

Soil Analysis of The Bhama River Basin Pimpri (Bk)

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Abstract:

Soil is composed of partly mineral matter and partly organic residue. As the specific heat of two differ considerably, the capacity of soil to absorb heat varies with the relative proportion of two. Variation in specific heat of soil depends on the extent of moisture and air present in it.

Movement of air in soil profile changes its temperature. During this process soil moisture is lost due to evaporation and transpiration. The higher soil temperature increases the rate of evaporation and thus leads to enlarged pore size and decreased absorbing capacity. Soil is unable to retain water for a longer period, it develops cracks, becomes less viscous and supply of nutrients due to capillary action decreases hence leads to less fertility.

Presence of excessive gypsum causes favored the development of fine roots efficient in water absorption, and the highest gypsum dose promoted the better spatial distribution of the root system and was more homogeneous in the vertical direction of the soil profile, High quantity of copper causes devastating effect on the yield of crop.

Keywords: Soil fertility, copper, gypsum, temperature, soil profile, soil health.

Introduction:

Agriculture is the art of cultivating the soil for the purpose of producing more abundantly crops that are necessary for the sustenance of man and domesticated animals. Soil may be defined as a natural body developed as a result of pedogenic processes that take place during and after the withering of rocks and in which plants and other forms of life are able to grow.

It forms a loose superficial mantle covering the earth's crust and is the seat of continual changes and transformations brought about by genetic factors. These changes make soil a dynamic entity.

Maintaining the fertility of our agricultural soils is of paramount importance not only for the present but for the future also. Soil analysis and its interpretation is an important management tool in assessing the need to apply nutrients in fertilizers and/or manures to maintain soil fertility.

Soils are composed of air, water mineral, organic matter and organisms. The amount of these constituents vary from place to place It is a three phase system in which mineral and organic matter forms solid phase, the water containing salt and some gases in solution the liquid phase and the various gases the gaseous phase. Each phase contain number of constituents which make the whole system highly complex. On account of changes continually taking place in soil, the system is never in equilibrium.

Soil has a threefold function to perform physical, chemical and biological. Physical function of soil is to act mechanical support for growing plants. The soil acts as a reservoir of air and water. Plants absorb water through their roots from this reservoir and roots breathe in oxygen from air stored in soil mass. The soil also stores the sun's heat and supplies it to growing plant. Chemical function of soil is to supply nutrients, which are obtained from weathering of rocks, plant decay and animal remains. Plants obtain nutrients like Calcium, sodium, potassium, iron, Aluminium, phosphorous, sulphur, chlorine etc from weathered rocks, nitrogen from organic compounds furnished by decayed plants and animals, hydrogen from water and oxygen partly from water and partly from soil air while carbon from carbon dioxide from atmospheric air.

Some of these compounds are soluble in water but most of them are insoluble. The soluble compounds are consumed by plants in the form of nutrients. The micro organisms present in the soil act as scavengers in removing dead plant or animals from the surface of the soil. They convert complex compounds into simple compounds which are water soluble and serve as source of nutrients for growing plants. Thus it

becomes essential to know the nature and composition of soil of the particular region so as to ensure the fertility of soil.

Although organic matter without mineral input can support plant growth, composted organic matter lack many of physical characteristics that are commonly associated with soil. It is the combination of mineral and organic matter that gives soil its unique properties. Together they makeup approximately 50% of soil volume, the remaining 50% is pore space filled with either air or water depending upon how wet the soil is.

Soil profile not only refers to the top layers of soil but also includes all the underlying layers down to the unaltered parent material on which the soil has been formed. The movement of mineral and organic material down the profile is determined by how easily the material moves in water and the rate of water movement. The mobility of chemicals within the profile at varying speeds produce soil horizons. Each horizon has different temperature depending on the type, concentration of mineral and quantity of water present in it.

Cultivation is a skilled operation that needs to be carried out at the right time, when the moisture contents of the soil lies within certain limits. The decline in aggregate strength with increasing moisture content has important implications for farming. If a clay rich soil is cultivated when it is too dry, it may break into large clods that will resist root growth. The soil is in the form of slurry, it smears to form plough pan. Highly viscous soil is not suitable for plant growth because of low oxygen contents, toxin accumulation, poor nitrogen value and weed problem.

