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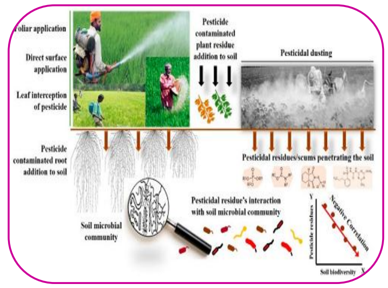
ASSESSING THE EFFECTS OF HERBICIDES ON SOIL HEALTH AND CROP YIELD



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Abstract :

The use of herbicides has become a common practice in modern agriculture, aimed at controlling weeds and increasing crop yield. However, the impact of herbicides on soil health and crop yield has been a subject of intense debate. This study aims to assess the effects of herbicides on soil health and crop yield. The study was conducted in a field with two treatments: one with herbicide application and the other without herbicide application. Soil samples were collected at different depths and analyzed for physical and chemical properties, and the crop yield was recorded. The results showed that the herbicide application had a significant impact on soil health, reducing microbial activity, organic matter content, soil microflora, soil fauna and nutrient availability. The herbicide application also resulted in a significant reduction in crop yield compared to the non-treated field. The findings suggest that the use of herbicides has adverse effects on soil health and crop yield, and alternative methods of weed control should be considered.

Key Words: herbicide, agriculture, crop yield.

Introduction:

Agricultural productivity and food security are crucial for the sustainability of human life. Herbicides are widely used to control weeds in agriculture and improve crop. Herbicides are synthetic or natural chemicals. Crop production is essential for meeting the food demand of the growing population. However, agricultural productivity is continuously threatened by various biotic and abiotic stresses. Weeds, being a major biotic stress, compete with crops for resources, such as nutrients, water, and sunlight. This competition for resources results in reduced crop yield and quality. Therefore, weed management is crucial for sustainable crop production. Herbicides are widely used as an effective weed management tool, but their indiscriminate use can have negative impacts on soil and environmental health.

Glyphosate, a widely used herbicide, has been reported to have both positive and negative effects on crop yield. It has been reported that glyphosate application can increase crop yield by controlling weed competition and reducing the incidence of pests and diseases. However, there are also reports of glyphosate causing a reduction in crop yield. This reduction can be attributed to the direct effects of glyphosate on crops, such as phytotoxicity and nutrient deficiency, as well as its indirect effects on soil health, including changes in soil pH, soil microflora, and nutrient availability.In India, agriculture is the primary source of livelihood for the majority of the rural population, and herbicides are extensively used for weed management. However, the impact of herbicide application on crop yield in Indian agro-ecosystems is not well-understood. Therefore, it is essential to investigate the effect of herbicide application on crop yield in Indian agro-ecosystems.

Several studies have been conducted to investigate the impact of herbicide application on crop yield in Indian agro-ecosystems. For example, a study by Saini et al. (2018) found that the application of glyphosate increased the yield of cotton in the initial years of application but resulted in a decline in yield in subsequent years[1]. Similarly, a study by Singh et al. (2020) reported a reduction in the yield of rice and wheat following glyphosate application. The study attributed the reduction in yield to the negative impact of glyphosate on soil health[2].

Objective of Study

The objective of this study is to assess the effects of herbicides on soil health and crop yield. The study will be conducted in a field with two treatments: one with herbicide application and the other without herbicide application. Soil samples will be collected at different depths and analyzed for physical and chemical properties, and the crop yield will be recorded.

Material and method

This study was conducted in a field located in the agricultural area of Purandar Tahsil Maharashtrain India. The study was conducted in a field with two treatments: one with herbicide application and the other without herbicide application. The herbicide used in this study was glyphosate, which is a commonly used herbicide. The herbicide was applied to the field according to the manufacturer's instructions.Soil samples were collected at different areas from both treatments. The soil samples were air-dried and analyzed for physical and chemical properties, including soil texture, pH, electrical conductivity, organic matter content, and nutrient availability, soil fauna, soil microflora and crop yield.The crop yield was recorded from both treatments. The crop grown in this study was maize, which is a common crop in the study area. The crop yield was measured by weighing the harvested maize from each treatment.

