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Consequences of Soil Quality on Crop Yield: An Update

Neeraj Pandey and Nitin Kamboj*

Department of Zoology and Environmental Science
Gurukula Kangri (Deemed to be University), Haridwar-249 404, India
**E-mail: kambojgurukul@gmail.com*

Abstract: The soil is the medium that can fulfill the basic requirement of food, shelter, and clothes for human beings. It is an essential part of our agriculture system. Therefore the crop yield depends on the nutrients intake of soil via plants in the form of cation or anion. It is the mixture of macro (needed in large amounts) and micro (required in significantly less quantity) nutrients essential for a better crop yield. A proper understanding of the physicochemical and nutrient dynamics of any soil is the key to knowing the productivity of crops. Various parameters such as soil temperature, pH, electrical conductivity, moisture content, bulk density, texture, soil organic matter, organic carbon, and sodium adsorption ratio, are essential sources to understand the properties of soil. This information will helpful to the farmers for producing better quality crops. In today's scenario, due to the shortage of water, people are using anthropogenic water as a source of irrigation. The irrigation by sewage water may change the chemical properties of the soil, affecting the equilibrium between acidity and alkalinity. Likewise, it may affect agricultural growth and farming quality. Besides this, excessive use of chemical fertilizers adversely alters the quality of the agriculture field. In this review, we have focused on various soil parameters that may affect the growth and nutrient quality of yield. This information will also develop the awareness among farmers for economic productivity.

Keywords: Physico-chemical parameters, Nutrients dynamics, Soil, Agriculture field

Soil is the part of the earth's crust serving as a significant resource for the socio-economic development of the living being. For livelihood, a total of 70% of the population depends upon agriculture and related allied activities; therefore, agriculture proves to be the predominant part of the world economy. The formation of soil took in both constructive and destructive manner and constituted of broken rock material, which has been reformed by chemical and mechanical processes either through weathering or erosion (Pujar et al 2012, Sumithra et al 2013). Soil is not just a mixture of mineral particles but also the biotic system of living beings as well as other related constituents. Besides this, soil formation is also affected by various meteorological parameters such as rainfall, humidity, air temperature, etc. (Pietraszko et al 2018). Soil is a combination of organic and inorganic constituents with minerals, water, and a small portion of air. The plants themselves do not synthesize the essential nutrients, so they are extracted from the soil. Therefore fertility of soil plays an important role in controlling the yield of crops. The water type used for irrigation may also affect the quality of the soil to some extent. Besides increasing the nutrient value of soil through irrigation, wastewater from various anthropogenic activities is constantly contaminating the soils and crop products (Kumar et al 2019a). Likewise, it is loaded on plant portions via a root system and transported to the food chain. Similarly, soil fertility may also be responsible for controlling the production of the crop (Kumar et al 2019a). The properties of any soil may vary spatially and temporally from a field to a larger regional scale. It gets influenced by both intrinsic and extrinsic factors. The intrinsic factor includes the soil formation process like soil parent material. The extrinsic factors may include soil management practices such as fertilization and crop rotation (Cambardella and Karlen 1999). Besides all the above problems, dumping of solid waste is one of the major issues that make soil infertile, and barren, while mixing with dumping materials. Solid waste with water contact forms leachate that contaminates soil as well as groundwater (Kamboj and Choudhary 2013). The disposal site must be located far away from the water sources like rivers and lakes, residing areas, areas in and around the forest, and agricultural land (Kamboj and Pandey 2017). This review article emphasizes is on the effects of soil physicochemical and nutrient quality on the growth and production of crops.

Role of Physicochemical Properties

Soil temperature: Soil temperature has a role in heat exchange between the soil and the atmosphere, known as heat flux (Elias et al 2004). It can also define the function of the internal energy of the loam. The heat transport in the ground (Zhao et al 2007) and the exchange of energy at the surface (Nwankwo and Ogugurue 2012) are the fundamental sources of the change in soil temperature. Solar radiation is an essential source of soil temperature. Temperature is the major factor that affects the physical, chemical, and biological properties of soil and plant growth. Therefore, the soil is the key reservoir of energy during the day and a source of heat to the surface at night and stores energy during the summer season and releases it into the atmosphere during the cold climatic condition (Gieger et al 2003). The amount of absorbed energy interacts with the lost energy from the soil, which decides the temperature of the soil. However, the fluctuation in soil temperature on daily basis depends on the changes in the air temperature and solar radiation. The rate of absorption of dark-colored soil is greater than that of light-colored soil (Sandor and Fodor 2012, Nwankwo and Ogugurue 2012) and the dark-colored soil have high temperature than the lighter one. (Lehnert 2013, Probert 2000). The metabolic activity of microbes can maintain the proper nutrient cycle in soils. The microbial optimum temperature in the soil ranges between 10°C and 35.6°C, for performing their activities. There will be a decrease in the soil microbial activities when the temperature is low, and at the freezing point, most of the activities cease (Allison 2005). During the soil microbial interaction, the breakdown of complex organic matter to a simpler form and nutrient mineralization is affected by the climate. Even the water retention capacity of the loam, transmission, and availability to the plants get influenced by the weather. Due to the elevation in metabolic activity, soil temperature increases that stimulate the availability of nutrients for plants because of changing soil water viscosity and root nutrient transport (Grossnickle 2000). Lower temperature induces the reduction of nutrient uptake. Many factors affect the soil temperature

