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Harmful Impact of Synthetic Fertilizers on Growing Agriculture and Environment

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Abstract

Soil provides essential environmental benefits for life as well as crucial for nutrition and survival of plants. Management of soil health is a critical practice for the preservation of biodiversity and to ensure long-term agricultural production. Scientific management of soil health is an important step for ecosystem sustainability. Some of the important factors like physicochemical and biological parameters that influence soil health. Fertilizers are heavily used in modern farming practices to control unavoidable challenges being faced in Agriculture. Nonetheless, they remain critical tools for global food safety.

Sustainable agriculture practices have been used on a global scale by reducing the negative consequences of chemical fertilizers because they drop in soil organic content as well as decline soil quality. They also harden soil, reducing soil fertility, depleting vital soil mineral nutrients, polluting air, water and soil all of which poses serious environmental hazard. Microbial activity in the cropping system has become low due to the application of chemical fertilizers alone. Regular application of chemical fertilizers can alter soil pH, increase resistance in pests, acidification of soil crust resulting in decreased organic matter and stunted plant growth. Hence, Long-term persistence of chemical fertilizers in the soil harms the biodiversity of soil. Present review paper deals with functioning and role of mineral elements in plant growth and development. Various types of organic and synthetic fertilizers are involved in fulfillment of basic needs of plants. Soil with poor nutrient content needs different types of fertilizers for regulation of physiochemical cycle of plants. The literature reviewed information suggested that our agriculture sector has not been dependent on synthetic fertilizers for plant growth and development i.e., directly linked with the crop productivity at industrial level. Chemicals associated synthetic fertilizers have been harmful for plant health and this will lead to drastic health damaging effect on new generations. In this way we again need to focus on development of natural fertilizers with their environmentally friendly inputs and health promoting activity.

Keywords: Soil health; Chemical fertilizer; Soil organic matter; Environmental risks; Organisms; Microbial activity

Introduction

Pesticides and fertilizers are supplied in soil to fulfill the need of vital plant nutrients. They are used for preservation of ecological balance and soil biodiversity must be addressed in order to meet the world's expanding food demand. They have been used in modern agriculture for enhancement and consistency agricultural productivity. But certain drawbacks are associated with the continuous use of chemical fertilizers such as the threat to human and environmental health [1,2].

Crop cultivation requires macro and micronutrients like nitrogen, phosphorus and sulfur for their growth and development. During the period of repeated crop harvesting and cultivation, the soil nutrient level decreases and such nutrients are not recycled back to the soil [3].

Therefore, vital nutrient requirements are compensated either through the natural process of decomposition of dead plants and animals; nutrients extracted from dead organisms revert to soil, or by adding fertilizers [4].

According to the soil science society of America, "any organic or inorganic material of natural or synthetic origin, other than liming materials i.e., added to soil to supply one or more essential plant nutrients to the growing of plants are considered as fertilizers" [5].

Fertilizers are decomposable materials used for the addition of nutrients to the soil by maintaining soil fertility and increasing plant growth. Nowadays, fertilizer has become crucial to recent

agriculture to nourish the rising inhabitants. Fertilizers contain minerals that support the growth of soil microflora, particularly microorganisms for direct uptake of nutrients to the growing plantlets. This important feature of fertilizers can help fulfill the nutritional requirements of starving people and also controls the death arise by food starvation in a different area of the globe [6,7].

Mainly fertilizers are available in natural and chemical forms. Natural fertilizers are made from organic materials that benefit both plants and soil. Organic fertilizers are made from natural sources such as plant and animal parts. Emerging microorganisms for sustainable agricultural development include cyanobacteria, earthworms, and other decomposing organisms [8,9]. These organisms are useful in the production of inexpensive and environmentally favorable biofertilizers. They can help plants with nitrogen deficit, soil aeration, water holding capacity, and vitamin B12 supplementation. In the rice crop cultivation area, the most efficient nitrogen-fixing cyanobacteria are *Nostoc linkia*, *Anabaena variabilis*, Aulosira fertilisima, *Calothrix* sp., *Tolypothrix* sp., and *Scytonema* sp. [10]. Their applications are also reported in barley, oats, tomato, radish, cotton, sugarcane, maize, chili and lettuce [11-13].

