EFFECT OF PESTICIDE AND FERTILIZER ON THE SOIL

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Abstract

Soil Conservation quality is critical for long-term crop production and biodiversity sustainability. Chemicals and fertilizers are inevitable in modern agriculture. Even though they are still significant assets for universal food security, those negative consequences must be considered, predominantly when justifiable agriculture is the primary goal. Fertilizers and pesticides have a long shelf life in soil and are known to degrade soil quality by killing soil microflora. Microflora present in the soil is an essential constituent of agriculture based environments which helps to boost soil fertility and crop productivity while also regulating simple soil processes. Soil microorganisms are traditionally utilized as bio-indicators present in the soil activity and quality. These factors, beside the special effects of pesticides and fertilizers, such as poisonousness and a change in the soil's substrate availability profile, result in an indirect shift in soil microflora population dynamics. We discuss the long-term effect of fertilizers as well as pesticide practice on cultivated soil microflora in terms of soil quality and viability, soil persistence, and toxicity factors in this paper and the discussion about the possibilities of the alternatives to these chemical pesticides and fertilizers in the near future for lesser harm to the soil and environment

Key words: Agriculture, Fertilizers, Microflora, Nutrients, Pesticides, Soil.

Introduction

In the modern age, agriculture is completely reliant on fertilizer and pesticides. Chemical pesticides or fertilizers have unquestionably contributed to the greatly needed enhancement as well as constancy of farming products over the few centuries. to effectively fight diseases and pests, as well as to provide adequate supplies of required plant nutrients. They have, however, reached a point where issues like P. Prashar's and S. Shah's human and environmental well-being, ecosystem balance, and soil biodiversity conservation must be tackled alongside the challenge of balancing the world's rising food demand.[1]. Soil microflora, which includes fungi, algae, bacteria, viruses, and protozoa, is an essential constituent of the agro-ecosystem and is accountable for a variety of vital and fundamental soil functions, including fertility of soil, increasing yield of plant via increased accessibility of inadequate nutrient, nutrient steering and putrefaction of both inorganic as well as organic matters. Soil microflora, which includes algae, protozoan, fungus, bacteria and viruses, is an important element of agro environment and is accountable for a number of essential and fundamental soil utilities, including nutrient cycling, soil fertility, increasing plant efficiency by enhancing the accessibility of scarce nutrients, and inorganic or organic matter decomposition. Soil microbes improve physical soil properties including water penetration structure, absorbency, and ventilation, by developing and alleviating soil groups. [2]. In addition, the soil microbial population is critical in pursuing environmentally sustainable activities such as biocontrol, which uses bacteria to detoxify soils that have been contaminated with pollutants and unwanted components. pathogens in plants[3].

Literature Review

Fertilizer and pesticide amendments have a significant impact on a variety of soil purposes and belongings, including sworn rhizome-testimony, nutrient contented of majority moisture, rhizospheric soil, pH, activities of soil enzymes and soil organic carbon and many others. The Figure 1 below clearly explains the functions of soil microflora.

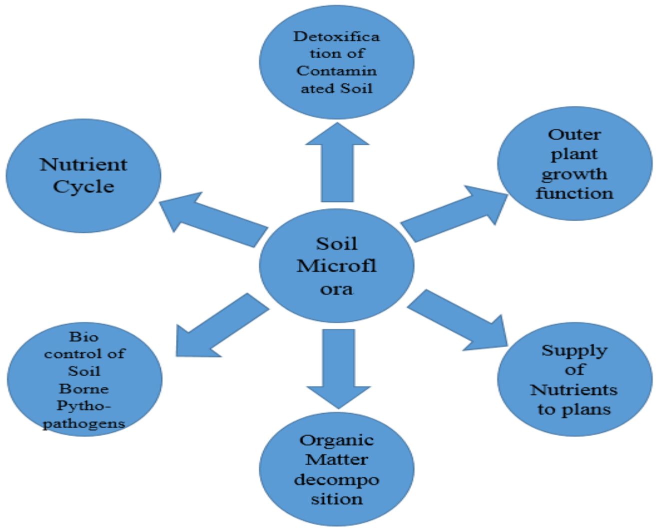

Figure 1: Functions of Soil Microflora in the Soil Fertility and Good Growth Factors