Soil mulch: The moisture content of the soil gets increases as the material inhibits the rate of evaporation (Horton et al 1996). Thus, more mulch materials reduce the temperature of the soil surface (Shinner et al 1994). Usually, more heat will flow into bare loam as compared to the mulched soil. Consequently, mulching of the earth's surface insulated the energy in the form of radiation (heat), lowered the temperature, and kept the loam cool (Dahiya et al 2007).

Slope of the land: The land slope is important in expressing the amount of radiant energy scattered through the land surface. This energy strike at a right angle dispersed to the minimum surface area compared to the left angle strike. So that, if the land slope increases, the amount of radiation per unit area of the land surface decreases (Elisabarashivilli et al 2010).

Vegetative cover: Vegetative cover of any land act as an insulator, affecting the soil temperature. The exposed soil absorbs more heat during the hot season, while in the cold season, the absorption rate is less, so it remains cool. Due to the presence of a dense amount of vegetative cover, the soil of the area neither becomes hot during the dry season nor too cold during the rainy season (Nwankwo et al 2012).

Organic matter content: A high amount of organic matter in the soil can increase water holding capacity that changes the color of the soil. Likewise, the increased amount of radiant energy absorption may increase the soil temperature (Fang et al 2005).

Evaporation: Considerable amount of energy is required in the process of evaporation of water. The water present in the soil utilizes the solar energy radiation to evaporate, thus exposing it engaged for heating the loam. Greater is the rate of evaporation, more speedily, the earth gets cooled, and its temperature gets decreased (Geiger et al 2003).

Water uptake: The lower the temperature, the lesser will be the water uptake. It is usually due to the decreased rate of absorption and increased rate of viscosity. Due to the decrease in uptake of water, the rate of photosynthesis gets reduced (Toselli et al 1999).

pH: pH is one of the essential physical parameters that play a significant role in maintaining the hydrogen ion concentration in soil (Pandesswari et al 2012). It is also the measurement of the intensity of acidity and alkalinity (Kamboj et al 2013). An increase in acidity and alkalinity harms water chemistry, thus resulting in corrosive behavior. When these types of water are used for irrigation in the agricultural fields, alter the biochemical reactions that occur in the soil (Fig. 1, Chitragar et al 2016). Due to the buffering function, the soil's pH value usually remains relatively stable (Masto et al 2009). Once there is a change in the pH, it may result in changes in the chemical properties. This change dramatically affects the existing form, transformation, and availability of soil nutrients directly (Ma and Zhao 2010). The changes in the pH value are generally related to the type of water for irrigation and the category of soil in taking it (Wan et al 2015). It was observed that there was no apparent effect on the pH of the agriculture fields when the sewage came from the breeding of livestock (Zhang et al 2011).

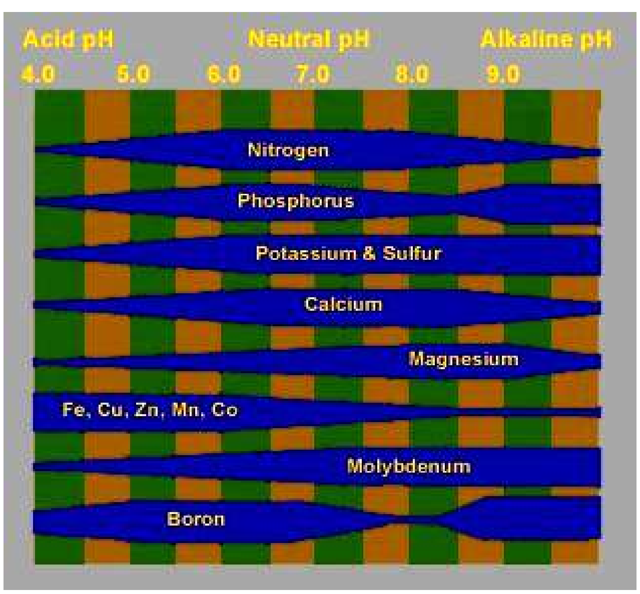
Electrical conductivity: Electrical conductivity is a measurement that has a relationship with soil properties that dramatically affects the texture, cation exchange capacity, level of organic matter, drainage pattern and condition, salinity, sub-surface characteristics, etc. (Solanki and Chavda 2012). Conductivity indicates the presence of dissolved solids and another major ionic form in the water bodies (Deshpande and Aher 2012). The increasing concentration of ions indicates a high electric conductive effect. High conductivity lowers the availability of water to the plants, thus affecting the rate of growth (Bauder et al 2013). Soil health is rapidly measured by Electric Conductivity. With the change in depth, conductivity differs, and variation is comparatively less in the unplanned soil profile. Likewise, the changes in the unplanned soil profile are due to land-surface slope, elevated permeability, and high rainfall, responsible for leaching out of alkali and alkaline bases (Dutta and Ram 1993). In the measurement of salinity and estimation of soluble salt concentration in soil, electrical conductivity plays a crucial role. Salinity is a leading water characteristic that affects crop yield (Wagh et al 2013).

