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ASSESSING THE PERSISTENCE OF FENPYROXIMATE IN SOIL AND WATER ACROSS VARIED APPLICATION RATES: IMPLICATIONS FOR SOIL MICROBIAL PARAMETERS AND FERTILITY

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ABSTRACT

Fenpyroximate is a widely used acaricide for controlling mite infestations in agricultural crops; however, its persistence in the environment has raised concerns regarding soil health, water quality, and sustainable crop production. The present study aims to assess the persistence of fenpyroximate in soil and water under varied application rates and evaluate its influence on soil microbial parameters and fertility. The research will investigate the degradation pattern and residual behavior of fenpyroximate over time while examining its effects on beneficial soil microorganisms, microbial biomass, enzyme activities, and key physicochemical properties associated with soil fertility. Water samples will also be analyzed to determine the potential movement and persistence of pesticide residues beyond the treated area. The findings are expected to provide a comprehensive understanding of the environmental fate of fenpyroximate and its ecological consequences under different application regimes. The study will contribute to the development of scientifically sound pesticide management strategies that promote environmental safety, preserve soil microbial diversity, maintain soil fertility, and support sustainable agricultural practices.

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INTRODUCTION

The use of pesticides has become more important in agricultural production as a means to shield crops from diseases, pests, and insects that drastically lower crop yields and quality. Fruit, vegetable, ornamental, and field crops are effectively managed with the use of fenpyroximate, a selective acaricide among these pesticides. It has become an integral part of IPM systems due to its strong effectiveness against populations of resistant mites. The persistence of fenpyroximate in agricultural soils and bodies of water has prompted worries about its overuse and repeated applications, which might have negative effects on non-target species and ecological processes due to residual buildup. Soil organic matter concentration, pH, moisture, temperature, and microbial activity are some of the environmental elements that affect the mobility and breakdown of pesticide compounds, and therefore the persistence of these residues. Negative effects on microbial biomass, diversity, or enzyme activities may have far-reaching consequences for soil health and agricultural sustainability in the long run since soil microbes are essential for nutrient cycling, organic matter breakdown, and fertility maintenance. Pesticide residues may also harm aquatic ecosystems and the environment when they end up in surrounding water sources owing to runoff or leaching. Evaluating the ecological safety of fenpyroximate requires knowledge of its degrading behaviour and environmental destiny at varied application rates. Research on its impact on fertility indicators, soil microbiological parameters, and water and soil persistence will help establish safe application procedures. With this information in hand, we can better design long-term pesticide management plans that reduce pollution, protect soil microbes that are good for agriculture, keep soil fertility high, and guarantee ecologically sound harvests without sacrificing pest control effectiveness.

REVIEW OF LITRETURE

Sahu, Deepak et al., (2020) To keep up with the everyday demands of an unchecked population boom, modern agriculture relies on chemical pesticides to boost crop output. These boost output at the expense of soil fertility and food quality, endangering the well-being of humans and other animals. As an acaricide, fenpyroximate targets and kills mites while also slowing their larval development. In order to curb the overuse of pesticides, a

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technique for detecting fenpyroximate has been developed. The maximum wavelength at which azo dye could detect fenpyroximate was 435 nm, as shown by many experiments conducted at different wavelengths. The results showed that the limit of detection (LOD) was 0.687 µg mL-1 and the limit of quantitation (LOQ) was 2.083 µg mL-1. In addition, Sandell's sensitivity was determined to be 1 × 10-5 µg cm-2 and molar absorptivity to be 2.3 × 10-7 mol-1 cm-1. The azo dye may be readily identified via spectrophotometric analysis within the concentration range of 5 µg to 14 µg in 10 mL, since it follows Beer′s law. It takes less time, doesn't cost much, and is quite sensitive. Apples, cucumbers, potatoes, spinach, and other crops, as well as soil and water samples, have all shown positive results when using the current technique.