1.1. Soil-Composition

Soil- a living, complicated, also a versatile ecosystem that supports/harbors a diverse range of micro and macroflora, both of which affect its properties. It is made up largely of inorganic mineral nutrients and organic matter, as well as a large number of living organisms, and it retains a mixture of physical, chemical, and biological influences[4]. Soil is the foundation of agriculture and, as a result, of all food makings. Other than this, its most distinguished purpose as a plants' medium for development, it serves a variety of other essential functions, including gas exchange, steam, nutrient and water flow, pollutant detoxification, and so on.

As a result, soil fitness administration is critical for guaranteeing long-term agrarian production and maintaining soil's variety, including microbial diversity. The black box of variety of microbes is the soil. It is the most abundant and favorable environment for bacteria, fungi, protozoa, algae, and viruses, among other microorganisms. As a result, preserving soil quality, including microbial diversity, is crucial for ensuring long-term crop production and maintaining soil biodiversity. The soil is the microbial diversity's black box. It is the most abundant and favorable environment for bacteria, fungi, protozoa, algae, and viruses, among other microorganisms. Cultivated soils have a greater diversity and quantity of microflora. When the genome size of Escherichia coli is taken into account, soil contains about species to be exact 104 microbial/gram, and Torsvik et. al found around distinct bacterial 6000genomes/gram of soil in a culture-independent study[5]. However, advanced logical methods have recently revealed that soil's one gram of can contain up to one million prokaryotic genomes. Figure 2 here is explaining further parameters required for the soil to remain usable in a specific order of its quantity and growth.

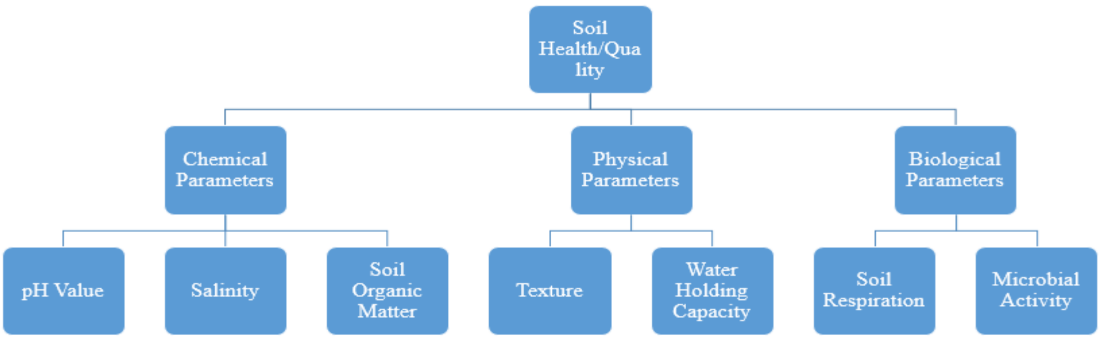

Figure 2: Fertility Parameters of the Soil on which Growth is Dependent

1.2. Fertilizer

Plant requires about sixteen basic components for standard yield and development, 13 of which are delivered by soil. Plants require the highest concentrations of phosphorus, potassium, and nitrogen as primary nutrient parts. Continuous crop production depletes nutrient stores in the soil, which must be replenished on a daily basis to sustain supply. Chemical fertilizers like primarily potassium (K), nitrogen (N), and phosphorus (P) are the most popular method for providing nutrients to cultivated soils. India and China are the worlds' top users of chemicals' fertilizer/Pesticides, whereas China, the United States, and India, in that order, produce the most of the same fertilizers. As a result, fertilizers can be used as an essential fragment of modern agricultural practices.