Moisture content: Soil moisture is one of the most vital physical parameters of soil. It impacts crop development by influencing supplement accessibility (Behera 2014). The nutrient absorption of soil depends on the moisture content. Texture and the structure of any soil decide its water content. Void ratio, size of the soil particles, minerals in the clay, organic matter, and condition of groundwater also play an essential role in the moisture content of the soil (Yennawar et al 2013). Clay has a larger moisture content, due to its high quality of porosity, while the sandy soil has a lesser amount of moisture due to a lower porosity level. The porosity is the deciding factor in the wetness of soil (William 2005). If the water holding capacity of any soil is adequate, it shows the physical activeness of the soil (Soffe 1995). However, the type of red and black soil has maximum water holding capacity (Thakre et al 2012, Vanderlinden et al 2005).

Texture: The retention of nutrients and capability of drainage, both are directly related to the texture. Soil texture is considered to be a persistent feature and is not readily getting changed in the field (Brady and Weil 2007). Based on the proportion of various sized particles, the soil could be classified into different textural groups. Besides this, Soil-water retention, aeration, and root penetration get influenced by soil texture directly. The texture of the soil plays a vital role in carbon storage and strongly influences the retention of nutrients and their availability (Hamarashid et al 2010). Soil with a tremendous amount of clay content will be more conducive than the earth with a higher amount of sand. Black soil has a loamy and clay texture, yellow soil, earthy clay, and red soil silt clay and loamy (Jain and Singh 2014). The surface of the loam influences the diversity of the microbial communities together with pH, organic matter content, and cation exchange capacity. The structure of the microbial community provides an appropriate home for the growth of the specific microorganism, making the degradation process efficient (Girvan et al 2003).

Bulk density: There are water-filled air pores in an "ideal soil" that fulfill the plants' needs with easy root penetration. The mineral particles provide the strength that helps in providing physical support and essential plant nutrients. Bulk density is also influenced by soil's physical and chemical properties (Chaudhari et al 2013). The amount of organic matter present in the soil, its texture, mineral constituent, and porosity get influenced by its bulk density. It is essential for soil management, soil compaction, and the planning of modern farming techniques (Sharma and Bhattacharya 2017). Aubertin and Kardos (1965) reported that the bulk density of clay ranges between 1.0 to 1.6 mg/m3. For sand, the typical thickness varies between 1.2 to 1.8 mg/m3 with probable root dispersion occurring at ≥ 1.4 mg/m3 for clay and ≥ 1.6 mg/m3 for sand.

Sodium adsorption ratio: Sodium adsorption proportion (SAR) is a proportion of the measure of sodium (Na+) comparative with calcium (Ca2+) and magnesium (Mg2+) in the water extracted from an immersed soil paste. It is the ratio of the Na concentration divided by the square root of one-half



Source: Chitragar et al 2016

Fig. 1. Values for pH of different nutrients in the soil

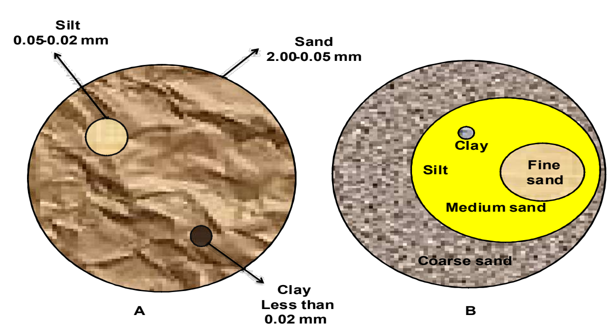


Fig. 2. 2A-Relative size of sand, silt, and particles; 2B-Identification of soil separates

of the Ca + Mg concentration. The SAR can measure the suitability of water used in agricultural irrigation. The water will be less suitable for irrigation if the SAR is high. El-Morsy et al (1991) reported that the water transmission properties of the soil get significantly affected by the SAR of irrigation water. Characterization of soil sodicity can be done by using the SAR index. The high value of SAR in the soil represents high content of sodium which has the potential to result in poor physical situations owing to crusting, logging of water, and poor permeability. The high concentration of sodium is responsible for clay swelling, dispersion, or disaggregation of soil. Irrigational water is greatly responsible for clay swelling. If the concentration of sodium and salinity in the irrigational water is high greater will be the rate of swelling (Hanson et al 1999).