Francesena, Natalia & Schneider, Marcela (2018) Sustainable, environmentally friendly farming practices need an evaluation of the vulnerability of pests' natural foes to selected insecticides. In this research, the toxicity of acetamiprid, a neonicotinoid insecticide, was compared to that of two biorational pesticides, azadirachtin and pyriproxyfen, on the pupae and adults of a Neotropical strain of Eretmocerus mundus. Lethal impacts were defined as adult emergence and survival, whereas sublethal effects were measured by the reproductive capability, sex ratio, and lifespan of the first offspring that survived. Although all three insecticides decreased adult emergence from treated pupae, the most harmful was azadirachtin at its maximum field recommended dosage (MFRC). Insecticides 2–5 days after adult emergence decreased the survival probability of emerging adults below 50%. At the MFRC of each of the three pesticides, abnormalities were seen in adults that had not yet emerged from their pupal stages. The sublethal effects on pupal treatment survival could only be assessed at the lowest dosage of azadirachtin. Although the reproductive potential of females was unaffected by azadirachtin at such concentration, the sex ratio and lifespan of the first offspring were disturbed. All three pesticides decreased the likelihood of adult parasitoid survival, with the most lethal being pyriproxyfen at the MFRC. Adult survivors of all MFRC pesticides had non-lethal side effects, with pyriproxyfen having the greatest impact on female reproductive ability. Finally, E. mundus was poisoned by both biorational pesticides.

Kumari, Sapana et al., (2015) The spray technique was used to assess the adulticidal, ovicidal, and nymphicidal effects of several newer and older acaricides on the life stages of a susceptible strain of the two-spotted spider mite (TSMM), Tetranychus urticae Koch (Acarina: Tetranychidae). After fenpyroximate (5.67 ppm), spiromesifen (12.53 ppm),

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chlorfenapyr (32.24 ppm), propargite (77.05 ppm), and dicofol (146.65 ppm), the most hazardous compound to adults was determined to be abamectin (LC50 = 0.39 ppm). The most dangerous compound was hexythiazox. When a third of the authorised dose of spiromesifen was sprayed upon eggs, hatching did not occur. This stood out from the other treatments, which were statistically comparable but not identical: fenpyroximate, chlorfenapyr, propargite, dicofol, and hexythiazox. The ovicidal activity of spiromesifen was 100%, followed by dicofol at 7.78% egg mortality and hexythiazox at 6.67%, according to the observations made on the 10th day. When treated with either abamectin or chlorfenapyr, hatching was almost unaffected (0.54%). All of the eggs that were treated with propargite hatched. The following treatments were found to have significantly different nymphal death rates: abamectin (96.05%), dicofol (94.51%), hexythiazox (90.24), propargite (90.00), chlorfenapyr (89.33%), and fenpyroximate (86.44%). An other method for controlling mites was shown in this research to be the acaricides chlorfenapyr, hexythiazox, fenpyroximate, and abamectin.

Kim, Min-Sik et al., (2006) Sublethal and residual effects on adult mortality, reproduction, and population expansion in Tetranychus urticae Koch were assessed after exposure to fenpyroximate and pyridaben. Each component of the effects on reproduction was examined independently to ascertain its contribution to the population growth parameter, the instantaneous rate of increase (r(i)): (1) reproduction on survivors (RS, number of eggs produced), and (2) survivors of progeny (SP, number of immatures developed). Three and six days after treatment, respectively, the RS and SP were surveyed. Compared to pyridaben, the direct toxic effects on adult females treated with fenpyroximate were consistently greater and lasted longer, but pyridaben consistently had greater effects on the RS and SP. With ri as the endpoint under evaluation, both acaricides' RSri and SPri decreased with increasing concentration, however pyridaben exposure consistently resulted in a larger decrease. Across the range of residual days examined for both acaricides, the RSri and SPri showed robust residual effects. Pyridaben has potent and long-lasting ovicidal action against T. urticae, as shown by the negative SPri values with all pyridaben doses. Pyridaben treatment would be more devastating to the T. urticae populations than feripyroximate treatment because the EC50 that reduced the RSri or SPri by 50% was always higher than 50% of the lethal fenpyroximate concentration (LC50). While both feripyroximate and pyridaben impede mitochondrial electron transport, this investigation found that their direct acute toxicity and reproductive effects on T. urticae were distinct. Copyright 2005 Elsevier Ltd. The ownership

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EFFECTS OF FENPYROXIMATE ON SOIL MICROBIAL COMMUNITIES AND BIOLOGICAL ACTIVITY