The importance of biofertilizer preparation includes:

a) Maintain porosity of soil and produce adhesive agents

b) Secretion of Plant hormones (such as auxin, gibberellins, etc.), vitamins, and amino acids

c) Enhance the water holding power of soil for improving the texture and consistency of soil

d) Increase in soil biomass after death and decomposition of plant parts or dead forest animals or biofertilizer organisms.

e) Reduce soil salt concentration

f) Controls weed growth

g) Availability of soil phosphate through organic acid excretion.

h) Efficient absorption of heavy metals [10,14,15].

Chemical fertilizers are usually readily available, and accessible in greater amounts, increasing crop yield with expensive affairs. Certain drawbacks associated with the overuse of chemical fertilizers are reducing soil porosity, root burn, reducing water holding for the plants, killing soil-friendly microorganisms, reducing soil fertility, disturbing soil pH, and also causing air and water contamination, making them dangerous to human health and the environment. The use of chemical fertilizers regularly depletes vital soil nutrients and minerals that are naturally present in productive soil. Chemical fertilizers constitute a major threat to the balanced and long-term growth of the plant and its connected ecosystem. Several scientists and researchers deeply discussed the best use of organic fertilizers as a solution to avoid soil pollution and other environmental hazards caused by the overuse of chemical fertilizers [16,17]. The harmful effects of chemical fertilizers have posed a severe threat to the environment and the quality of vegetables, crops, fruits, etc. Now, organic or natural fertilizers might be the right solution for eco-friendly and sustainable agriculture practices at the commercial level [18].

Fertilizers

Fertilizers are organic substances with different nutrients and minerals used in the agriculture field to maintain soil quality and improve the yield of plants. It is one of the important components along with water and soil, for healthy crop growth and development [19].

Based on their origin fertilizers may be classified in the following two ways:

a) Natural fertilizers are employed without any modification.

b) Manufactured fertilizers are produced in the laboratory through several steps of processing.

Manufactured fertilizers may be classified as:

a. Processed Natural Fertilizer- Produced by decomposition of organic material e.g. vermicompost.

b. Synthetic Fertilizer- classified into two types:

i. Agricultural

ii. Horticultural fertilizers.

Only a few macronutrients are commonly found in agricultural fertilizers. These are primarily used in agriculture. They are normally expected before or after seeding [20,21].

Horticultural fertilizers are made up of many of the same ingredients as agricultural fertilizers, as well as a few others, to provide well-balanced fertilizers with micronutrients [20]. Water-soluble (rapid release) or comparatively insoluble horticultural fertilizers are available (controlled release). Controlled release, sustained release, and timed-release fertilizers are meant to be applied every 3-6 months, depending on watering, growth rates, and other factors, but water-soluble or rapid release fertilizers must be applied at least every 1-2 weeks in excess watering situations. Horticultural fertilizers, unlike agricultural fertilizers, are sold directly to customers and are part of the retail sector. They're used in houses, gardens, and farms of many kinds. Fertilizers, on the other hand, can be classed according to the origin of their ingredients [22,23].

This means fertilizers can be one of two types:

a. Inorganic - made up of simple inorganic compounds or minerals that are normally extracted from the ground and used as a single mixture.

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b. Organic - derived from a live entity such as a plant or animal [24,25].

Plant Nutrition

Chemical fertilizers are the main source of macronutrients and micronutrients for plant's growth and development. In addition to three prime elements i.e., oxygen, carbon, and hydrogen, plants need a sufficient amount of nutrients [26,27].