Use of phosphorus, potassium, and nitrogen fertilizer for long period alters soil biochemical properties, causing microbial population changes. Long period of fertilizers usage in a variety of crops has resulted in disparities in soil organic carbons (SOCs), moisture, pH value, and nitrogen (N) content, as well as microbe nutrient supply. In comparison to chemical input, organic soil additives have been shown to improve a wide variety of soil functions and properties. Organic input, rather than chemical fertilizers, tend to increase SOCs and N contents, resulting in greater microbial diversity. Sradnick et al. described the source of soils' SOCs contents and pH variations because of fertilization as differences in the catabolic profile of microbes living in soil in a sand type soil which have been subjected to mineral fertilizers for longer period of time and cattle manures' treatment.[6].

1.3. Positive Effects of Fertilizers

Increased SOC, elevated nutrient concentrations such as Nitrogen, Potassium, and Phosphorus, and improved crop yields, all of which influence rhizodeposition, have been identified as indirect effects of increased SOC, elevated nutrient concentrations such as Nitrogen, Potassium, and Phosphorus and improved crops yields, all of which influence rhizodeposition. Afterward a thirteen-year management of paddy soils by inorganic phosphate fertilizer for water-logged double paddy crop, Zhong and Cai confirmed a encouraging stimulation of several soil parameter[2]. As compared to those who did not obtain P fertilization, the amount of microorganism, biomass of microbial, as well as population practical variety all improved significantly. Simultaneously, researchers discovered that nitrogen application had a positive impact on microbial diversities, activities, and rice crops' yields only when plenty of P was available, whereas K had no adverse/after effects on paddy crop produce or microorganism bounds. Bhattacharyya et al. found that 39 years of NPK fertilizer application had a positive effect in a tropical flooded rice region [7].

They discovered that, while continuous application of chemical fertilizers increased greenhouse gas emissions and the potential for global warming, it had a positive effect on soil fertility by growing C and N reservoirs, microbial communities, and soil enzymatic processes. Chemical fertilizer have been representing to have no major environmental effect in the microbials' physiognomies agricultural soils[8]. There's found no discernible variance found in the microbial biomass or functional diversity when black colored soils in Northeast part of China were open to various variations of chemical NPK fertilizers over a long time. Furthermore, it was discovered that the functional variety of plants increases as the fertilization dosage is increased, i.e. two or three times the fertilizer-treatments. However, the general presentation of organic fertilizers beneath all conditions is continuously greater than these chemically charged fertilizers.

1.4. Pesticides

Plants diseases are being one of the foremost common reasons for loss of crop loss worldwide, posing a serious threat to global food security. Pest-induced plant diseases cause nearly 10% to 15% of the world's main crops, such as wheat, corn, potato, and maize, to lose yield each year. To date, the most popular way of controlling phytopathogens has been to use organic pesticides. As a result, their intake has been steadily increasing for decades. Pesticide usage in farm soils has increased significantly since the turn of the century, in order to minimize pest-related crop losses and meet rising food demand. Asia is the world's leading in producing pesticides, followed by Europe, and China is the world's leading pesticide producer and user, narrowly tailed by the US. Pesticides are poisonous, bioactive compounds that affect soil fertility and agro-ecosystem quality directly or indirectly. As per stated by United Nations' Food and Agriculture Organization (FAO), pesticides comprise insecticides, fruit thinning agents, defoliants, nematicides, herbicides, fungicides, rodenticides, plant growth regulators, desiccants, agents to prevent premature fruit fall, and chemicals added post-harvest to avoid seed damage during storage or shipping [9].

According to the FAO, pesticides include defoliants, insecticides, fruit thinning agents, nematicides, herbicides, fungicides, rodenticides, plant growth regulators, desiccants, agents to avoid premature fruit dropping, and chemical functional after harvest to avoid seed damage throughout shipping or storage [10]. Though, arrangement founded on the chemical arrangement of the active particle provides a plan of the properties, conduct and natural surroundings of these pesticides.

In theory, a pesticide shouldn't damage any further soil species than targeted, have a limited time of action, be inexpensive, and biodegrade quickly. The vast majority, on the other hand, have chronic and acute toxicities as well as are classified as biocide, meaning they will damage all living things except the target insect[10]. Many of them can infiltrate soil microbe cell walls, disrupting the usual metabolism and causing apoptosis. In addition to their well-known negative consequences, such as soil and water degradation, entry into the food chain, and health effects on higher organisms, pesticide have recently been recognized as a major danger to soils' natural as well as bio-diversity ecosystems, like humans, the growth of unaffected insect diversities [11].

