increased yield of

14-18 kgs/hectare of seed cotton".[8] This proves that N is one of the element responsible for increasing soil fertility.

Of the three major elements N has quickest and most pronounced effect. Primarily it tends to encourage above ground vegetative growth and imparts to the leaves a deep green colour. It increases percentage of protein in grains. It is essential for chlorophyll, amino-acids and protoplasm. It increases cation exchange capacity of roots and thus makes plant more efficient in absorbing other nutrients like P, K and Ca.

Even though N is main nutrient of plants, the deficiency or excess of it has adverse effects on plant growth. Deficiency causes stunted growth and restricts root systems. The leaves turn yellow to yellowish green and tend to drop off. Excess of N has harmful effects on certain crops. Very dark green, soft and sappy leaves are indicators of an oversupply of N. Excess of N delays maturation by encouraging excessive vegetative growth. It may weaken the straw. It may decrease quality of certain fruits and on certain occasion decreases the registance power of plants. Therefore suitable amount of N is required for optimum yield.

To find soil fertility in the sangli district the percent values obtained experimentally and collected for N. These values and their index values calculated by Azziz method are shown in col.No.7 and 8 respectively. The index values are used to show low, medium and high fertility. Soil with index value below 35 is treated as less fertile, between

35 to 70 as medium fertile and above 70 as high fertile.

The column No. 8 in table No. 4.1 for strata I shows that 44 out of 102 soil samples i.e. 43.1% soils are less fertile in respect of N as their index value is below 35. 56 out of 102 soil samples i.e. 54.91% of soils are medium fertile as their index value ranges between 35-70 and only 2 out of 102 soil samples i.e. 1.96% of soils i.e. very few soils whose index is above 70 from strata I are fertile in respect of N. That means all except few soils in strata I have low to medium fertility.

The table 4.1 also shows that soils from Dhulgaon and Haripur villages are more fertile compaired to other villages from the same strata.

The column 8 in table No. 4.2 for strata II shows that 63 out of 133 soil samples i.e. 47.4% of soils are less fertile as their index values are below 35, 66 out of 133 soil samples i.e. 49.6% of soils are medium fertile while only 4 out of 133 soil samples i.e. 3% of soils are more fertile in respect of N. That means about half of soils from strata II are infertile and remainging half of soils are medium fertile.

Most of the soils from Dudhebhavi, Kameri, Kognoli, Uplavi have more N compaired to the soils from other villages of the same strata. The soils from the above villages are therefore more fertile than others. Soil sample number 40, 52, 80, 86, 90, 99, 101, 104, 105 and 132 have higher index value. So the fertility of these soils is very

high in respect of N.

The column 8 in table No. 4.3 for strata No.III shows that 72 out of 181 soil samples i.e. 39.8% soils are less fertile. 99 out of 181 soil samples i.e. 54.7% of soils are medium fertile while very few i.e. only 10 out of 181 soil samples i.e. 5.5% soils are fertile in respect of N.

The soils from Alte, Bendri, Irali, Karanjawade, Manjarde, Tadavale, Yelur villages have more nitrogen compaired to the N content of soils from other villages. Sample No.3, 73, 75, 80, 81, 85, 111, 152, 154, have high content of N. So soils are fertile.

The column 8 in table No. 4.4 for strata IV shows that 8 out of 46 soil samples i.e. 17.4% of soils are less fertile as their index number is less than 35. 33 out of 46 soil samples i.e. 71.7% of soils are medium fertile while 5 out of 46 soil samples i.e. 10.9% soils are more fertile in respect of N. Most of soils from Kokrud, Natoli and Petlond villages are medium to high fertile in respect of N. In short the soils of strata IV have more N than strata I, II, and III.