These nutrients are classified as primary nutrients, secondary nutrients, and micronutrients (Figure 1). Plants' nutritional requirements are divided into three categories:

a. Primary macronutrients: These are large-scale nutrients that plants require. Carbon (C), Hydrogen (H), Oxygen (O), Nitrogen (N), Phosphorus (P), and Potassium (K) are the six macronutrients (K).

b. Secondary macronutrients: Plants require a large number of secondary macronutrients, although not as many as primary macronutrients. Calcium (Ca), Sulfur (S), and Magnesium (Mg) are the three (Mg).

c. Micronutrients: Plants require very little amounts of them. These micronutrients are just as important as macronutrients. Trace elements are another name for them. Iron (Fe), Molybdenum (Mo), Boron (B), Copper (Cu), Manganese (Mn), Zinc (Zn), and Chlorine (Cl) are seven such micronutrients (Cl).

d. Other nutrients like silicon (Si), cobalt (Co), and selenium (Se).

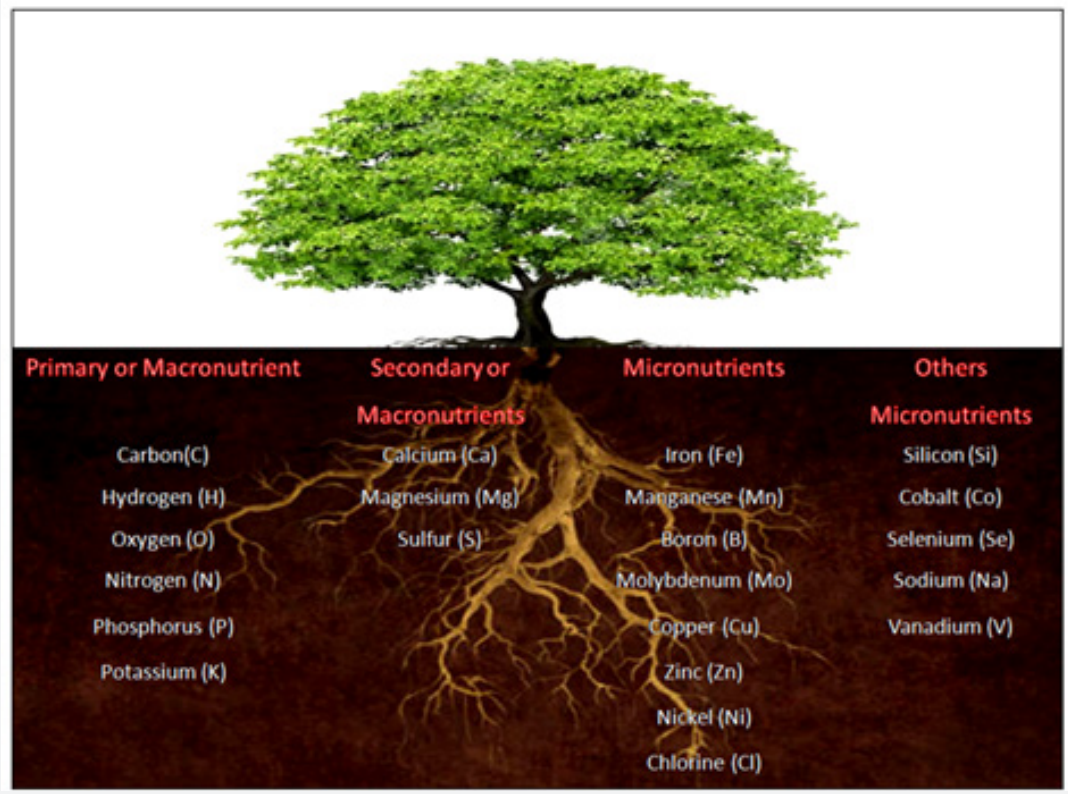

Figure 1: Essential elements required for plant growth.

The six basic macronutrients are needed by all plants. Plants' micronutrient needs can differ. Some plant kinds may not require a specific micronutrient, while others may require more. Plants absorb carbon, hydrogen, and oxygen from the air or water to suit their needs. They get their nutrients from the earth or the leaves by photosynthesis [23] (Table 1).

