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Effect of Applied Pesticide on the Microbial System of Agriculture Soil

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Pesticides are widely used to control the pest as well as to improve the yield of agricultural products. Pesticide applied in the soil affects the microorganisms, soil enzymes, and physicochemical parameters in the soil and in turn affect the soil fertility. Understanding the impact of pesticide on the soil both short-term and long-term exposure would provide a set of analytical data for risk assessment and resilience of the soil parameters. This would open up other possible ways given to improve the crop productivity. This review mainly focuses on standard biomarkers such as microbial enzymes, soil enzymes novel proteins, and microbial community other parameters developed as indicators, of pesticide contamination.

Keywords: Environment health, pollutants, degradation, remediation, rhizosphere.

Pesticides are anthropogenic products intended to control pest in the agriculture as well in the household maintenance. It been used since the end of the Second World War (EPA 2009) and has been reached to two million tons per year (De *et al*. 2014). Pesticide usage in India is only 3.75 %, which is comparatively less than any other country in the global scenario. HCH, DDT and Malathion are commonly used pesticides (Brucker *et al*., 2008). Organophosphates and carbamates are the synthetic pyritheriod used commonly but extremely toxic to living forms (Van Wijngaarden *et al*. 2005). In India the maximum (44.5%) usage of the pesticide reported from cotton field (Agnihotri 1999). These insecticides effect on beneficial microbial diversity in the soil and decrease in soil fertility (Johnsen *et al*. 2001).

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Fate of Applied Pesticide

Pesticides reach the soil through spray drift, run-off, or wash-off vectors (Racke *et al.* 1997). Pesticides contaminate water, air, plants, food and ultimately in to human via, runoff and subsurface drainage; interflow and leaching; and the transfer of mineral nutrients and pesticides from soils into the plants and animals that constitute the human food chain (Abrahams 2002). The pesticide that becomes to be as integrated into transport and degradation processes that characterize soi1 ecosystems (Glatfelter *et al*. 1989). The pesticides in the environment undergo volatilization, leaching, adsorption, photodecomposition, degradation by other non - biological processes and biodegradation (Sawhney *et al.* 1989). Biodegradation is the process that involves the use of living microorganisms to detoxify or degrade the pollutants into less toxic forms (Zhang *et al*. 2011). Several bacteria utilize pesticide as a carbon, energy source and convert into simple harmless forms.

Impact on Soil Enzymes

Extracellular enzymes secreted around the microbial cells (Mayanglambam *et al*. 2005) influences soil fertility (Antonious 2003; Bucket and Dick 1998). Direct effect on the soil microbial community reflects reduced production of many extracellular enzymes responsible for biogeochemical cycles (Klose *et al*. 2006). Nevertheless, residual pesticides in the soil alter the functions of hydrolases, oxidoreductases, and dehydrogenase, phosphatase activities (Menon *et al*. 2005; Monkiedje and Spiteller 2002); (Kucharski *et al*. 2000; Trasar-Cepeda *et al*. 2000). Effect of pesticide on the bacteria, fungi and actinobacterial enzymes like dehydrogenase, phosphatase, and to their respiratory activities are detrimental. Pesticide like monocrotophos and quinalphos (organophosphates), and cypermethrin (pyrethroid), tend to increase the activities of cellulase and amylase enzymes. Interestingly, combinations involving monocrotophos with cypermethrin demonstrated synergistic and antagonistic effects on both enzymes in the soils activity of arylsulfatase (Table 1) and β-glycosidase implying that S-mineralization in soils and the total oxidative potential of microorganisms are affected by pesticides (Gundi *et al*. 2007).

