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Impact of Pesticide Residues to the Soil Health

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ARTICLE ID: 26

Introduction:

India's population has increased quickly, especially since gaining independence, which has forced the nation to heavily increase its agricultural output in order to meet its own food demands and maintain its independence. Apart from meeting the country's food requirements, the ultimate goal of this development was to commercialize a significant industry that employed many of its residents. Ensuring food safety across the country required establishing the necessary procedures to boost agricultural output. This gives India, which was a part of the Green Revolution in the 1960s, the opportunity and the demand for the commercial introduction of insecticides and high-yielding cultivars. For many years, farmers all around the nation used pesticides recklessly due to a lack of knowledge at the time. Numerous detrimental effects are caused to the ecology, the health of the soil, and living organisms by these actions. Pesticides not only harm the health of the soil but also persist in it for years or even decades after application. The term "pesticide" includes insecticides, herbicides, nematicides, acaricides, rodenticides, bactericides, fungicides, insect repellents, disinfectants, and so on. The continued use of dangerous pesticides threatens the healthy soil ecosystems necessary for sustainable food production. Pesticide characteristics including solubility in water, tendency to adsorb to the soil, persistence, and soil characteristics like sand, silt, clay, and organic matter are important for controlling the fate of the chemicals in the environment. Numerous techniques can be used to get pesticides into the soil, such as granule release, washing off treated foliage, spray drift during leaf treatment, direct application to manage soil pests, and release from treated seed. The pace at which a pesticide breaks down in the soil, or its half-life, is used to measure how persistent it is there. Since half-life tells us how long a compound will stay in its original form in water or soil, a compound with a longer half-life is more likely to

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leak through soil. Pesticides typically attach themselves to soil particles strongly and can remain in surface soils for several months or even years. Although persistent pesticides are effective at managing pests over the long term, they have harmful and negative effects on the flora and fauna of the soil. They also pose a risk to the ecosystem's long-term toxicity. The amount of residual pesticide in soils is influenced by several factors, including plant development stage, number of applications, and soil properties. Furthermore, pesticides have an effect on the biochemical processes in soil that are driven by enzyme reactions and microbial metabolism. They may have a detrimental effect on the biotransformation of organic molecules by changing the kinetics and bioavailability of nutrients through enzymatic activity and advantageous soil microorganisms.

Effect of Pesticides on Soil Properties:

Pesticides are impacted by a multitude of factors after coming into contact with the soil, including the rate of adsorption, organic matter, soil texture, microorganisms, and moisture availability. The likelihood that pesticides will be adsorbed is influenced by the quantity of clay and organic matter in the soil; the more of these materials there is, the more positive and negative charge sites they have, increasing the number of adsorption sites. Pesticide persistence and leaching are impacted by this. It also lessens the chance that a pesticide would leak into the ground and leave behind residues that will remain dormant for extended periods of time. Pesticides frequently have a longer half-life in soils that include a lot of clay and organic matter. In the event of pesticide contamination, the soil serves as a reservoir from which the chemicals can break down, seep into the air or water, get into the bodies of invertebrates, or be taken up by plants. Pesticide residues have an adverse effect on the beneficial soil microorganisms and the biotransformation that takes place in the soils.

Effect of pesticides on soil biological properties:

Insect population declines are caused by widespread use of pesticides. Tens to hundreds of millions of organisms can be found in a little bit of soil. These organisms help the ecosystem do essential tasks including controlling pests and illnesses, breaking down dead plants and animals to produce new life, and cycling nutrients that plants need to develop.

Effects on arthropods:

Whether sprayed directly or indirectly, pesticides act as a sink or reservoir in the soil. Earthworms aid in the breakdown of organic waste, enhance soil aeration, and increase the

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amount of nutrients in the top layer of soil. Earthworms support human health by feeding on decaying trash and serving as a bioindicator of soil fertility. By eliminating the flora that earthworms ingest, certain pesticides can kill them and so indirectly reduce the population. In the rice-maize cropping system, imidacloprid, chlorpyrifos, and phorate were all toxic to earthworms.

Effect on snails and slugs:

Slugs and snails may absorb insecticides like carbamates and organophosphates and apply them to their bodies. Since diazinon, phorate, and carbofuran are soluble in water, high amounts of these compounds were discovered in their systems. They are unaffected by the pesticides, but the predatory birds that eat these slugs and snails will suffer negative effects and finally die.

Effect on soil microorganisms:

Because they break down and alter organic materials, soil microorganisms are essential for maintaining the soil's structure and releasing nutrients for plant uptake. Overuse of agrochemicals in agriculture reduces biodiversity in the soil. The overuse of pesticides has decreased the populations of helpful soil microbes, which has lowered soil quality and limited the availability of minerals like phosphorus, nitrogen, and potassium. Nitrification, mineralization, and the recycling of phosphorus are only a few of the significant soil processes that depend on the balanced presence of several types of organisms. However, the extensive usage of pesticides disrupts the many roles played by soil enzymes, which are vital to the processes. The two primary sources of nitrogen for plant growth are bacteria that fix air nitrogen and microbes that transform organic nitrogen into inorganic forms. Carbonaceous organic compounds decompose more easily thanks to the soil microbes. The development, activity, and enzyme of the soil microflora are negatively impacted by pesticides, which reduces the fertility and health of the soil. For example, in plots treated with carbofuran and phorate, the microorganisms in the rice and maize cropping system are decreased.

Effect on soil enzymatic activity:

Pesticides that end up in the soil have the ability to alter the enzymatic activity of the soil and have a detrimental effect on microbial metabolism. Free enzymes, immobilized extracellular enzymes, and enzymes secreted by (or included in) microorganisms are the most common types of enzymes found in soils. These enzymes are the main indicators of biological

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balance, including soil fertility and quality. Depending on the kind of pesticide used, the type of soil, and the environmental factors, the impact of pesticides on soil enzymatic activity might differ significantly. Impact of Pesticides on the Chemical Properties of Soil: Pesticides adversely affect the soil's chemical makeup, texture, and response to plant growth and development. To block methane from being created, dimethoated soil is applied to rice fields; in pea plants, HCH, pyriproxyfen, and fipronil reduce grain protein, seed yield, root nitrogen, shoot nitrogen, and root phosphorus.

Conclusion:

Farmers' negligent use of pesticides affects several aspects of the soil. Agrochemical usage over an extended period of time may negatively impact soil microbial activity and soil processes that affect crop yield and the soil nutrient cycle. As a result, the biodiversity and ecology suffer. To protect the environment and human life from the damaging effects of pesticides, sufficient safeguards must be taken. Agrochemicals may be applied more accurately and efficiently with modern techniques, which might reduce their ecotoxic effects and prevent health hazards for people. Choosing an organic farming strategy is becoming a commonly accepted technique. Ultimately, organic farming is better for the environment, human health, and soil quality.

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