Types of Chemical Fertilizers

Fertilizers may be defined as materials having a definite chemical composition with a higher analytical value and capable of supplying plant nutrients in available forms. Usually, fertilizers are inorganic (except for Urea and Ca $(CN)_2$ (calcium cyanamide) and solid organic nitrogenous fertilizers). They are obtained from different industries that have less residual effect [27] (Table 2).

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Table 1: List of mineral elements and their important properties [28,29].

Mineral Elements	Important Properties
Carbon: (requirement: 450,000 parts per million or ppm)	Many plant components have carbon as their backbone, such as starch, carbohydrates, and cellulose; It is synthesized in plants, algae, exception cyanobacteria.
Hydrogen: (60,000 ppm)	Hydrogen is also required for the formation of carbohydrates and plants. Air and liquid water are used to make it.
Oxygen: (450,000 ppm)	Oxygen is required for cellular respiration. Respiration enables the plant to generate the energy (ATP).
Phosphorus: (2,000 ppm)	Phosphorus (P) is required for essential plant functions, including energy transfer, root growth, fruiting, and blooming. It is required by plants in a range of mild to high concentrations for the normal growth of fruits and seeds. Phosphorus is the important component of ATP; phosphorus is needed for the conversion of light energy to chemical energy (ATP) during photosynthesis. Phosphorus can also be employed for cell signaling affect the activity of certain enzymes through phosphorylation.
Potassium: (10,000 ppm)	Potassium (K) is involved in activation of a variety of enzymes of respiration and photosynthesis. It also aids with water transport and encourages fruiting and flowering. The opening and closing of the stomata are controlled by a potassium ion pump. Stomata serve as gatekeepers, regulating the flow of chemicals in and out of the body. Necrosis or interveinal chlorosis might result from a potassium shortage (lack of chlorophyll in leaf veins).
Nitrogen: (15,000 ppm)	Nitrogen is a component of all proteins, and it is also required for development and reproduction. Nitrogen is the component of nitrogenous base. Nitrogen (N) is a necessary component of plant compounds, including chlorophyll. Plants and animals cannot use molecular nitrogen from the atmosphere directly, thus it must be transformed into nitrogen compounds like ammonium and nitrate. Both are the outcome of nitrogen fixation caused by lightning and other electromagnetic phenomena in the atmosphere.
Sulphur: (1,000 ppm)	Sulfur is required for plant growth, development and production of energy. It is considered as a secondary nutrient. It is involved in plant defense mechanisms. It provides protection against pests and environmental stress. Sulfur is received as the sulfate ion by plants through their roots because converted to sulfide before being integrated into organic sulfur compounds.
Calcium: (5,000 ppm)	Calcium controls the flow of nutrients into the plant. Calcium (Ca) regulates the transfer of certain nutrients into the plant. It is responsible for the activation of certain plant enzymes. It plays an important role in photosynthesis and plant structure.
Magnesium: (2,000 ppm)	Magnesium is a crucial component of chlorophyll (photosynthesis-critical plant pigment). It is necessary for the synthesis of ATP. It also acts as an effective activator in a variety of enzyme processes. The Calvin cycle's regulation of carbon fixation in chloroplasts is possibly by magnesium. Interveinal chlorosis is caused by magnesium deficiency.
Iron: (100 ppm)	In plants, iron (Fe) serves as a cofactor for enzymes essential for Photosynthesis. Iron deficiency, often known as "Lime induced chlorosis" is a plant condition that causes interveinal chlorosis and necrosis.
Molybdenum: (0.1 ppm)	Molybdenum is a cofactor for enzymes involved in the synthesis of amino acids, as well as in nitrogen metabolism.
Boron:	Boron (B) functions in cell division, pollen germination, fruiting and flowering, and active absorption of salt.
(20 ppm)	It is also important in sugar transport and synthesizing certain enzymes. Boron deficiency causes necrosis in young leaves and stunting like dying growing tips and bushy stunted growth.
Copper: (6 ppm)	Copper (Cu) plays an important role in photosynthesis, plant growth and development. It is necessary for lignin production. Signs of copper deficiency include spiraling of leaves and stunted plants.
Manganese: (50 ppm)	Manganese is required for the formation of chloroplasts. Deficiency symptoms are similar to those of iron deficiency. Manganese deficiency can cause color changes in the leaves, such as discolored patches.
Zinc: (20 ppm)	Zinc is required by a wide range of enzymes involve in DNA transcription. This is commonly seen in organic soils, soils with a high pH, and soils with a heavy phosphorus treatment. The stunted growth of leaves, sometimes known as "little leaf" is a common indication of zinc deficiency.
Silicon (Si)	It increases plant strength, productivity, and health by strengthening of cell walls.
Cobalt (Co)	Cobalt is necessary for nitrogen fixation.
Vanadium (V)	Vanadium (V) is needed by some plants in very low concentration. It may also be used as a substitute for molybdenum.

