

# Analyzing Pesticide Utilization in Soil and Water for Sustainable Agriculture

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## ABSTRACT

The cultivation of vegetable crops is widespread in India, particularly in Odisha, where farmers employ various insecticides to control pests. This research endeavors to elucidate the presence of insecticide residues in the soil, water, and vegetable fruits within vegetable farms in the Gajapati District of Odisha, India. The study adopted a cross-sectional design, randomly selecting multiple farms in the region during the years 2019-20. Samples of soil, water, and diverse vegetables were collected and systematically assessed for multi-pesticide residues through various laboratory analyses. Farmers in the villages were noted for utilizing a broad spectrum of insecticides on their vegetable crops. Among the tested farms, eleven exhibited significant levels of insecticide residues in the soil, with six surpassing the established maximum residue limit, containing residues such as profenofos, triazophos, chlorpyrifos, cypermethrin, and malathion. Interestingly, no insecticide residues were identified in water samples from the 22 farms. However, vegetable fruit samples revealed the presence of cypermethrin and chlorpyrifos residues. Approximately 20% of the vegetable samples tested positive for insecticide residues. In a parallel study on vegetable fruits, farmers cultivating vegetables reported symptoms such as skin itchiness, muscle pains, redness of the eyes, and headaches, attributing these health issues to pesticide exposure. In conclusion, a maximum of 20% of vegetable samples exhibited positive results for insecticide residues during the sampling phase. While farmers and farm residents reported pesticide-related illnesses, none sought medical attention. Interventions to mitigate pesticide exposure among farmers may focus on identified risk factors, particularly the toxicity, hazardous effects, and adverse health consequences associated with pesticide application in their fields.

**Keywords :** Insecticide, residues, vegetable

## Introduction

Vegetables play a vital role in India's agriculture, being cultivated extensively across the country. As of 2018, the leading vegetable-producing nations globally

include China, India, and Egypt (Choudhury 2013). In India, from 2011 to 2020, vegetables consistently held the position of the primary crop in terms of production, surpassing other crops. During

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this timeframe, vegetable cultivation expanded by 2.4%, growing from around 21,000 hectares in 2010 to nearly 21,480 hectares in 2018, with a corresponding yield increase of nearly 6% from 10.2 tons per hectare (BAS, 2018). In 2018, the top five vegetable-producing states in India were West Bengal, Odisha, Gujarat, Bihar, and Madhya Pradesh (APEDA, 2021). Tomatoes and brinjals, like many other vegetables, are susceptible to damage throughout their growth stages, from seedling to fruiting. Various pests and insects pose a threat, with the fruit and shoot borer (FSB) being a significant culprit causing substantial harm to production. FSB has led to yield losses of 20% in India. This moth larva, about the size of a sesame seed and reddish in color, feeds on vegetable stems and fruits from the inside, causing damage. Additionally, it bores into terminal shoots, leading to withering and a delay in the crop's vegetative development (Agri business, 2013).

## **Materials and methods**

### **Sample collection**

Fruit sample was collected from overall of twelve areas of 1 kg-vegetable (six 1-kg samples according to farm, two replicates) had been taken from numerous plotting within every of the ten pattern farms. For each farm, each mirror organization of six 1-kg vegetable samples were mixed well together, and a final 1-kg vegetable pattern was drawn, positioned in an icebox, and introduced inside 24 h which turned into the same old working system for laboratory analysis.. Soil and water samples are collected as per standard. In general, fourteen soil samples had been collected from different farmer's field. One area soil

pattern and some other reflect sample have been taken from every of the 14 farms. Each sample weighed 0.5 kilogram of soil. In one farm, a final sample of soil became drawn from well-mixed samples of soil gathered at one-of-a-kind plotting, then placed in an opaque plastic bag, and taken for laboratory evaluation. A soil auger turned into used to get the soil samples from a depth of 6 inch. The sampling popular running method encouraged with the aid of the Department of Agriculture for soil sampling is one meter intensity. Similarly, 14 field water samples and any other samples have been taken from diverse assets along with river, irrigation canal, and consuming water system placed within the 22 sample farms. There had been a complete of twenty-two samples from all the 14 farms. There turned into one sample in every farm. The replicate turned into used merely as a returned-up sample. Each water sample had a quantity of 2 L. Two samples of the soil and water are represents each farm. All soil and water samples had been stored in an icebox, and introduced to the laboratory inside 24 h. The samples had been stored in a laboratory fridge at a temperature of 5°C, and analyzed using laboratory analysis techniques. In the laboratory, the samples were stored in a freezer for storages.