Soil organic matter and organic carbon: Supply of nutrients, contributing to cation exchange capacity, and soil texture all are controlled by soil organic matter (It can define as the non-living extract of the plant and animal alterations). Besides, it includes total biomass, micro, and macrofauna, and entire decomposition products (Roscoe et al 2004).The non-living biomass composition has 95% of soil organic matter. It is divided into two categories: (i) organic matter in numerous phases of disintegration (non-humic substrate in which the morphological aspects of original biomass can be recognized) and (ii) material that is altered with no morphological characters from original biomass (active fractions and stabilizes organic matter) (Fig. 3).

The storage of soil organic matter depends on the primary addition of carbon from the plant detritus (residue) and the loss of carbon through the soil organic matter decomposition. (Machado et al 2006, Awale et al 2013). The more considerable amount of carbon sink in the biosphere is mainly due to the change in the soil organic matter. It acts as a building block of the soil organization and plays a vital role in balancing CO_2. It drives out the climatic variation in the environment (Lal 2004, Smith 2012). Soil organic matter and organic carbon both are interlinked. Other metabolic reactions, such as the exchange of ions absorption, or dissolution reaction, result in constituting dissolved organic carbon (Guggenberger and Kaiser 2003). The increase of organic content in the soil may also increase the water-holding capacity of the loam (Bharti and Kamboj 2018).

Soil nutrients dynamics: Nutrients are the compounds required for performing different metabolic activities that are essential for fertility, growth, development, and production. If the soil is deficient in nutrients or its amount is excess, it will affect the proper functioning and growth of a plant, resulting in various diseases. Nutrients in the soils determine the genetic expression of the crop plants' physiological and morphological traits (Kumar et al 2019b). The nutrients are further divided into two categories viz. micronutrients and macronutrients (Table 1).

Macro-nutrients: The nutrients are required in a large amount for the growth of the crops and are significant elements due to their presence in a large amount. The

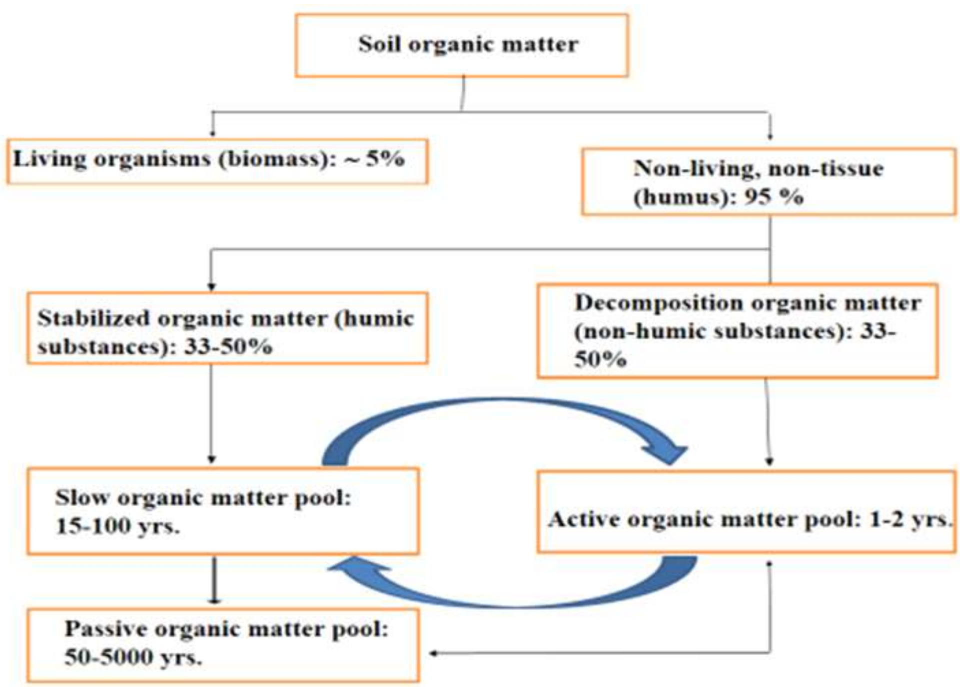


Fig. 3. Classification of soil organic components and a conceptual model of the various pools of soil organic matter

majority of the macro-nutrients are minerals except a few viz., C, H, and O. They are easily get absorbed by the roots of the plants (Chitragar et al 2016). The toxic level of macro-nutrients is very high if their concentration level exceeds the optimum level it may cause stunted growth and poor yields for plants. Testing of the soil gives enlightening information about the accessibility of supplements as a result, compost is given to amplify the harvest yield. Evaluating the fertility status of soils helps us to determine the nutritional disorders and factors that affect crop productivity. The source of irrigational water plays an important role in it. The different types of water sources used for irrigation purposes in the agricultural field affect the nutrient balance of the soil (Kamboj et al 2021; Fig. 4). Either soil becomes rich in nutrients or gets deficit, due to which fertility, productivity, or yield of the crop gets severely affected. For the proper growth of the crops, nutrient equilibrium should be present in the water, soil, and plants. In case of the irrigation through wastewater, the soil gets highly enriched with macro and micronutrients that play a crucial role in the productivity and yield of crops. (Kumar et al 2018).