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Table 2: List of important synthetic fertilizers [32].

S. No.	Synthetic Fertilizers	References
1	Urea	
2	Anhydrous Ammonia	
3	Ammonium nitrate	[20]
4	Urea ammonium nitrate solution	
5	Ammonium sulfate	
6	Monoammonium phosphate	
7	Diammonium phosphate	
8	Nitro phosphate	[30]
9	Ammonium polyphosphate	
10	Single superphosphate	
11	Triple superphosphate	
12	Phosphoric acid	
13	Potassium chloride	
14	Potassium sulfate	
15	Potassium nitrate	
16	Magnesium oxysulfate	[31]
17	Dolomitic limestone	
18	Calcium chloride	
19	Borax	
20	Boric acid	
21	Solubor	
22	Magnesium sulfate (Epsom salts)	
23	Manganese oxysulfate	

Chemical fertilizers are divided into three types based on the primary nutrient requirements of plants. Nitrogenous fertilizer, phosphorus fertilizer, and potassium fertilizer are the three types. Chemical fertilizer consists of elements such as nitrogen, potassium, and phosphorus. These are used for increasing the productivity of land [33,34] (Table 3).

Table 3: Properties and characteristics of chemical fertilizers [35].

Nitrogenous Fertilizer	Phosphorus Fertilizer	Potassium Fertilizer
Ammonium chloride, ammonium sulfate; amide, urea; nitrate, and calcium ammonium nitrate are all examples of ammonical nitrogen. For nitrogen-deficient plants, this is the most effective fertilizer. It is a source of nutrients for both plants and soil.	Phosphate is obtained from phosphate fertilizers. They are an important source of fertilizer for the land. In comparison to nitrogen fertilizer, they have a lower demand.	Potassium is obtained from muriate (potassium chloride) and potash sulfate. Potassium sulfate is required for plant growth to be healthy. Potassium assists in the synthesis of glucose in plants. Potash is separated into two types: non-chloride potash and chloride potash. Potash in non-chloride forms, such as sulfate and muriate, and potash in chloride forms, such as sulfate and muriate.
Characteristics		

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Ammonium sulfate is more powerful than urea in terms of nutrient absorption. Nitric nitrogen was employed during the start of the paddy plant's reproductive cycle. The paddy plant can use up to 30% of total ammonium nitrogen. During the wet season, nitrogen fertilizer is helpful.	The combination of phosphate and nitrogenous fertilizer improves the plant's absorption efficiency. For acidic soils, rock phosphate and basic slag are best. Phosphate compost, such as superphosphate, is placed near the crop root region or in the soil layer. Superphosphate can be used in soils that are neutral to alkaline. It's planted in the roots of fruit trees like apples and citrus.	It is suitable for all crops and can be used on a wide range of soils and it increases plant resistance for several crops, such as fruit trees and potatoes, potassium sulfate is preferred to potassium nitrate. It is water soluble, dissociates into K+ ions, and is consumed in the soil. The plant eventually absorbs it.

Advantages of chemical fertilizer

a. Chemical fertilizers are employed to restore soil fertility.

b. Fertilizer improves nutrient status and the environment of the soil.

c. It enhances the power of stability in plants against wind and natural disasters.

d. It increases the growth rate and crop yield.

e. Plants get all the nutrients from chemical fertilizer in equal proportion.

f. Chemical fertilizers are water-soluble; they can be absorbed readily.

g. The unnecessary component is not found in chemical fertilizer.

h. Improve and enhance plant growth and development.