The earth's atmosphere maintains a delicate balance of various gases including greenhouse gases which will allow incoming short wave solar radiation to pass through relatively unimpeded, but partially absorb and re-emit outgoing long wave terrestrial radiation. This process known as greenhouse effect is vital for life on earth and it is through this process the earth's average temperature raises from -18°C to $+15^{\circ}\text{C}$. However, various human activities like burning of fossil fuels and deforestation are contributing to an increase in the natural levels of these green house gases that enhance the greenhouse effect resulting in an increase in global temperatures. The consequences of which is the increase in soil infertility.

Soil temperature plays an important role in maintaining the viscosity of soil. The importance of soil temperature lies in its influence on the various soil processes, chemical as well as biological. Soil temperature influences the seed germination, if the temperature is too low or too high, seed fails to germinate due to non availability of food nutrients and high rate of evaporation, which decreases the viscosity of soil to minimum. Thus increasing the pore space of soil and decreasing the microbial activity to minimum due least water retention capacity. This increases the specific heat of soil which should generally vary from 0.17 - 0.27cal/degree.

Soil is composed partly of mineral matter and partly of organic residue. As the specific heat of two differ considerably, the capacity of soil to absorb heat varies with the relative proportion of two. The specific heat of mineral substances is less than that of organic material. Hence mineral soils get heated more easily than organic soils.

Specific heat of soil shows variation due to its moisture contents and air profile. Variation in viscosity of soil is not only due to concentration but is also due to specific heat. The diurnal changes in soil temperature depends upon the intensity of solar radiations received at surface, the loss of heat by radiation and convection and the rapidity with which the heat is conducted to lower layers. The radiation is greatest at surface due to porous structure and lowest at the moist or wettest layer of the soil. Under field condition, the moisture content of soil controls temperature to a large extent.

The removal of excessive water from the soil facilitates changes in temperature and increases the humus contents thus making it darker in colour and warmer, thus increase the organic contents of the soil. This leads to differential growth of micro organisms which intensifies the process of withering and soil development.

Soil samples from Bhama river bank of Pimpri Chinchwad area (Pune) were collected on the same day for three consecutive years and the samples were analysed for the major factors like colour, pH, conductivity, calcium carbonate, available, potassium, available, nitrogen, available phosphorous, available, copper, gypsum & microbial contents.

The samples were sieved through different mesh sieves and dried under shade at room temperature. Solutions of varying were prepared and their rate of flow was determined at various temperatures. It was found that the amount of gypsum and available copper were very high in the soil due to which the fertility of soil was getting effected.

Result And Discussion

Soil health or soil quality determines the productivity of soil which depends on soil functions such as nutrient supply, water storage and structural stability of soil. This indicates that water percolation is greater in the regions where alcohol formation takes place due high rate of disintegration of organic matter. Due to small pore size in water as solvent, percolation is less hence the leaching of nutrients is not rapid. In case of extremely small pores, the fertility is also increased because of less percolation due to presence of humus, chalk, lime etc which improves percolation by binding individual particles.

The pore size also enables us to have knowledge of particle size. Greater the particle size smaller is amount of hygroscopic water which is the unavailable water for the use of plants. Amount of hygroscopic water depends on the texture, nature of colloidal material, both organic and inorganic, humidity and temperature of atmosphere. Variation in soil temperature changes the temperature of soil air due to movement of air in soil profile. During this process soil moisture is lost due to evaporation and transpiration, the atmospheric air enters the soil pores to fill up the void left by receding water. The higher soil temperature increases the rate of evaporation and thus leads to enlarged pore size and decreased absorbing capacity and thus changes its heat capacity. Soil is unable to retain water for a longer period, it develops cracks, becomes less viscous and supply of nutrients due to capillary action decreases hence leads to less fertility.

The transpiration ratio varies with the environmental factors and presence of mulch reduces evaporation which in turn increases the soil viscosity and intensity of soil colour. Heat capacities of soil not only depend on the temperature but also on the soil colour. Hence dark colour soil warm up more rapidly and possess higher heat capacity and high viscosity. As the soil samples have been collected from the temperate region, near the bank of river, so they have lower heat capacity due to high humus contents which is a poor conductor of heat. Hence this soil is not fit for growing green leafy vegetables but crops like rice, maize, corn, sugarcane can be grown in this soil.