Micro-nutrients: Micronutrients or trace elements are required in very little quantity but their lack may result in serious concern for the plant, which simultaneously affects crop production. All the micro-nutrients are absorbed through roots. Through weathering of mineral and organic matter decomposition, nutrients become available to the soil, which plants intake in the form of ions. Threatening to agricultural

Table 1. Different types of micro and macronutrients and their role in plant metabolism

Micronutrients	Macronutrients
Boron (B) • It plays an important role in the metabolism and movement of sugar compounds in plants. • Synthesis of plant harmonics and nucleic acids and formation of lignin of cell wall takes place with the help of Boron.	Nitrogen (N) • Amino acids are the building blocks of protein including mostly all the enzyme which controls the biological processes and nitrogen is the major part of all the amino acids. • If the supply of nitrogen is good then the growth and development of roots will be enhanced. Consecutively, uptake of other nutrients also gets increased.
Chlorine (Cl) • Plays an important role in ionic balance and photosynthesis and is essential for osmosis.	Phosphorus (P) • It enhances many elementary processes counting photosynthesis, flowering, maturation, fruiting, maturation, and fixation of nitrogen. • DNA and RNA moleculesare made up of phosphate groups. • Present in both the form i.e., organic and inorganic, that can be easily translocated in the plants. • Most of the energy transfer in the plants is dependent on phosphorus. • The availability of phosphorus to the plants is in a very limited quantity in most of the soils since it is released very slowly.
Copper (Cu) • Formation of the cell wall, photosynthesis, respiration, and other such processes involving nitrogen.	Potassium (K) • Mostly it occurs in all the parts of the plant in significant amounts. • Through the potassium ion pump, it regulates stomatal closing and opening. • As a nutrient, the rate of its mobility solubility is outstanding.
Iron (Fe) • The main constituent of chlorophyll formation and many reactions involving enzymes. • It also plays an important role in the process of photosynthesis and respiration.	Calcium (Ca) • The majority of the amount is present in the leaves of the plant. A small concentration of it is also present in roots, seeds, and fruits. • A major constituent of the cell wall. • It is also involved in photosynthesis and plant structure.
Manganese (Mn) • Many of the enzymes have manganese content in them. • It is involved in photosynthesis and the growth of roots also takes place in its presence. • It is also involved in N_2 fixation.	Magnesium (Mg) • Chlorophyll contains magnesium as a constituent material. When the plant is deficient in magnesium molecules, its translocation starts from the older tissues to the younger side, showing the deficiency of nutrients to the older part first and then to the younger area.
Molybdenum(Mo) • It is involved in N_2 fixation.	Sulfur (S) • It is important in the development of chloroplast and is a structural part of some amino acids and vitamins.
Zinc (Zn) • It is part of DNA proteins and many organic complexes. • It also acts as an important enzyme in protein synthesis. It is also responsible for harmonic production and seed development.	

potentials is due to the soil nutrients because their availability depends on soil organic matter content, soil pH, adsorptive surface, soil texture, and interaction of nutrients in the soil. Throughout the world, the soil's micro-nutrients are available in fewer amounts, due to which the plants growing in the soil suffer from nutrient deficiencies, affecting their growth and showing various disorders (Rengel 2007, Alloway 2008). Strong leaching and high precipitation result in humid tropical regions' micro-nutrient deficiencies and humid temperate regions. The symptoms of micronutrient deficiencies appear on younger leaves at the apical part of the plant, while the toxicity symptoms appear on the older leaves of the plants (Chitragar et al 2016). Various factors viz., clay content, pH, soil organic matter, cation exchange capacity, level of phosphorus in the soil, and tillage practices affect the solubility and availability of micronutrients in the soil.

Nutrients Essential for Growth of Plants

Nitrogen: Nitrogen is the main element and gets quickly absorbed by the roots of the higher plants in the form of nitrate and ammonium ion (Sumithra et al 2013, Masto et al. 2009). Sewage irrigation shows a lesser effect on ammonium ions present in the deep inside soil and groundwater, but long-term irrigation results in a higher concentration of nitrate, causing groundwater pollution inthe deep soil layer (Liu and Lu 2002). Nitrogen (N) is an integral part of all the proteins, enzymes, and metabolic processes involved in the formation of energy and it transfers to the cell. (Singh et al 2014). The nitrogen cycle is greatly influenced by biological processes and act a significant role in the soil system (Fig. 5). Roots of some higher plants havea symbiotic relationship