Phosphorus (P)

Next important nutritive element after nitrogen is phosphorus. According to the 'Range of plant nutrients', suggested by Dr. S.P.Roy Choudhury and mentioned by Ignatieff (1951) in the report of the Rice Commission F.A.O. next to N comes P in the order of importance. Experiments conducted on the application of phosphates to lateritic soils of Ratnagiri

district (Maharashtra state) have shown that "there is a linear response of paddy to the application of graded dosages of phosphates upto an application of 67 kgs/hactare in steps of 22 kgs/ha. An average response of 13 kgs of paddy per hectare has been obtained per kg. of phosphate applied." [9]

It is of great importance in carbohydrate metabolism, fat methbolism, energy transformation and respiration. It stimulates root development, gives strength to straw. It hastens ripenning of plants and counter acts the effect of excessive nitrogen. It improves quality and yield of grains and increases disease resistance power and formation of root nodules in legumes. It is the constituent of nucleic acid phytin, phospholipids and enzymes which are useful for plant growth.

Deficiency of P retards the growth of roots, turning leaves to yellow colour early shooting of leaves and late flowering. Therefore P is essential constituent for proper growth of plants and crop yield also. Therefore P determines the fertility of soil.

P is not found in ionic form in the soil. Therefore, it is considered in the form of its oxide. The values obtained and collected from different soil samples in the form of kg/ha. of P_2O5, are shown in col.No.9 and index values calculated by Azziz method for the same are shown in column No.10 of table in appendix. Instead of considering ranges of P_2O_5 (kg/ha) as it is, as shown in Rating Chart prepared by IARI and given before, the index values for the same are used to show low, medium and high amount of P_2O_5 in the

soil and also low, medium and high fertility of soil. The soils with index number 0 to 8 are considered to be less fertile, while the ranges 8 to 20 and above 20 are considered to be medium and high fertile respectively.

The column No.10 in table No.4.1 for strata I show that 44 out of 102 soil samples i.e. 43.1% of soils are less fertile as their index value is below 8. 27 out of 102 soil samples i.e. 26.5% of soils and 31 out of 102 soil samples i.e. 30.4% of soils are medium and more fertile in respect of P. The table also shows that the soils of Haripur, Borgaon Dhulgaon and Savarwadi villages are very poor in P content.

The column 10 in table No. 4.2 for strata II shows that 63 out of 133 samples i.e. 47.4% of soils are less fertile as their index value is below 8. 32 out of 133 soil samples i.e. 24% of soils and 38 out of 133 soil samples i.e. 28.6% of soils are medium and more fertile in respect of P respectively. The table also shows that most of soils of Bagani, Belunki, Dudebhavi, Kameri, Vibhutwadi and Walwan villages are poor in P content compaired to the P values of soils of other villages.

The column 10 in table 4.3 for strata III shows that 80 out of 181 soil samples i.e. 44.2% of soils are less fertile as their index value is below 8. 25 out of 181 soil samples i.e. 13.8% of soils and 76 out of 181 soil samples i.e. 42% of soils are medium and more fertile in respect P. The soils from Kambali, Karanjawade, Mangale, Narwad, Padali Rayewadi and Shigaon villages are poor in P content is as -