As the soil samples have been collected from the bank of the river which contains lot of mineral contamination along with organic matter, therefore the heat capacity of the soil has lower values than the expected value i.e. $\approx 80\text{cal.degree}^{-1}$. This is due to less contribution of organic matter which decays to the increase in temperature and hence specific heat. Soil high in moisture contents warm up slowly hence it is not suitable for seed germination and for growing leafy vegetables. Hence for proper growth of vegetables it is essential to maintain the soil viscosity as well as heat capacity by maintaining the soil texture, temperature and moisture contents.

Gypsum

Drought condition was found to diminish the effect of gypsum on soil and plants as a 10% reduction in wheat yield was observed in a drought year as compared with a normal year. Plant density, fertile spikelet, and 1000-grain weight were improved as the soil-applied gypsum increased. Regarding chemical composition of leaf, plants grown on un-amended plots had higher Na and lower potassium (K) and calcium (Ca) concentrations in leaf tissue. The application of gypsum caused a significant increase in nitrogen (N),

phosphorus (P), Ca, K, iron (Fe), and zinc (Zn) concentrations in wheat tissue but copper (Cu) and manganese (Mn) concentrations remained unchanged. It also increased Ca:Na and K:Na ratios in leaf tissue and had positive effects on crop yield.(14). The increasing doses of gypsum favored the development of fine roots efficient in water absorption, and the highest gypsum dose promoted the better spatial distribution of the root system and was more homogeneous in the vertical direction of the soil profile. (13).Hence this soil is more suitable for the growth of crops like wheat, maize etc.

Copper

These elements are sometimes referred to as trace elements or minor elements. However, a much more appropriate term is micronutrient. Some plants absorb large amounts of Na and Cl just because they are abundant in the soil, but only a small amount is necessary to the plants. Shortages of micronutrients were not noticed much until the use of very high-analysis fertilizers became common. Adequate levels of micronutrients could be maintained in the soil in the past when crop yields were low. But with the heavy applications of fertilizers that are now generally applied, micronutrients are quickly depleted. The effect of small amounts of micronutrients is remarkable. A deficiency may have a devastating effect on plant growth, even though the plant requires only a minute amount. Some micronutrients are a part of the enzyme molecules or act as an aid in the function of the enzyme. Others function in the processes of plant metabolism. Some micronutrients, such as Cu and Fe, aid in the formation of chlorophyll. The amount of micronutrients needed usually is only a few pounds per acre; therefore, they generally can be included in other complete fertilizer mixes. It is very important that micronutrients are mixed thoroughly because only a small amount is needed and it must be applied evenly over the field. Overdoses can be toxic to plants, perhaps killing them or making them unfit for human consumption. It should be noted that plants also absorb varying amounts of several nonessential elements just because they are available, but the plants apparently show no adverse side-effects. The eight essential micronutrients are boron, chlorine, cobalt, copper, iron, manganese, molybdenum, and zinc. Only a small amount of these elements is necessary for good plant growth, but deficiencies can have a devastating effect (15). Remediation of heavy metal contaminated soils is necessary to reduce the associated risks, make the land resource available for agricultural production, enhance food security and scale down land tenure problems arising from changes in the land use pattern. Several common pesticides used fairly extensively in agriculture and horticulture in the past contained substantial concentrations of metals. For instance in the recent past, about 10% of the chemicals have approved for use as insecticides and fungicides in UK were based on compounds which contain Cu, Hg, Mn, Pb, or Zn. Examples of such pesticides are copper-containing fungicidal sprays such as Bordeaux mixture (copper sulphate) and copper oxychloride.(16) The application of numerous biosolids (e.g., livestock manures, composts, and municipal sewage sludge) to land inadvertently leads to the accumulation of heavy metals such as As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Mo, Zn, Tl, Sb, and so forth, in the soil(17.). Although most manures are seen as valuable fertilizers, in the pig and poultry industry, the Cu and Zn added to diets as growth promoters and As contained in poultry health products may also have the potential to cause metal contamination of the soil [18,19] The manures produced from animals on such diets contain high concentrations of As, Cu, and Zn and, if repeatedly applied to restricted areas of land, can cause considerable buildup of these metals in the soil in the long run.