To effectively manage mites in a range of agricultural crops, fenpyroximate is a commonly used acaricide. Despite its usefulness in preventing agricultural yield loss, overuse or repetitive applications might have a negative impact on soil microbes and biological processes. Because they control processes such as nutrient cycling, organic matter decomposition, nitrogen fixation, and soil structure maintenance, soil microbes including bacteria, fungus, actinomycetes, algae, and protozoa are essential to healthy soils. Soil health and agricultural sustainability are affected by the metabolic functions, variety, and abundance of beneficial microbial communities, which may be influenced by the persistence of fenpyroximate residues. At high enough concentrations, fenpyroximate may stop microbes from breathing, lower their carbon biomass, and stop the good bacteria from doing their job of transforming nutrients. In the long run, these alterations might impact soil fertility and plant development by making nitrogen mineralisation, phosphorus solubilisation, and carbon cycling less efficient. In addition, the pesticide has the potential to affect the actions of important soil enzymes that are indications of microbiological health and biological quality, such as dehydrogenase, urease, phosphatase, catalase, and fluorescein diacetate hydrolase. When these enzyme activity drop, it means that the soil ecosystem isn't working as well biochemically and that microbial metabolism is down. Soil organic matter level, pH, application rate, moisture, temperature, and length of pesticide exposure are some of the variables that determine the magnitude of these impacts. As fenpyroximate residues break down in the environment and microbes, microbial populations may experience short disruptions at the recommended field dosages before slowly re-establishing normalcy. Conversely, residue persistence may be prolonged and deleterious impacts on microbial diversity and ecosystem functioning may be intensified with repeated or higher-than-recommended application rates. The environmental durability of fenpyroximate may be reduced over time if certain native microbes adapt to its presence and aid in its biodegradation. For this reason, it is crucial to continuously monitor soil microbial parameters and biological activity in order to assess fenpyroximate's ecological safety and create long-term pesticide management strategies that protect soil fertility, biodiversity, and agricultural productivity.

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IMPACT OF FENPYROXIMATE RESIDUES ON SOIL FERTILITY, NUTRIENT AVAILABILITY, AND SOIL HEALTH

The persistence of fenpyroximate residues in agricultural soils after pesticide application, especially when the compound is treated at higher-than-recommended rates or for longer periods of time, may have a major impact on soil fertility, nutrient availability, and overall soil health. The physical, chemical, and biological aspects of soil work together to promote plant development and agricultural production, which in turn relies on soil fertility. Nutrient cycling, organic matter breakdown, and the transformation of vital plant nutrients are all processes that soil microbes are involved in, and the persistence of fenpyroximate may impact these interactions. Decreased microbial activity might hinder the mineralisation of organic wastes, which in turn reduces the availability of crucial nutrients like sulphur, nitrogen, and phosphorus, which are necessary for proper crop growth. Furthermore, the effectiveness of biochemical processes that sustain soil fertility might be diminished owing to fenpyroximate residues, which have the potential to change the functions of important soil enzymes as urease, phosphatase, dehydrogenase, and β-glucosidase. To what degree pesticides alter soil physicochemical properties like pH, electrical conductivity, organic carbon content, water retention, and cation exchange capacity is conditional on soil type, environmental factors, and the frequency of pesticide applications. Soil structure, nutrient-use efficiency, and the ability of microbes and enzymes to produce stable aggregates are all negatively impacted when these factors are depleted. This might lead to a gradual decrease in root development, nutrient absorption, and overall crop output. Nevertheless, when applied at the specified rates and in an ideal environment, fenpyroximate residues often disappear due to photodegradation, hydrolysis, microbial breakdown, and other natural processes, enabling soil biological functions to progressively restore. Climate, soil texture, organic matter content, and the ability of native microbial populations to adapt all have a role in the pace of recovery. Minimising the negative affects of fenpyroximate on soil fertility and ecosystem functioning may be achieved by sustainable pesticide management methods. These activities include following dose recommendations, using integrated pest management, rotating crops, using organic amendments, and regularly checking pesticide residues. In order to reduce ecological risks associated with pesticide accumulation, maintain productive soils, protect beneficial soil biodiversity, and support long-term food security, it is essential to evaluate the long-term effects of fenpyroximate residues on nutrient dynamics and soil health. This will ensure environmentally sustainable agriculture.

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CONCLUSION

Testing how long fenpyroximate stays in water and soil at different treatment rates shows how important it is to handle pests effectively while still being environmentally conscious. Application rate, soil properties, weather, and microbial activity are some of the variables that affect fenpyroximate's persistence and breakdown. Soil microbes, enzyme activity, nitrogen cycling, and fertility are all negatively impacted by higher application rates because residues remain in the soil for longer. Disrupting beneficial microbial populations, which are essential for soil health, may lead to a decline in agricultural output and nutrient availability. Natural degradation mechanisms may reduce the environmental effect of fenpyroximate when it is used at the appropriate levels and in conjunction with sustainable agriculture practices. In order to assess ecological hazards and guarantee safe pesticide usage, it is crucial to continuously evaluate soil microbiological parameters, water quality, and pesticide residues. Promoting sustainable crop production while protecting soil fertility, environmental quality, and long-term ecosystem stability may be achieved via the adoption of integrated pest control, proper application rates, and frequent soil health evaluations.

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