SANGLI DISTRICT

FERTILITY OF SOIL IN RESPECT OF K

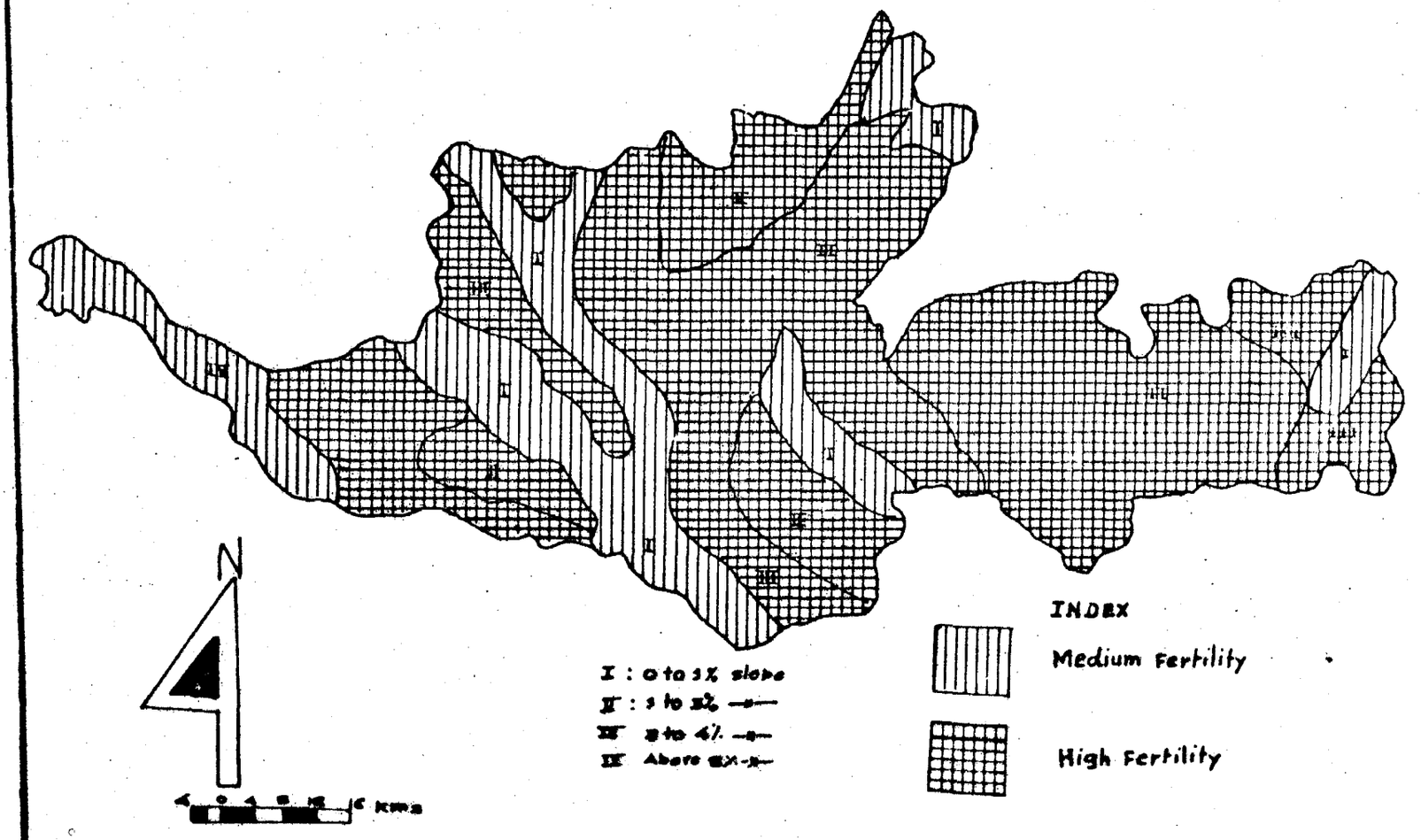

Fig. NO 12

compaired to the P containt of soil in other villages of same strata.

The column 10 in table 4.4. for strata IV shows that 13 out of 46 poil samples i.e. 28.3% of soils are less fertile as their index value is below 8. 15 out of 46 soil samples i.e. 32.6% of soils and 18 out of 46 soil samples i.e. 39% of soils are medium and high fertile in respect of P.

In short most of soils from strata No.I, II and III are low to medium fertile in respect of P. And most of soils from strata IV are medium to high fertile in respect of P.

Potassium (K) -

Potassium is third important nutritive element from the'big three'. Like N and P it is also required in more amount by the plants. It does not enter into the composition of any plant constituent, but its presence in the solution of the cell sap imperts vigour and disease resistanc to the plants It increases efficiency of the leaf in manufacturing sugar and starch. It helps to produce stiff straw in cereals and reduces lodging, It is necessary in the development of chlorophyll. This element is important for the earlier in grain formation and it lowers the harmful effects of excess of nitrogen. Abundant quantities of K do not exert harmful effect on the crop. But the leaves of crops suffering the from K deficiency appear dry and scorched at the edges and as a result it lowers the synthesis of starch. This shows

the importance of K in crop growth.