The most common heavy metals found at contaminated sites, in order of abundance are Pb, Cr, As, Zn, Cd, Cu, and Hg [20]. Those metals are important since they are capable of decreasing crop production due to the risk of bioaccumulation and biomagnification in the food chain. There's also the risk of superficial and groundwater contamination. Knowledge of the basic chemistry, environmental and associated health effects of these heavy metals is necessary in understanding their speciation, bioavailability, and remedial options. The fate and transport of a heavy metal in soil depends significantly on the chemical form and speciation of the metal. Once in the soil, heavy metals are adsorbed by initial fast reactions (minutes, hours), followed by slow adsorption reactions (days, years) and are, therefore, redistributed into different chemical forms with varying

bioavailability, mobility, and toxicity [21, 22]. This distribution is believed to be controlled by reactions of heavy metals in soils such as (i) mineral precipitation and dissolution, (ii) ion exchange, adsorption, and desorption, (iii) aqueous complexation, (iv) biological immobilization and mobilization, and (v) plant uptake [23]. Copper is the third most used metal in the world [24]. Copper is an essential micronutrient required in the growth of both plants and animals. In humans, it helps in the production of blood hemoglobin. In plants, Cu is especially important in seed production, disease resistance, and regulation of water. Copper is indeed essential, but in high doses it can cause anemia, liver and kidney damage, and stomach and intestinal irritation. Copper normally occurs in drinking water from Cu pipes, as well as from additives designed to control algal growth. While Cu's interaction with the environment is complex, research shows that most Cu introduced into the environment is, or rapidly becomes, stable and results in a form which does not pose a risk to the environment. In fact, unlike some man-made materials, Cu is not magnified in the body or bioaccumulated in the food chain. In the soil, Cu strongly complexes to the organic implying that only a small fraction of copper will be found in solution as ionic copper, Cu(II). The solubility of Cu is drastically increased at pH 5.5 [25], which is rather close to the ideal farmland pH of 6.0–6.5 [26].

Copper and Zn are two important essential elements for plants, microorganisms, animals, and humans. The connection between soil and water contamination and metal uptake by plants is determined by many chemical and physical soil factors as well as the physiological properties of the crops. Soils contaminated with trace metals may pose both direct and indirect threats: direct, through negative effects of metals on crop growth and yield, and indirect, by entering the human food chain with a potentially negative impact on human health. Even a reduction of crop yield by a few percent could lead to a significant long-term loss in production and income. Some food importers are now specifying acceptable maximum contents of metals in food, which might limit the possibility for the farmers to export their contaminated crops [27].

Report Of Soil Analysis Of Pimpri (Bk)

The parameters are given below

S.No	Parameter	Result as on 1 st Dec 2009 (T 28 ^o C)	Result as on Dec 2010 1 st (T 27 ^o C)	Result as on Dec 2011 1 st (T 28 ^o C)	Medium value of good soil	Inference
1	pH	7.54	7.72	7.93	5.5 to 9	Ok
2.	Colour	Blackish brown	Blackish brown	Blackish brown	Blackish brown	Ok
3	Conductivity	0.894 mml	0.9502	1.009	<1 mmhos/cm	Ok
4	Calcium Carbonate	4.5 gm/100 gm	7.75g/100g	8.889g/100g	4 to 10 gm/ 100 gm	Ok
5	Available phosphorous	16 kg/ha	22Kg/ha	26.37Kg/ha	10 to 25 kg/ha	Ok
6	Available Potassium	112.3 kg/ha	143.6Kg/ha	167.3kg/ha	150 to 250 kg/ha	Ok
7	Available Nitrogen	272 kg/gm	335kg/ha	467kg/ha	250 to 500 kg/ha	Ok
8	Gypsum	0.2075/ 5gm	0.3143/5g	0.374/5g	-	High
9	Available Copper	123.846 kg/ha	136.8kg/ha	144kg/ha	-	High

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