The effect of pesticide on soils' organisms are a main concern. Pesticides can be transformed in soil by a number of chemical, biological, and physical, processes, as a result, soil microbes can be thought of as biological agents in the transfer of toxic pesticides that have accumulated in the soil biome. Also, given soil microorganisms' soil clean-up capability and their important position in a variety of main soil processes, it's important to investigate the effects of longer period, persistent usages of chemically active pesticide are systemic and functional makeups of agriculture purpose lands' micro-flora.

1.5. Pesticide-Degradation

Pesticides in general, are poisonous/xenobiotic by their natural existence, and they destroy a large amount of microbes present in them. The continued use of toxic chemical in the earth causes stress, that allows local microbial species to adapt and establish tolerance. Toxic chemicals are broken down in to non-toxic compound and, in few other circumstances, back in their actual element[12]. Microbial activity, especially that of bacteria and fungi, is the most common mode of pesticide deprivation in soil. Pesticides can be converted or destroyed by soil microbes and used as a source of energy or nutrients.

Discussion

2.1 Fertilizers' Effects on Soils' Properties

Practical variety of soil microbes was found to be greater in treatment by manure soil equated to minerals fertilized soil based on population level physiological profiles. Alkaline phosphatases, - proteases, dehydrogenases and glucosidases, are all markers of soil fertility and microbial development. Usage of organic manures for long period has been shown to enhance dehydrogenase activity (DHA) and microbial biomass, while NPK (Nitrogen, Phosphorus, and Potassium) fertilizers have no such impact. Additionally, copper, which is typically present in soil as a consequence of irrigation or the implementation of fertilizer or pesticide, has been found to have a negative impact on soil dehydrogenase activities, with this effects being extra pronounced in NPK treatment soil equated to treatment by organic manures soil. Similarly, treatment by organic N has been shown to induce the functions of extra soil enzyme such as urease and saccharide, in contrast to mineral fertilization. Organically fertilized soils had substantially lower enzyme activities than soils which is fertilized inorganically cyclically planted along with clover and barley[13]. Thus, it could be determined in accumulation of NPK-fertilizers commonly incline to decline the accomplishments of mostly every soil-enzyme.

2.2 Fertilizers' Effects on Soils' Micro-flora

Fertilizer are intended to improve the nutritional contents of soil to enhance crop yield, and as a consequence of increased rhizodeposition, crop residue dropping and root-turnover, they are associated for increasing SOCs, boosting microbial activity. The availability of resources as N, P, and C control the functional diversities of the soil micro-organism communities, which has been well studied. As a result, there is a close link in between microbial cultures, and SOC as well as microbial processes[14]. This clearly demonstrates that the form and composition of fertilizer used has a major effect on cultivated land microbial population structure

Inorganic fertilizers, on the other hand, fall short as opposed to organic amending products in this regard. Though fertilized soils have higher overall microbial numbers than untreated soils, organic composts modified soil that have been treated by chemical fertilizer for a prolonged period of time have a greater effect. Several studies have shown that organic manure treated soil have substantially higher increases in organic carbon content, microbial organisms, and behaviors than in-organic fertilizer treated soil in crop such as mustards, cottons, tobaccos, wheat & maize [15]. Furthermore, the bacterial population composition of organic manure-treated soils resembles that of untreated soils more closely than that of inorganic NPK fertilizer-treated soils. for enough long time-periods, and is much more uniformly spread.

