EFFECT OF PESTICIDE APPLICATION ON NUTRIENT UPTAKE BY PLANT

DINESH K YADAV[1]*, BRIJESH YADAV[2], RAHUL MISHRA[1], KHUSHBOO RANI[1], ABINASH DAS[1], ABHIJIT SARKAR[1], ALKA RANI[1], J K SAHA[1]

[1]ICAR-Indian Institute of Soil Science, Bhopal, Madhya Pradesh; [2]ICAR-Directorate of Mushroom Research, Solan, Himachal Pradesh

*Corresponding author, E-mail: Dinesh.Yadav1@icar.gov.in

Population of India currently stands at 1.39 billion and is estimated to reach nearly 1.64 billion by 2050. To feed the growing population foodgrain production has also increased many folds from 50 million tonnes of 1950-51 to 303.34 million tonnes in 2020-21. Still, further annual increase of 6.4 million tonnes is required to meet the 2030 target of 355 million tonnes. One of the major challenges in achieving this target is management of crop loss due to various insect pests, diseases weeds, and nematodes. Crop loss of 18 percent in India lead to a monetary loss of ₹1,36,000 Crores. Though there are many ways like physical, cultural, mechanical, biological, and chemical methods to manage crop loss due to these problems data shows that Indian farmers generally prefer chemical crop protection measures (Figure 1) and that makes agricultural chemicals very crucial in Indian agriculture sector.

Dr. Norman E Borlaug, father of the green revolution also stated total ban on chemical crop protection measures in the agriculture sector might lead to a fifty percent decrease in global food production along with 4-5 times rise in food prices. Compared to many countries consumption of pesticides in India is very less 0.6 kgha^{-1} (Figure 2).

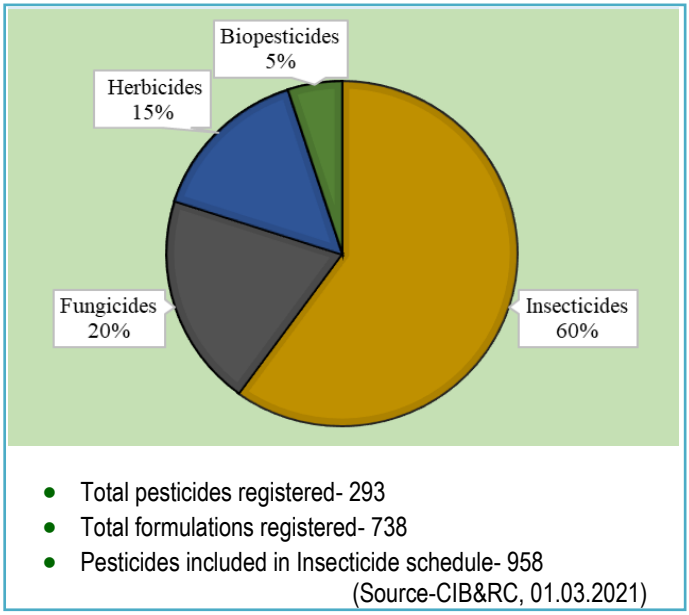

Figure 1. Pesticide use pattern in India

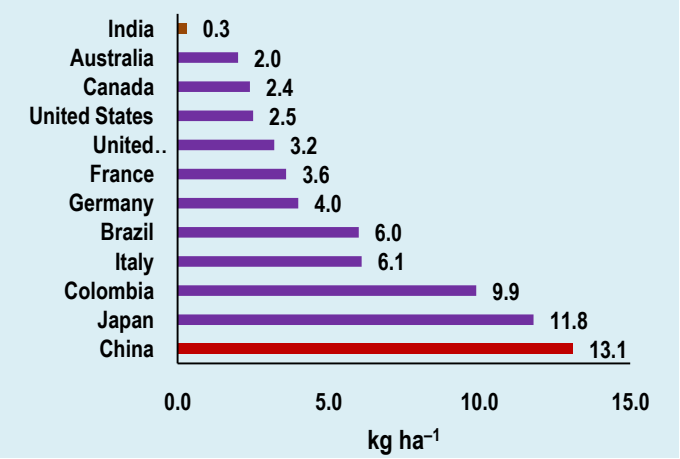

Figure 2. Country-wise pesticide consumption (Source-FAOSTAT)