1.1. Drawbacks of chemical fertilizer

i. The quality of soil and plant health will be affected by improper use of the chemical.

ii. It contains some elements that disturb the soil properties such as soil pH and water holding capacity.

iii. It is needed in excess amount in agriculture and is very costly for poor farmers.

iv. It decreases the excretion of nitrate through plants into the soil for the improvement of soil microflora.

v. It spoils the organization and texture of the soil due to the absence of organic material.

vi. Soil-dwelling organisms earthworms make the soil fertile are also destroyed due to improper application of chemical fertilizers.

vii. Some nitrogen fertilizer is toxic to both animals and humans [34].

Differences in Natural and Synthetic Fertilizers

Plants and soil benefitted from natural fertilizers made from organic sources. Plants wouldn't be burnt or harmed by it. Natural fertilizers come from organic sources like compost, bat guano, manure, seaweed, blood meal, and plant and animal components and leftovers. Naturally produced nutrients may encourage beneficial soil microorganisms and enhance the soil's structure and texture. In order for plants to access simple forms of nutrients, complex organic compounds must first be converted by soil bacteria. The macro- and micronutrients that are typically lacking in synthetic fertilizers can be provided by organically generated fertilizers in accordance with the nutritional needs of plants [36,37].

Table 4: Types and important characteristics of organic fertilizers [38].

S. No.	Organic Fertilizers	Characteristics
1.	Manure	It is made from animal excreta (cow dung & goat droppings). Cattle Manure is a superb source of nitrogen and organic carbon even as goat manure is wealthy in nitrogen and potash.
2.	Compost	It is available through composting and decomposition of organic matter such as vegetable and plant waste, and animal excreta.
3.	Rock Phosphate	It is a sedimentary rock that contains a high amount of phosphate minerals. It is used naturally to fix the phosphate level in the soil.
4.	Poultry litter	It is a great and minimal expense compost. It is comprised of chicken waste and sawdust. Poultry fertilizer contains both miniature components and full-scale components. They are utilized for the molding of soil than substance composts. After land use of litter reuse supplements and natural make a difference to the dirt, building soil fertility and quality.
5.	Bone Meal	It is a mixture of slaughterhouse waste products like animal bones and slaughterhouse waste products. It is an excellent source of phosphorus and amino acids. It is used as an organic fertilizer for plants and a nutritional supplement for animals. It is a slow-release and active fertilizer.
6.	Vermicompost	It is a species of worms, especially red wigglers, white worms, and other earthworms, to produce a heterogeneous mixture of decomposing food waste.

(Source 44)

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Nitrogen, phosphorous, and potassium levels in naturally produced fertilizers are typically lower than those in synthetic fertilizers, yet they still need to nourish plants (Table 4).

Plants have no mechanism to distinguish between organic or synthetic fertilizers. They are quick boosters of nutrients and responsible for the fast growth of plants. They are also improving soil texture and long-term soil fertility. Synthetic Fertilizers are "Man made" inorganic compounds - usually derived from by-products of the petroleum industry. Synthetic fertilizers are water-soluble and well-known for being fast-acting. They are available in a variety of forms such as liquid, pellet, granules, and spikes. So, they are easily absorbed by plants. Examples of synthetic fertilizers are ammonium nitrate, ammonium phosphate, superphosphate, and potassium sulfate [38]. Synthetic fertilizers do not support microflora present in the soil. The application of a synthetic fertilizer kills a significant percentage of beneficial microorganisms. These tiny creatures are responsible for breaking down organic matter into a stable alteration for improving soil quality and fertility. It is short-lived, which can cause rapid growth at the expense of developing a strong root system. It may give results in 1–2 weeks [39] (Table 5).

Table 5: Difference between organic and synthetic fertilizers [40,41].