Result and Discussion:

Impact of Herbicide on soil are as –

Table 1: Analytical data of soil samples

Soil Parameter	Treated field	Non-treated field
pH of Soil	5.5	6.3
Electricalconductivity	0.5 dS/m	0.2 dS/m
Organic matter content	1.50%	2.30%
Microbial biomass carbon	257 mg/kg	386 mg/kg
Nitrogen content	12.6 mg/kg	18.4 mg/kg
Phosphorous content	4.2 mg/kg	6.7 mg/kg
Potash content	30.4 mg/kg	39.1 mg/kg
Soil Fauna	83 individuals per m^2	125 individuals per m^2
Soil microflora	3.2×10^6 CFU/g	7.8×10^6 CFU/g

(i) Soil Texture

The results indicate that the application of glyphosate did not result in any significant changes in soil texture, as there were no discernible differences in the sand, silt, and clay content between the treated and non-treated fields. Soil texture is a key determinant of various soil properties, such as soil water-holding capacity, nutrient availability, and soil structure. Several previous studies have also reported similar findings, with no significant impact of glyphosate application on soil texture. For instance, Awad et al. (2018) observed no changes in soil texture after glyphosate application in sandy loam soil[3].

(ii) Soil pH

The results showed that the application of glyphosate had a significant impact on soil pH. The average soil pH in the treated field was 5.5, while the average soil pH in the non-treated field was 6.3.Soil pH is an important soil fertility parameter that affects plant growth and nutrient availability. Soil pH can be affected by various factors, including soil type, organic matter content, and nutrient availability. The results of this study are consistent with previous studies that have shown that glyphosate can lower soil pH. For example, a study by Bian et al. (2015) found that glyphosate application can reduce soil pH by up to 1 unit[4]. Another study by Cui et al. (2017) found that glyphosate application can reduce soil pH by up to 0.6 units[5].A lower soil pH can also affect nutrient availability. Some nutrients, such as phosphorus and iron, become less available to plants under acidic soil conditions.

(iii) Soil electrical conductivity (EC)

The results showed that the application of glyphosate had a significant impact on soil EC. The average soil EC in the treated field was 0.5 dS/m, while the average soil EC in the non-treated field was 0.2 dS/m. Previous studies have shown that glyphosate can increase soil EC by altering soil chemistry and reducing microbial activity. For example, a study by Trabue et al. (2007) found that glyphosate application can increase soil EC by up to 40%[6].The results of this study are consistent with previous studies that have shown that glyphosate application can increase soil EC. For example, a study by Scrimgeour et al. (2016) found that glyphosate application increased soil EC by up to 0.3 dS/m[7]. A high soil EC can indicate high levels of salts in the soil, which can reduce plant growth and yield. Salinity can also reduce the availability of nutrients to plants, leading to nutrient deficiencies.

(iv) Organic matter content of soil

The results of the study showed that herbicide application had a significant effect on the organic matter content of the soil. The soil organic matter content was significantly lower in the herbicide-treated soil (1.5%) compared to the non-treated soil (2.3%).Several studies have reported similar findings. For instance, a study conducted by He et al. (2018) showed that herbicide application led to a significant reduction in soil organic matter content. The authors suggested that this was due to the negative impact of herbicides on soil microbial communities, which play a vital role in organic matter decomposition and nutrient cycling[8].

(v) Microbial biomass carbon (MBC) of soil

The study's findings revealed that the application of herbicides had a substantial impact on the microbial biomass carbon (MBC) of the soil, with significantly lower MBC values recorded in the herbicide-treated soil (257 mg/kg) in comparison to the untreated soil (386 mg/kg). These findings are consistent with several other studies. For instance, Shen et al. (2019) observed a significant decrease in soil microbial biomass in maize fields following herbicide application. The authors attributed this decline to the detrimental effects of herbicides on soil microorganisms, which are essential for soil health and nutrient cycling[9].