PESTICIDE AND ENVIRONMENTAL DYNAMICS

Source of Pesticides in Soil: Pesticides reach soil ecosystem either through deliberate application or accidentally through spray drift, equipment wash offs, burial of container, washed away from plant surfaces, plant residues, pesticide vapours dissolved in rain etc. Hardly about 0.1 percent of the applied pesticides reach the target pest sites and rest 99.9 percent move into the environment there it affect different non-target organisms along with contaminating soil, water, biota and atmosphere.

Factors Affecting Sorption: In soil system, sorption of pesticide get influenced by soil properties like organic matter (SOM), clay fractions, CEC, metal oxides, metal hydroxides, temperature, pH, moisture content, exchangeable cations and other environmental conditions along with pesticide properties such as solubility, charge distribution, polarity (polar/non-polar), molecular size, basicity (pKb), and acidity (pKa).

Movement/Transport of Pesticides in environment: Pesticide remains in soil either in free or adsorbed state. Sorbed form is the unavailable form for biological action and microbial degradation while, 'free form' of pesticide is subject to movement within and outside the soil ecosystem. Pesticides can move both horizontally (runoff) and vertically (leaching). Runoff causes contamination of surface water while leaching causes contamination of groundwater. The movement of pesticides is higher in coarse-textured soil than in fine soil. Additionally, they also get transported to air through volatilization; to water resources through runoff and leaching; to biota through uptake; and move within the soil ecosystem through diffusion and mass flow (Figure 3).