Quality	Organic (Natural)	Synthetic (Chemical)
Expenditure	More expensive than synthetic fertilizers. Available in small bag size, economical and enough for the home garden.	Cost-effective except Controlled-release pellets are more expensive. Synthetic fertilizers are readily available in greater amounts.
Nutrients	It contains nutrients in raw form. Micro and macronutrients are typically present. It also provides a little number of trace nutrients.	Nutrient amounts are highly accurate. A mixture of nutrients can be formulated for specific needs. High nutrient concentration in the soil leads to leaching and run-off. It contains water-soluble iron and not contains necessary micronutrients.
Nutrient Supply	Nutrients are supplied according to the plant's needs. It reduces the chance of leaching or run-off. Microflora in the soil ecosystem breakdown the organic material and supply the necessary nutrients. It promotes stronger root growth for better disease and insect resistance.	Synthetic fertilizers give lawn and garden. It is short-lived which can cause rapid growth at the expense of developing a strong root system. It may give results in 1–2 weeks. Nutrients are water-soluble. So, it was released very quickly. It is available in a variety of forms such as pellets, granules, liquid, tablets, spikes, and controlled release.
Effect on Soil	Provide a healthy soil ecosystem by supplying organic material, which is obtained from the decomposition of complex sources such as dead plants, animals, and insects, etc. Improves soil texture, which increases water retention, particularly important in drought conditions.	Synthetic fertilizers supply very little to the ecosystem or structure of the soil. It may decrease soil fertility due to chemical nitrogen stimulating excessive microorganism growth and reducing the organic matter in the soil.
Plant Safety	Do not burn plant leaves or roots. Manure should be composted for the greatest safety.	Incorrect and overapplication may burn plants due to high concentrations of chemical nutrients. It can cause excess top growth and stress roots.

(Source 40,41)

Effects of Synthetic Fertilizers on Plant Nutrition and Health

For appropriate growth and development of plants require 16 key nutritional elements in which 13 elements are provided by soil. Primary nutrients include nitrogen, phosphorus, and potassium (NPK), which are required in the largest proportions [13]. Continuous crop cultivation in the same soil has resulted in the depletion of nutrients stored in the soil. This is controlled by the supply of chemical fertilizers (NPK) into the cultivated soil.

Successive increase in population, rising food demand in near future resulting in consumption of chemical fertilizer has continuously increased with time. Several reports are available on the use of chemical fertilizers at the global level. The consumption of fertilizer has increased for arable and permanent crop areas from 79.29 tones/1000 Ha in 2002 to 98.20 tones/1000 Ha in 2010. The demand for total fertilizer has been increasing further at 1.9 % per annum from 2012 to 2016. According to FAO, China and India is the world leading consumer of chemical fertilizers while the highest production of the same is reported in China, USA, and India (FAO 2012). So, fertilizers may be seen as a requisite part of modern agriculture [42,43].

Long-term application of NPK-based fertilizers has a significant impact on soil biochemical properties, which leads to

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microbial population changes. Due to the long-term application of fertilizer in a range of crops such as wheat and corn, changes in soil organic carbon, nitrogen concentration, pH, and moisture alter nutritional availability to microorganisms [3]. In contrast to chemical inputs, natural biofertilizers positively impact soil characteristics and functions. These natural inputs are more likely than chemical fertilizers to increase organic carbon and nitrogen content, resulting in greater microbial populations (Figure 2).