Also, chemical Fertilizers reduced of bacteria's gram negative strength, which comprises numerous plants-friendly bacteria like Pseudomonas, whereas organic amendments promote the development of bacterial populations similar to those found in untreated soils in rice and wheat crops. Another benefit of organic fertilization is that it eliminates the bioavailability of toxins in soils such as heavy metals and pesticides. Chemically powered manures inclined to create complex pollutant, reducing their bio-availability, in addition to can soil organic matter quality. The toxicity of those heavy metals along with the pesticides like cypermethrin and cadmium on soils' microflora microorganisms in soils preserved with inorganic fertilizers were more susceptible to these pollutants than microorganisms in soils cured with organic sustained manures. Microbial organisms within organic-fertilized agricultural ecosystems have been found to be more numerous and functionally complex than those in inorganic-fertilized agricultural ecosystems over long time intervals in a number of crops [15][6].

Furthermore, fertilization regimes have a major impact on the overall bacterial population composition in agriculture soils. A change in physical variability and the leading bacterial classes of agriculture soil was observed as a result of long period application of inorganic fertilizer of various forms, like Nitrogen, Nitrogen and Phosphorus, or any other organic manure and diverse emerging crop's phases. Chemical fertilization frequently causes nutrient channels or patches to form in the soil, resulting in nutrient gradients that affect microbial communities. As a result of N-gradients produced by chemical fertilizer like ammonium sulphate or urea, soil microorganism biomass and microorganism functional variety have increased.

So, despite the fact that co-abundance and heterogeneity of diverse species in rice soils with high useful multiplicity, management activity and farming type had no significant impact on the microbial and functional populations of the rice, co-abundance and heterogeneity of different species existed in rice soils with high functional diversity. To summarize, chemical fertilizers alter the systemic and functionally made composition of soil's microbial population, as well as the dominant soil organisms, in a significant way. Furthermore, as opposed to chemical fertilizers, organic ones are more attractive and soil friendly choice for increasing the nutrient content of agricultural soils.

2.3 Persistence of Pesticides in Soil

Since chemical remains are quickly processed or adulterated in dynamically evolving alive systems rather than in comparatively stagnant soil systems, pesticides appear to survive for longer periods in soil than in plants or animals. The pesticides' persistence within the soil is influenced by a diversity of factors like soil, climate, and the pesticides themselves. Chemical composition, volatility, water solubility, preparation process, and application method are some of the pesticide's properties. Pesticide behavior and fate are also affected by soil types, invertebrates and clay content in the soil, hydrogen ion concentration, soil microflora diversity, and organic matter. Aside from that, environmental influences such as precipitation, temperature, and the ultra-violet rays of the sun can influence chemical pesticide degradation in soil. [16].

2.4 Factors Affecting Pesticide Toxicity

A pesticide's toxicity is determined by a variety of biotic and abiotic conditions in the soil, in addition to its chemical composition. Since different soil creatures react to the same pesticide in different ways, the creature is the most significant biotic-parameter. Pesticide toxicity is most affected by the application dose. However, the toxicity and remaining soil absorptions surge as the initial performance dosage is increased. Variations in soil microbial parameters have been shown to be caused by a variety of culturing methods, bacterial population-level substrate utilisation activities, Community Level Catabolic Profiles (CLCP), and Phospholipid Fatty Acid (PLFA).

The harmful effects of pesticides on microflora are also influenced by soil characteristics. In humus-rich chernozem soils, the herbicides glyphosate avoided the dominant soil bacterias, while in glycol-kind soil, whereas the endogenous micro-flora is defined by eubacterias, glyphosate promoted the progress of such organism. In glyphosate-treated soil, microbial parameter like fluorescein diacetate hydrolysis, respiration of soil and utmost likely quantity count responded very firmly. Overall, the amount of actinomycete and fungi increased, whereas the number of bacteria decreased slightly. As a result, it is possible to conclude that long-term use of a chemical agents results in more pronounced effects along with lasting improvements in the systemic soil microbes' diversity.

2.5 Soil Fertility's Effects on Pesticides

Soils' microflora is vital for many ecological processes, including maintaining and improving nutritious deliberations of essentials like phosphorus and nitrogen present in soil. As a consequence, regardless of the cause, any alteration in the microbial population composition of agricultural soil is certain to distress complete soil potency. As previously reported, pesticides treatment has a direct effect on soil microbial properties, which has resulted in increased soil fertility.