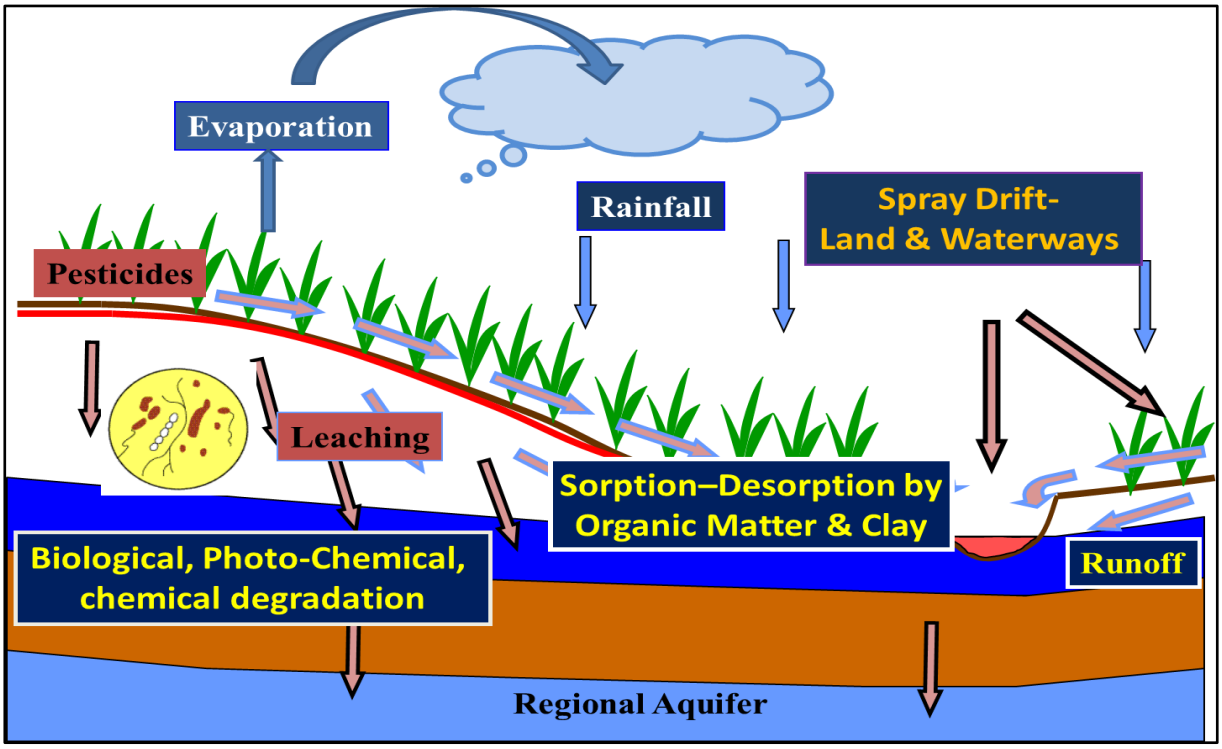

Figure 3. Diagram showing movement of pesticides in environment

Effect of Pesticides on Nutrients Uptake, Soil Microbial Population and Enzymatic Activity: Glyphosate, is an organo-phosphorus herbicide exhibited antagonistic action on uptake and transport of micronutrients like iron (Fe) and manganese (Mn) in sunflower plants. Studies (Eker et al., 2006; Cakmak et al., 2009) showed that sub-herbicidal dose reduced micronutrient uptake and transport in sunflower plants. Glyphosate molecule due to the presence of carboxyl and phosphonate moiety which makes complex chelate, resulting in reduced micronutrient uptake and transportation in Sunflower plant. The clear-cut effect of glyphosate was observed as in terms of leaf chlorosis in sunflower plant (Figure 4).

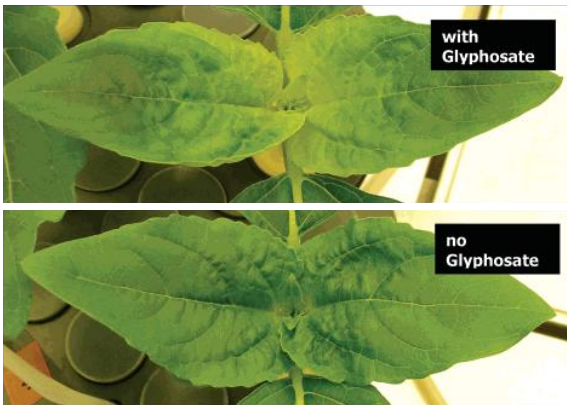

Figure 4. Effect of glyphosate on leaf chlorosis in sunflower plant

Pesticides might affect most of the soil microorganisms (SMO) through interfering with their metabolic and enzymatic activities. Also, disrupting the activities of SMO could affect soil nutritional quality parameters that lead to various ecological consequences. The activity of the dehydrogenase enzyme is directly related to the microbial activity of the soil. The soil microbial biomass is the labile pool of organic matter and plays a role as sink and source of plant nutrients. It plays a crucial role in nutrient cycling and is important for maintaining soil fertility and nutrient concentration. It was observed that 2,4-D herbicide application resulted in the maximum decline of soil dehydrogenase activity (DHA) compared to chlorpyriphos, carbofuran, and carbendazim. It was observed that 2,4-D application reduced DHA by 58.24% compared to control soil (Arora et al.,2019). Propiconazole is a triazole fungicide that also affects soil fertility and microfloral diversity. Application of fungicide @ 15-20 $kgha^{-1}$ in red sandy loam and black soils declined phosphatase, urease activities, bacterial and fungal populations. It was also reported that propiconazolec enhanced soil microbes and enzyme activities at the recommended dose (Sataputeet al., 2019).

CONCLUSION

Soil fertility is crucial for maintaining sustainable agricultural production for the global food and nutritional security. Though agrochemicals are branded as necessary evil in agriculture industry these are essential inputs for increasing agriculture production by eliminating various pests. Therefore, it should be always used in a judicious manner. In order to prevent the excessive use of pesticides by the farmers the scientific fraternity along with other agencies like government, non governmental organizations (NGOs), distributors, industry, policymakers and cooperative society should take initiative with to make farmers aware about the negative effect of these agrochemicals with its over use.

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