Table 1. Impact of Different Pesticides on Soil Enzymes

Pesticides	Enzyme	Impact	References
Carbendazim and imazetapir	Nitrogenase	Pesticides reduce nitrogenase activity in *R. leguminosarum, S. meliloti*, and *Bradyrhizobium sp.* in pot and field conditions	Niewiadomska 2004
Metalaxyl and Mefenoxam	Phosphatase	Decrease enzyme activity	Sukul 2006
Acetamiprid	Nitrate reductase	Decrease arginine deaminase activities	Singh and Kumar, 2008

Table 2. Impact of different Pesticides on Soil Microflora

Pesticide	Microbial species	Effects	References
Methamidophos	Soil microflora	Decreased	Wang *et al*.(2007)
Atrazine	*ChlamydomonasReinhardtii*	Inhibited	Reboud *et al*. (2007)
Methamidophos	Soil microbes	Decreased	Wang *et al*.(2006)
Mefenoxam, metalaxyl	N - fixing bacteria	Inhibited	Monkiedje *et al*. (2002)
Carbendazim and imazetapir	Soil microorganisms	Reduced	Niewiadomska (2004)
Atrazine, isoproturon,	*Bradyrhizobium* sp.	Inhibited	Khan *et al*. (2006)

Table 3. Soil Enzymes influencing mineral cycle

Soil enzyme	Enzyme reaction	Mineral cycle
β-glucosidase	Hydrolysis of Cellobiose	Carbon
Cellulase	hydrolysis of Cellulose	Carbon
Phenol oxidase	hydrolysis of Lignin	Carbon
Urease	hydrolysis of Urea	Nitrogen
Phosphatase	Release of PO_4^-	Phosphorous
Arylsulphatase	Release of SO_4^-	Sulfur
Urease	Hydrolysis of urea	Nitrogen
Protease	Hydrolysis of protein	Carbon

Impact on Soil Microbes

Applied pesticide can change the environment in the size and structure of microbial community. Leads to a shift in the microbial community enhances the growth and establishment of species that are capable to degrade this type of chemical fertilizer, pesticide and change the overall soil quality (Table 2) either short term and long term effects. Residual pesticide in the soil disturbs the physical-chemical properties of soil that leads change in the soil fertility. Ultimately, the bacterial, which has the capacity to transform or degrade the pesticides, surpass the plant growth stimulating bacteria. They can metabolize even the most persistent pesticides either by the utilization of the compounds as sources of energy, or by co-metabolism with other substrates supporting microbial growth Bitmann *et al.* 2005; Ratcliff *et al.* 2006 and Dick *et al*. 2010).

Impact on Soil Nutrients

The indiscriminate use of pesticide has found to alter which are that contributing to soil fertility (Tilman *et al*. 2002). Chemical pesticides are toxic to soil microorganisms; hence, physiology in soil altered when particular populations are altered. Pesticide also affects the size of soil populations (Edwards *et al*. 1973). Most of the pesticides persist in the soil for such a long period to absorb by plants grown in a field year later (Anonymous 2009). Persistence of pesticide would influence soil population either by increasing the community, which can degrade pesticide. Hence, the loss of the population that is responsible for the release of many of the macro, micro, and trace elements in the soil disrupts the bio-geo cycles.

Soil Enzymes are Indicators of Soil Fertility

Soil Enzymes are biological catabolism of soil organic and mineral components. Soil enzyme activities closely relate to soil organic matter (Table 3), soil physical properties and microbial biomass, changes much faster than other parameters, thus providing early indications of changes in soil fertility, and mostly involve simple procedures (Dick *et al*. 1996). In addition, the soil enzyme activities are measures for microbial activity, soil productivity, and inhibitor of pollutants (Tate 1995). Well-documented and quick assays are available for a large number of enzyme activities (Dick *et al.* 1996; Tabatabai 1994). These enzymes include dehydrogenase, glucosidases, urease, amidases, phosphatases, arylsulphatase, cellulases, and phenol oxidases.

CONCLUSION

Impact assessment due to the agricultural usage of pesticide would reveal the many changes taking place in the field. Such chances would be easy tools to evaluate the impact of applied pesticide on all forms, including soil microbes, plant, insects, and human. It will also address many other unresolved questions with regard to soil fertility, emergence of multi drug resistance, taro genic effects in many forms as well as premature puberty in women. Therefore, based on the above discussed data community can develop specific biomarkers for mutual exposure taking advantage of the ongoing characterization of toxicity signaling pathways and cause of many unknown diseases.

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