A suitable laboratory analysis methods are used to research the material samples (APEDA, 2021). Briefly, the insecticide residues were desorbed from the samples and analyzed the use of gas chromatography operated in a break up mode. The vegetable samples underwent a 3-degree clean up to dispose of particulates and impurities. Major chromatogram peaks were recognized

inside the samples through evaluating retention times and mass spectra to peaks from a calibration technique. The water sample underwent every liquid-liquid extraction, and one solid segment extraction the use of as water samples are purifier than soil samples. The elements within the oven utility along with the temperature programming, retention time of diverse insecticides, and temperature of the detector were formerly decided and depended on each shape of pesticide. In the fuel chromatography analysis for multi-pesticide residues in the soil and vegetable samples, two detector nitrogen phosphorous and electron tablet detector were used. Solid segment extraction changed into completed using acetonitril. The first easy up stage used; the second, carbon graphite; and the 0.33 and very last

stage used flourisil. The restoration technique modified into 70%. The coefficient of version became tons less than 10 %. Two trials have been done for every sample. The restrict of willpowerfor organophosphates modified into 0.02 mg/kg, and 0.5 mg/kg for organochlorines and pyrethroids.

### Results and discussion

The farmer-respondents within the research reported that fruit and shoot borer is the most commonplace pest of vegetables in their communities. Other pests which have been encountered were aphids, bacterial wilt, blight, and thrips. To manage the diverse pests in vegetable production, farmers used unique pesticides, every of which targets a variety of pests (Table 1).

**Table 1. Use and positive residue response on soil and water from different villages**

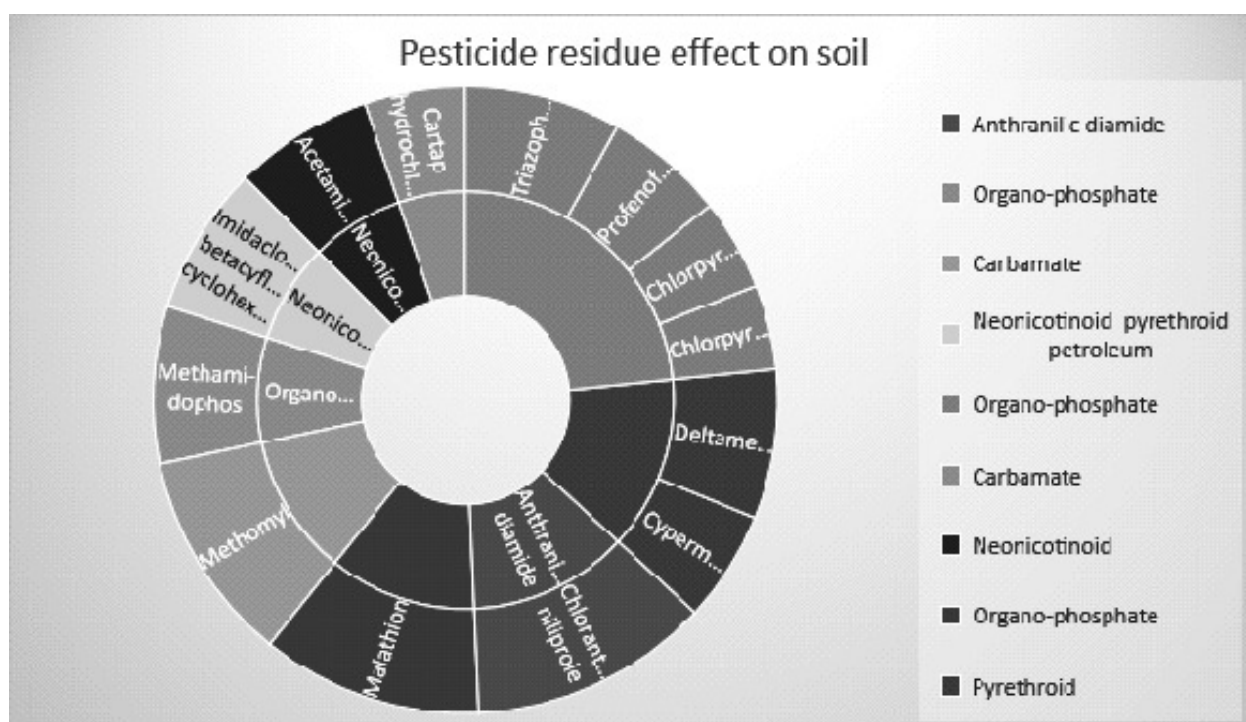
| Sample | Positive for insecticide residue |             |
|--------|----------------------------------|-------------|
|        | No of insecticide found          | No of farms |
| Soil   | 9                                | 11          |
| water  | 5                                | 4           |

Insecticide residue evaluation of vegetable fruits. The 10 pattern farms, moist season pattern vegetables in 2 farms had been detected as having chlorpyrifos and cypermethrin, with the previous at a stage higher than the prescribed most residue level (chart 1). Similarly, cypermethrin became detected in harvested vegetables from 2 farms, with degrees within the prescribed restriction. From the dry season evaluation, cypermethrin became detected from

samples in 2 farms, and additionally from harvested vegetables in 1 farm, at tiers same to the prescribed restriction. All of the farmers within the vegetable fruit have a look at reported making use of, anthranilic diamide and Malathion (malathion, organophosphate) to govern pests in their vegetable plants. However, farmers used chlorpyrifos, organophosphate at the very best common charge of 473 ml/utility, observed via cypermethrin, pyrethroid at an average of 30 ml/application.