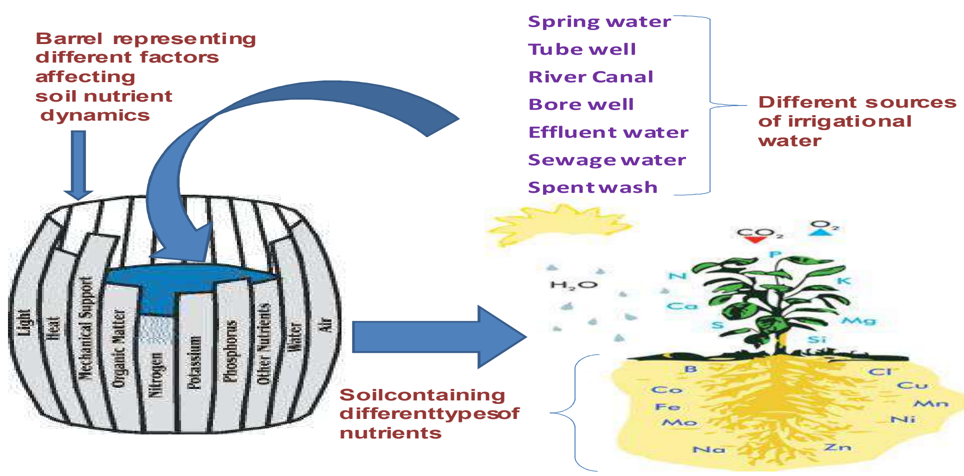


Fig. 4. Representation of different types of nutrients present in the soil

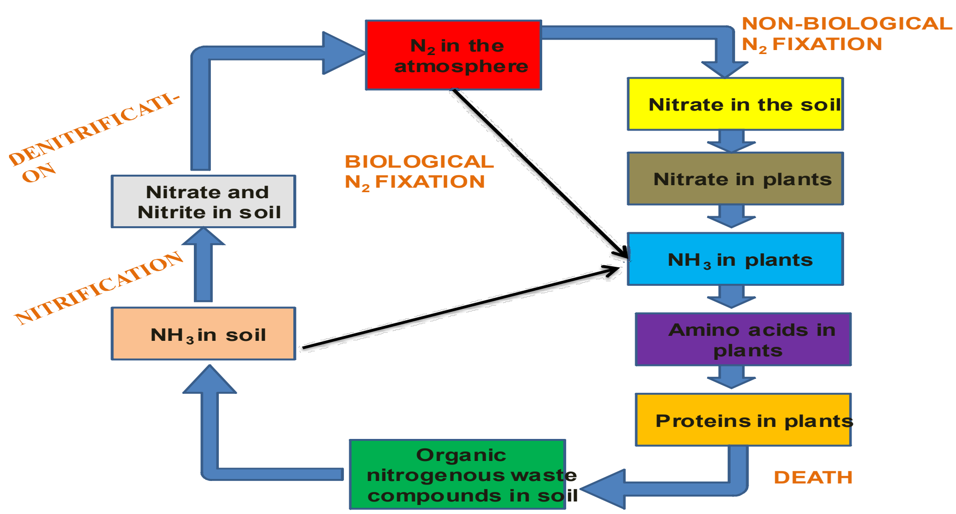


Fig. 5. Nitrogen cycle representation representing biological and non-biological N_2 fixation pathway

with certain bacteria like Nostoc and Anabaena that fixes atmospheric nitrogen in the form of ammonium ion (e.g., Corolloid root of Cycas).

Phosphorus: Every plant cell contains phosphorus as one of its constituents. It is also counted as a key reservoir responsible for better plant growth. Therefore it acts as limiting nutrients that remain in the plant nuclei as an energy storage packet (Jain et al 2014). For the growth of the plant, a large amount of phosphorus is required, which plays a vital role in photosynthesis and is concerned with the creation of oils, sugars, and starches (Singh et al 2014). There is an abundant amount of phosphorus present in the fruits and seeds of plants. For the germination of the seed, flowering, and fruit formation, phosphorus plays an essential role, and its deficiency results in the purple stem of leaves and poor yield of fruits in crop fields (Wagh et al 2013). Phosphorus is the vital micro-nutrient required for the metabolic activity and proper growth of the plant. Processes like growth, respiration, and reproduction depend upon the availability of phosphorus in the soil in which the plant grows (Wagh et al 2013). In the topographic region, the soil's available phosphorus content is higher than the soil in the lower topographic level (Singh et al 2014). The soil with an ample amount of phosphorus content results in the early growth of the plants and hastens ripeness (Solanki and Chavda 2012). The soil with the maximum leaching rate has a high phosphorus ratio as compared to the soil with the minimum leaching rate (Ashraf et al 2012).