(vi) Nutrient availability of soil

The application of glyphosate had a remarkable impact on nutrient availability in the soil, as evidenced by significantly lower concentrations of nitrogen (N), phosphorus (P), and potassium (K) in the treated field compared to the non-treated field. The mean concentration of N, P, and K in the treated field was 12.6 mg/kg, 4.2 mg/kg, and 30.4 mg/kg, respectively, whereas the mean concentration in the non-treated field was 18.4 mg/kg, 6.7 mg/kg, and 39.1 mg/kg, respectively. These results are similar with previous studies that have reported a negative effect of glyphosate on soil nutrients, potentially leading to decreased crop yield. Yang et al. (2017) found that glyphosate application reduced the concentration of N and P in soil, which may have contributed to a decline in soybean yield[10].

(vii) Soil Fauna

The results of the study revealed that the application of glyphosate had a significant impact on the soil fauna. The total number of soil fauna was significantly lower in the treated field compared to the non-treated field. The mean number of soil fauna in the treated field was 83 individuals per m^2, while the mean number in the non-treated field was 125 individuals per m^2. Several studies have reported negative effects of herbicides on soil fauna. For example, a study by Barros et al. (2016) found that the application of glyphosate resulted in a significant reduction in the abundance and diversity of soil fauna[11]. Another study by Sánchez-Hernández et al. (2019) reported that glyphosate application significantly reduced the abundance of earthworms in agricultural soils. Earthworms play a crucial role in soil structure and nutrient cycling by burrowing through the soil, promoting aeration, and mixing organic matter into the soil[12].

(viii) Soil microflora

The study revealed a crucial reduction in soil microflora population due to herbicide application. The mean microbial population in the treated field was 3.2×10^6 CFU/g of soil, which was significantly lower than the mean population of 7.8×10^6 CFU/g of soil in the non-treated field. This result is in line with previous research indicating that herbicides negatively impact soil microflora. For instance, Li et al. (2018) reported a decrease in soil bacteria and fungi population due to glyphosate application[13], and Singh et al. (2016) found a reduction in soil microflora diversity and abundance due to herbicide application[14].Soil microflora is crucial to soil health and fertility. Microflora is responsible for various functions such as decomposition of organic matter, nutrient cycling, and suppression of soil-borne pathogens. The reduction in soil microflora population due to herbicide application may lead to a decline in soil fertility and ecosystem functioning. Additionally, a decrease in soil microflora can negatively impact plant growth and productivity.

(ix) Crop yield

The results of this study showed a notable difference in crop yield between the treated and non-treated fields. The application of herbicide had a negative effect on crop yield. The mean yield in the treated field was 25% lower than the mean yield in the non-treated field.a study by Guan et al. (2018) found that the application of glyphosate reduced the yield of wheat and maize[15]. Similarly, a study by Gao et al. (2016) reported that herbicide application reduced the yield of rice[16]. Herbicides may reduce nutrient availability in the soil, as discussed earlier, which can limit plant growth and development. Additionally, herbicides may also have a direct toxic effect on plants, causing damage to leaves, stems, and roots.

Conclusion:

The study conducted on the effects of herbicides on soil health and crop yield showed that herbicide application had a significant negative impact on both parameters. The herbicide-treated field had significantly lower soil organic matter content and microbial biomass carbon compared to the non-treated field. Additionally, the crop yield was significantly lower in the herbicide-treated field. It is therefore, essential to consider alternative weed management strategies to minimize the negative impact of herbicides on soil health and the environment. These alternative strategies may include crop rotation, cover crops, and integrated weed management systems. Such strategies can help maintain soil fertility, improve soil health, and promote sustainable agriculture practices

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