Like phosphorus K also is considered in the form of K_2O (its oxide). The values obtained and collected for different soil samples in the form of kg/ha. of K_2O are shown in column No. 11 and index values calculated by Azziz method for the same are shown in column No.12 of tables in appendix. Insted of considering ranges of K_2O(kg/ha) as it is as shown in Rating chart prepared by IARI given before, the index values for the same are used to show low, medium and high amount of K_2O in the soil. The soils with index number 0 to 15 are considered to be less fertile, while the ranges 15 to 30 and above 30 are considered to be medium and high fertile respectively.

The column 12 in table No. 4.1 for strata I shows that only 10 out of 102 soil samples i.e. 9.8% soils are infertile in respect of K as their index value is below 15. 47 out of 102 soil samples i.e. 46.1% of soils and 45 out of 102 soil samples i.e. 44.1% of soils are medium and high fertile in respect of K. The soils from Digraj and Mhaisal villages have higher amount of K therefore soils of these two villages are more fertile than the soils of other villages of the same strata.

The column 12 in table No.4.2 for strata II shows that 17 out of 133 soil samples i.e. 12.8% of soils are less fertile as their index value is below 15. 45 out of 133 soil samples i.e. 33.8% of soils are medium and 71 out of 133 soil samples i.e. 53.4% of soils more fertile in respect