Potassium: Potassium (K) is considered to be one of the essential elements found abundantly in soil. Potassium in the soil is found in four forms viz. solution, exchangeable, fixed or non-exchangeable, and structure or mineral (Fig. 6 & 7). The interchangeable level of K and Non-exchangeable level of K contain a lesser portion of the whole K. The bulk of the entire soil K is concentrated in the mineral portion of the soil (Sparks and Huang 1985). The availability of K to the plants and microbes is in the order: solution> exchangeable> fixed (non-exchangeable)> mineral (Spark and Huang 1985, Sparks

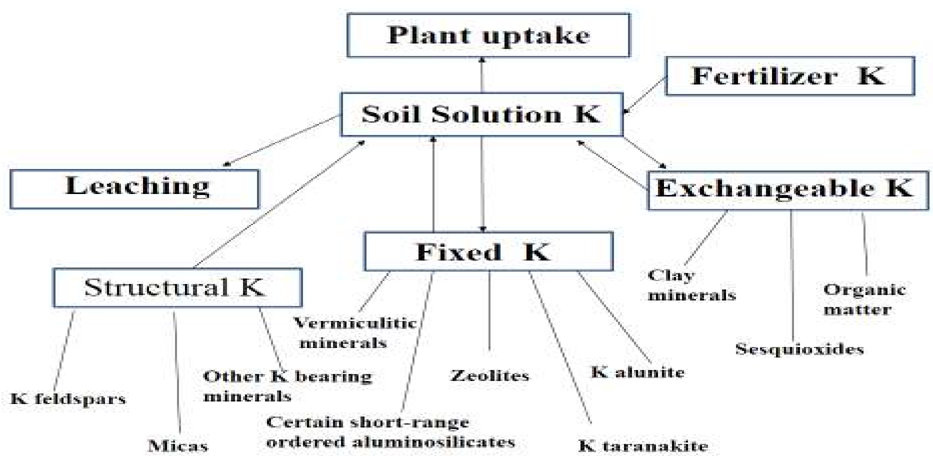


Fig. 6. Various forms of K found in the soil, their inter-relationship (Sparks and Huang 1985)

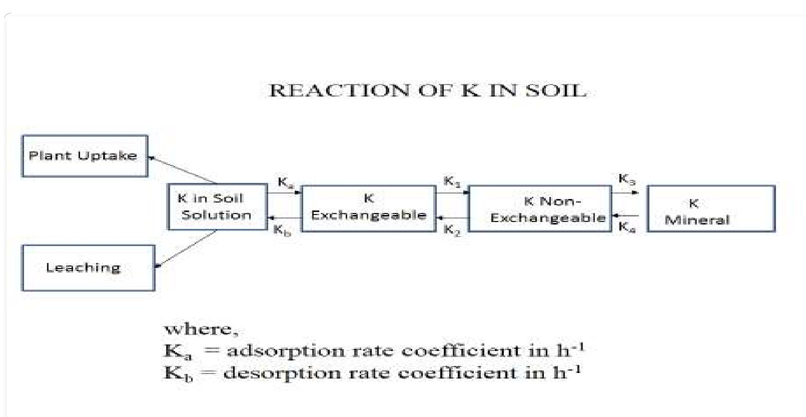


Fig. 7. Exchangeable K dynamics in soil

1987, Sparks 2000). There is a kinetic and equilibrium reaction exists between the four forms of soil potassium, which affects the level of soil solution K at a particular time, and thus, the amount available for plants. The frequency and a way of reaction between the solution and exchangeable forms of K govern whether the applied K will be leached into the lower distances, taken up by the plants, converted into unavailable forms, or released into the available forms. The rate of reaction between the soil solution and exchangeable phases is strongly dependent on the kind of clay mineral present and the methods implied to measure the kinetics of K interchange (Amacher 1991, Sparks et al 1996). Though it is not an essential element for plants still it plays a key role in plant growth, protein synthesis, maintenance of plant water stability, etc. (Sumithra et al 2013). Many of the metabolic reactions ranging from lignin and cellulose used for the formation of cellular structures, for the regulation of photosynthesis, and manufacture of plant sugars used for several plant metabolic needs, are dependent on the concentration of potassium (Solanki et al 2012).

If the soil is deficient in nutrient content, organic or chemical fertilizers containing nitrogen, phosphorus, and potassium are added up. The chemical fertilizers bring up a quick reaction with the soil and promote plants to grow up at a faster rate. They are available to the plants for a shorter period and get diminished. On the other hand, organic fertilizers are sustained in the soil for a longer period and are available to the plants constantly, promoting their growth and yield. So, the better option will be to use a mixture of chemical and organic fertilizers in a specific ratio. This will help the plant to grow properly without affecting the quality of the soil (Raj and Joshi 2019).