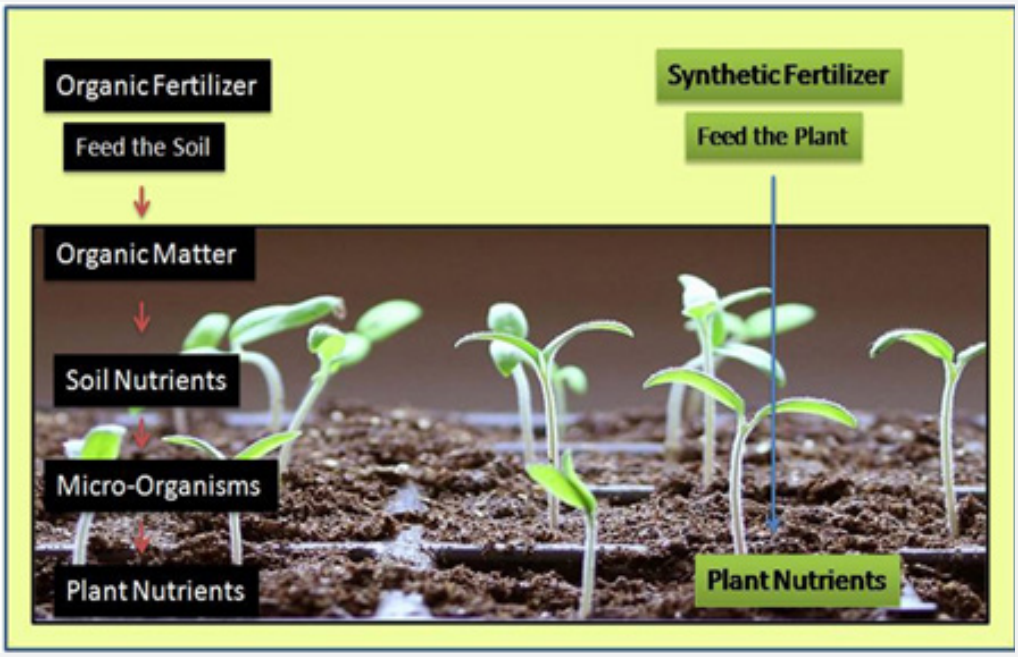

Figure 2: Exploitation of synthetic and organic (Natural) fertilizers.

A sufficient supply of key minerals and nutrients is critical for soil fruitfulness and vegetation. Excessive fertilizer usage generates a nutrient supply imbalance in the soil, resulting in continuous soil deterioration. Continuous application of Chemical fertilizers speeds up plant growth resulting in poor root and stem development, as well as nutrient-deficient crops and fruits. In these circumstances, the chances of survival of growing crops are lower and more vulnerable to the attack of pests and associated diseases. Furthermore, chemical fertilizers prevent crops from getting enough water, resulting in root or fertilizer burn [44]. The major drawbacks of Synthetic fertilizers are hazardous for land fertility and their worth. Thus, Organic (natural) fertilizers can help improve the quality of soil fertility and enrich new minerals such as nitrogen, carbon, hydrogen, phosphate, sulfur. While synthetic fertilizer is to harm soil fertility and affects humankind [45,46].

Conclusion

Applications of chemical fertilizer are one of the most serious consequences of Environmental deterioration. Chemical fertilizers are the most essential component of farmed fields. These agricultural practices have been significantly impacting soil quality. Excessive use of chemical fertilizer resulted in massive soil pollution. Chemical fertilizers may harm soil attributes, nutrient content, dominant soil species, structural and functional diversity of microbial communities, soil enzyme activity and many other factors [8].

It may be inferred that the use of chemical fertilizers in excess amounts for an extended period has a variety of unhelpful impacts on the soil micro-flora of agricultural ecosystems. Organic fertilizers have been established as favorable soil amendments that improve the overall quality and fertility of the soil. The applications of organic (natural) fertilizer have contributed to sustainable agricultural practices.

Recently, bio-fertilizers have emerged as an alternative to synthetic fertilizers. They have the potential ability to utilize CO_2, water, and nutrients to convert solar energy into biomass. The overall study stated that biofertilizers can be utilized for improving the quality of food products, physicochemical properties of soil, controlling soil-borne diseases, added organic matter, release growth-promoting substances, solubilize the insoluble phosphates, use as nutraceuticals, and also applied in pharmaceuticals. Hence, biofertilizers prepared from organic

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compounds are economical and environmentally friendly. Hence, organic fertilizers are drawing better inputs in the agriculture field because they are commercial as well as environmentally pleasant options to move forward with a sustainable approach.

Conflict of Interest

The authors have no affiliation with any organization with a direct or indirect financial interest in the subject matter discussed in the manuscript.

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