SANGALI DISTRCT

SOIL FERTILITY IN RESPECT OF N, P AND K

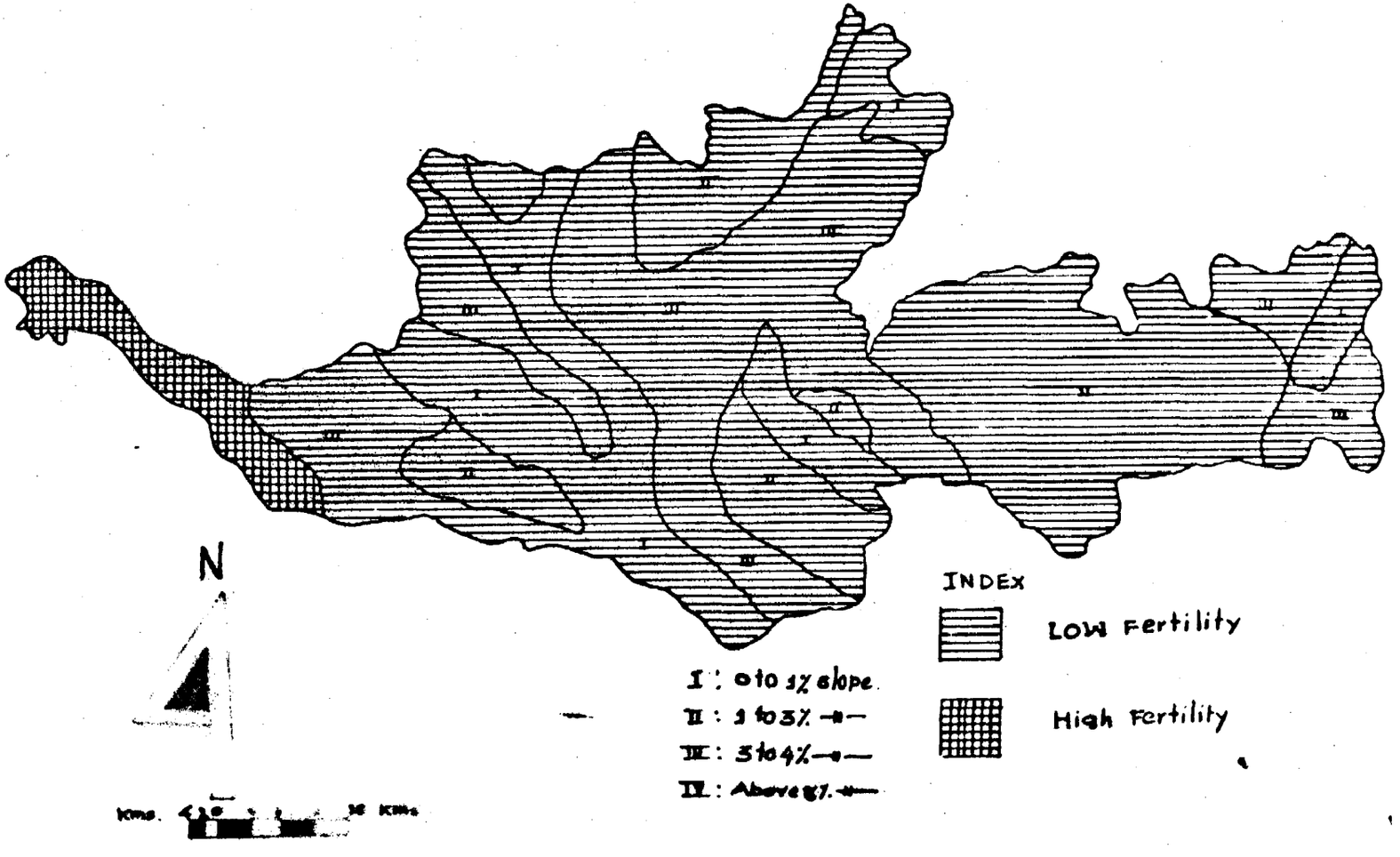

Fig. NO. :13

of K. Most of soils from Belunki, Ghorpade, Kognoli, Shegaon have higher amount of K. So the soils of these villages are more fertile than the soils of other villages of same strata.

The column 12 in table No. 4.3 for strata III shows that 18 out of 181 soil samples i.e. 9.9% of soils are less fertile; 64 out of 181 soil samples i.e. 35.4% of soils are medium fertile which 99 out of soil samples i.e. 54.7% of soils are more fertile in respect of K. The soils from villages Alte, Bendri, Irali, Manjarde, Rasulwadi, Rayewadi are more fertile than soils from other villages.

The column No.12 in table No. 4.4 for strata IV shows that 7 out of 46 soil samples i.e. 15.2% of soils are less fertile. 22 out of 46 soil samples i.e. 47.8% of soils are medium fertile which 17 out of 46 soil samples 12. 37% of soils are more fertile in respect of K in this strata. The soils from village petlond has only higher amount of K content compaired to soils from other villages of same strata. In short soils are fertile (fig.No.12) in respect of K all over the district.

In short most of soils from the strata I,II and III have low content of N and P. Therefore soils from these strata confined to eastern part of Shirala, Walwa, Tasgaon, Khanapur, Atpadi, Miraj, Kavathe-Mahankal and Jat are infertile in respect of nitrogen and phosphorus. The soils from strata No. IV which is confined to western part of shirala taluka has medium amount of N and higher amount of P but the soils of

this strata as low amount of K compaired to the soils from remaining strata. It may be due to leaching of K by heavy periodical rainfall. The soils of strata No.I,II and III have high content of K. So the soils of study area are fertile only in respect of patassium.

Effective Soil Fertility

Plants are the living bodies like us. If they do not get right type of food and other conditions they grow poorly. Certain elements like N, P, K, S, Ca etc is the food of plants. These are called as nutritive elements. Out of the total nutritive elements N, P and K are required in more amount by the plants. Though evenonly one of them, supplied sufficiently to the plant, it is not enough for their proper growth. Because the lack of others restrict the growth of plant by different ways and also develops some deseases in plant. It results into minimising the yield from agriculture.plant. Therefore ability of soil must be more for supplying nutritive elements for proper growth and maximum yield from crops. The ability of soil for supplying nutritive elements is nothing but soil fertility. So soild with more nutritive elements is more fertile and visa versa.

The term effective soil fertility is used to show the soil fertility of the study area. Where main three nutritive elements i.e. N, P and K are considered together. For this effective and proportionate indices are used. These

indices are shown in column No.13 and 14 of table No. 4.1, 4.2, 4.3 and 4.4 in appendix.

The column No. 13 and 14 in all tables in appendix and also fig.No. 13 shows that the soils of strata No.IV which are confined to western part of shirala taluka are more fertile than the soils of strata No. I, II and III.

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