Impact of soil nutrients on crop yield: The fast growth in the anthropogenic activities in the agricultural field to increase the crop yield, in some way or the other affects the productivity of the soil to a greater extent. The quality and fertility of soil directly influence the nutritive content of the food crops and the overall nutrient output of the agricultural system (Bruulsema et al 2012). Soil nutrients after increasing upto the saturation level, become intolerant to the further intake of external supplements and with time start degrading the soil properties thus making it sodic. The micronutrient deficiency in soil has become one of the major concerns about plant growth and yield. In the last few decades, it was observed that deficiency of micronutrients viz., zinc, boron, and molybdenum is ascertained. Soil with the deficiency of zinc was mainly seen in Asia including the countries viz., India, Turkey, China, and Indonesia. The deficiency was also observed in the north-western part of South America and sub-Saharan Africa as reported by Udo de Haes et al (2011) emphasized that the soil with maximum calcium content dominant in the Middle East has high pH with lesser organic content (i.e., <1%), therefore the crops obtained from these regions have low micronutrient content. Similarly, a lesser amount of rainfall and variance in the fertilization rate also adds to micronutrient deficiency in these regions. Kiran (2017) assessed the soil quality of the Gurdaspur region and found out that some of the micro-nutrients viz., zinc and copper were present in a very lesser amount. Even boron and iron were also present in fewer quantities. Due to the nutrient deficiency, the productivity of soil and yield of wheat gets lessened. Similarly, the Rupnagar region had high to very severe nutrient deficiency in zinc, copper, and boron resulting in lesser yield. The districts such as Nawanshahr, Jalandhar, and Sangrur had moderate to high yields in respective nutrients such as zinc, boron, manganese, etc. In the overall context, the areas with low wheat yields have a greater micro-nutrient deficiency compared to the area with high yields.

Methods and techniques to be adopted to manage the soil fertility and crop yield: In order to improve the variety of crops and yield, different methods and techniques are to be adopted in a way to cope with the nutrient loss or hyper accumulative conditions. Some of the techniques are well illustrated below:

Nuclear or isotopic techniques: In this technique, an isotopic form and nitrogen and phosphorus i.e., N-5 and P-32 are used. This isotopic form helps in tracing out the labeled fertilizers containing nitrogen and phosphorus into the soil, water, and crops. It gives overall quantitative data on the efficiency of the usage, their translocation, their residual effects, and also their transformation from one form to another. N-15 helps in quantifying the nitrogen fixed from the atmosphere via nitrogen fixation by the crops from the leguminous family. The isotopic carbon i.e., C-13 helps to quantify the residues of crop that is incorporated for the stabilization and fertility enhancement as reported by Kirda et al (1999).

Zai technology: In sub-Saharan Africa (SSA) due to the low or unreliable rainfall and less moisture content, the fertility of the soil is deteriorating at a greater pace. This has resulted in a low crop yield. Zai technology is one of the trending ways to promote soil moisture enhancement by retaining the water, thus increasing the fertility of the soil. In this technique, the organic method gets buried beneath the soil in small pits that helps in restoring fertility and also conserves water in the soil. Though adoption of this technique is not that high, it is one of the eco-friendly techniques as reported by Danso-Abbeamet al (2019).

Machine learning technique: For the prediction of the yield of a crop, the machine learning technique proves to be one of the most effective tools. Machine learning helps to predict the yield based on machine learning as reported by Pandith et al (2020). Machine Learning is a technology that allows computers to learn and improve automatically over time by regularly training them. It consists of a series of well-defined models that gather certain data and use precise algorithms to obtain the desired outcomes. In order to improve the productivity and quality of the crops grown, machine learning techniques have been used in the agriculture area. Machine Learning algorithms are used to evaluate which conditions will generate the best yield for a specific crop.

CONCLUSION

Soil degradation is taking place at a greater rate. It is due to the conventional agricultural practices that are mostly dependent on concentrated input of chemicals. The physicochemical and nutrient quality of soil is essential in improving the productivity and yield of crops that may fulfill the increasing human demands. Looking towards a few years back, we can observe that the farmers are using excessive amounts of fertilizers and pesticides to improve productivity without knowing much about their negative roles. On one hand, yield is increasing, and on the other hand, soil quality is decreasing. The crops with the shorter height get wilted out, thus suppressing the expected growth. So, analysis of the soil parameters becomes an essential part of any research work. The use of intensive agriculture practices may have a large number of disadvantages in the long run. Therefore, modern techniques are adopted for sustainable agriculture by applying bio-fertilizer and bio-pesticides instead of chemical ones. For a better tomorrow, a new hope has confronted the economic and environmental viewpoints. Same as bio-fertilizers, bio-pesticides used for pest control appears to be an essential tool in recent years. Due to the intrinsic and extrinsic factors, soil fertility variation is also very high in many of the nutrients. Before starting any experiment, one should keep the field un-planted for one season to reduce the error resulting due to the soil fertility variation. Therefore, it has become an important parameter to maintain soil health for the security of food for the future generation and increasing agricultural yield. The matter discussed in this article may help the farmers to utilize the information in managing the condition of nutrient equilibrium that is an essential part of plant metabolism and growth.

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