Methamidophos, organophosphate become additionally suggested as used at a median of 30 ml/application. All market samples from each moist and dry seasons tested poor for insecticide residues. In summary, a most of 20 % of the vegetable samples examined high quality for insecticide residues at anyone stage of sampling done. Pesticide residues in flora may additionally attain the consumers thru ingestion of raw ingredients [Lukassowitz, 2013]. Various surveys around the world determined that 50–70 % of greens are infected with insecticide residues, which plant roots

absorbed from infected soils and migrated to fit to be eaten elements [Karanath, 2002]. In Tanzania for example, Mwevura *et al.* (2000) found excessive degrees of organochlorine pesticide residues in suitable for eating biota in coastal regions. In India, Baral (2006) detected residues of fenvalerate, tau-fluvalinate, lamba-cyhalothrin, and monocrotophos in vegetable fruits. In america, endosulfan sulfate was the most regularly occurring (16.76 %) pesticide residue determined in vegetables, accompanied by way of endosulfan II (12.8 %) and metamidophos (4.5 %) (FAO, 2000).



**Chart 1 : Distribution of positive residues in vegetable in various stages**

In widespread, the soil serves as a “purifying filter ” that impacts pesticide infection of groundwater. The soil profile plays a tremendous role in figuring out the chemical’s leachability to the groundwater,

and soil natural content on pesticide patience. However, cutting-edge technology has evolved insecticides which are more water- soluble, thermolabile, polar, and persistent, to higher allow



effective pest manage. These may also explain why pesticide compounds, specially herbicides, were detected in surface and floor waters (Andreu, Banard, Aharonson, Hamilton).

### **Effect of pesticide on farmers' health**

Perceptible groupings of insecticides deposits in soil, water (each groundwater and surface water), air, or even products present threats to human wellbeing and the climate. A look at of cultivating families with homes inside 200 feet from their homesteads identified better convergences of organo-phosphorous pesticides (comprising of chlorpyrifos, parathion, phosmet, and azinphosmethyl) inside the family soil than the ones found inside the ranch soils (Mukherjee, 1992). In this notice, the occupants are most likely uncovered to family residue and soil-polluted insect poisons considering homes are exceptionally near the ranches.

### **Application of farming pesticides -**

The ranchers and homestead laborers inside the dirt and water look at said encountering irritation of the pores and skin, redness of the eyes muscle torments and entanglements as being connected with their pesticide openness. Current agriculture has to address important factors, inclusive of population growth, food safety, health risks from chemical pesticides, pesticide resistance, degradation of the natural surroundings, and climate trade. In current years, a few new principles concerning agriculture and food manufacturing have appeared. A concept as such is weather-smart agriculture that seeks solutions within the new context of climate alternate. Another most important ongoing controversy exists

among the advocates and the warring parties of genetically engineered pesticide-resistant flora, concerning not handiest their safety however additionally their impact on pesticide use. In additional outrageous times, quakes, stomach cramps, unreasonable pee, bradycardia, great step, pinpoint students, and hypotension might be found (FAO 2000). Significant impacts of pesticide openness have likewise been accounted for on engine or neuromuscular inclusion, with side effects that might incorporate paresthesia, seizures, quakes, ataxia, nearby or general fasciculation, and quakes (Spiewak, 2001)(Leilanie, 2015).

### **Conclusion**

In the investigation encompassing soil and water, farmers in the villages of the Gajapati region exhibit a determined inclination to utilize a diverse array of pesticides on their vegetable crops. This selection comprises 25 different brands, including class I (highly toxic) insecticides, 9 class II (moderately toxic) insecticides, and 7 each of classes III and IV (respectively, slightly toxic and nearly non-toxic) insecticides. Pesticide residues, whether in the soil, water, or air, have the potential to persist as environmental contaminants, impacting both flora and fauna, as well as human health. The study's findings advocate for the implementation and standardization of environmental monitoring for pesticide residues in water, groundwater, soil, air, and plants, especially in critical agricultural production areas and communities. Monitoring insecticides in vegetables should be conducted concurrently with soil and water

assessments, as certain pesticides have the capacity to leach into the soil and groundwater. This research contributes to achieving Sustainable Development Goals (SDGs) 2 and 15, among the total of 17 SDGs outlined by the Food and Agriculture Organization (FAO, 2021)

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