In a review, at a dose of 1500 mg/kg of soil and a 28-day exposed period, the population of nitrifying bacteria in fungicides dimethomorph treated soils and mancozeb was found to be significantly reduced. In certain cases, pesticide treatment has a direct effect on soil microbial properties, and as a result, improvements in soil quality have been observed. The inhabitants of nitrifying bacteria in soil treated with the fungicides dimethomorph and mancozeb was significantly reduced at a dose of 1500 mg per kg of soil and a 28-day revelation period. Insecticide diazinon and herbicide linuron had a similar but less pronounced effect. At the same dose and exposure duration, the same three pesticides almost similarly inhibited populations of N2-fixing bacteria. Ethalfluralin therapy blocked the functions of soil dehydrogenase and amylase at the same time [17].

Conclusion

According to an FAO survey, the global population at a rate of about 160 humans/min, and by 2050, we need to generate 70percent more food resources to feed an extra 2.3 billion strength of people. Agriculture is the most basic method for meeting humanity's food needs, and soil is the only way in which agriculture can be practiced. To meet the world's food needs, maintaining soil quality and fertility is crucial. The development of new and improved crop varieties, as well as the utilization of based on chemical agent to increase fertilizer supply and protect crops from all types of pests, has been a key response. This consequence in modern farming is technologically intensive, chemical-intensive, and capital-intensive. Whereas it has largely met the food demand, it has resulted in a slew of environmental, social concerns and financial. Pollution is among the most serious consequences of this technology and chemical rigorous farming. These farming activities have had a significant impact on soil, which is the most fundamental component of cultivated fields.

Soil pollution has resulted from the overuse and misuse of chemical fertilizers and pesticides. High levels of poisonous, non-toxic, and permanent chemical pesticides and fertilizers, as well as any alters in soil properties induced by these inputs, have an effect on the biodiversity of habitats in nurtured fields. Chemical pesticides and fertilizers have an effect on soil resources such as nutrient quality, dominant soil organisms, microbial structural and functional diversity, soil enzyme activity, and a number of other factors.

Both situations can have a variety of consequences, from temporary changes to long time period, permanent shifts. Chemical inputs tend to have immediate benefits, such as improved crop yields due to increased nutrient availability and successful pest control, but their long-term use alters soil microbial communities significantly. Otherwise, manures, biocontrol agents' and chemical fertilizers, have been recognized as beneficial soils' additives that improve overall soil quality and productivity, resulting in long-term agricultural practices. Organic amendments, dissimilar to chemical responses, are both cost effective and environmentally friendly alternatives for moving forward towards a sustainable solution.

Since microbial communities are such a significant connection in composite soils' environments, changes in their arrangement and alignment are certain to have a significant effect on many soil functions and natural food webs. Around the same time, the microbial ecology of agricultural lands is intimately related to soil quality and fertility. As a result, changes in soil microflora composition and properties can pose a long-term threat to global food security. As a result, it's reasonable to conclude that using chemical fertilizers and pesticides in large quantities and over a long period of time has a variety of harmful side-effects over agricultural ecosystems' soils' microflora. Most garden centers and greenhouses have a variety of natural fertilizer alternatives that use natural materials to enrich the soil such as:

- Bone meal is a byproduct of the meat production industry made from roasted animal bones. It's an abundant calcium and phosphorus' source for fertilizing-bulbs, trees, and shrubs in soils with a pH of less than 7. Since phosphorus moves slowly through the soil, it's best to use bone meal at the plant roots at the bottom of planting holes.
- Cottonseed meal is mildly acidic, with a nitrogen-to-phosphorous-to-potassium (NPK) ratio of 7-3-2 in most cases. In warm soils, the nutrients in it are readily accessible to plants, and there is no chance of nitrogen burn, which is a frequent side effect of chemical fertilizers.

While manure is a full fertilizer, the NPK ratio varies depending on the animal source. Fresh manures have a higher rate, but they should not be added to plant roots. Application rates differ a lot, so double-check the sticker for the correct numbers. Any manure is spread at 500 pounds/1,000 sq. ft., and others are applied at 70 pounds/1,000 sq. ft

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