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Applications of Biochar in Insect Pest Management

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SUMMARY

Chemical insecticides are commonly used to manage insect pest. However, this over reliance on synthetic pesticides had negative environmental effects and led to pesticide resistance. Therefore, it is essential to establish environmentally friendly pest management strategies and maximise the usage of chemical pesticides. According to some literature, using biochar had positive effects on insects as well as reduced nutrient loss and increased soil water retention, among other things.

INTRODUCTION

Biochar is a solid material, rich in carbon that is created through pyrolysis under specified circumstances of low oxygen and high temperatures ranging from 250 to >800 °C (Lehmann et al., 2006). It is also referred to as agriculture's "black gold." Because it uses less energy, the manufacturing of biochar is both affordable and environmentally benign, and it is effective at reusing waste materials. According to MNRE (2020), India's current biomass availability is anticipated to be more than 750 million tonnes per year, with a surplus of about 230 million tonnes per year. The majority of the wastes come from wheat and rice crops. Approx. 93 million tonnes of crop waste are burned annually (Gupta and Dadlani, 2012). The addition of biochar to managed agricultural and forest land increases soil fertility and productivity. Additionally, it might help with water retention and nutrient leaching control while lowering soil acidity and water-soluble nutrient leaching (Abit et al., 2012). Chemical pesticides are most commonly used for insect pest management in the modern world. However, this over reliance on synthetic pesticides had negative environmental effects and led to resistance in many insects. Therefore, there is urgent need to establish environmentally friendly pest management strategies and minimise the usage of chemical pesticides. According to several publications, using biochar application to crops & soil reduce the nutrient loss, increased soil water retention, and had positive impacts against insects. The usage of biochar has primarily been studied for soil enhancement, with little research being done on how it affects insects. Development of safer and more environmentally friendly alternatives to conventional techniques of pest management, such as the use of biochar, is need of the hour. Because, biochar is not toxic to mammals so, it application is a safest way to manage insects. The direct effects of biochar on insect survival and/or performance are not well understood. Biochar can be a great alternative to controlling insects due to its porous structure, high surface area, and abundance of oxygen-containing functional groups like hydroxyl and carboxyl on its surface. It is also cost effective in production. Use of alternative natural supplements like biochar, which pose no risk to people or the environment, is one of the potential alternatives to the use of some alternative applications of conventional insecticides to manage mites and insects. Some insects that consume plant sap can have their development and reproduction suppressed by biochar. For instance, thorough laboratory tests show that the application of biochar to soils can impair developmental performances and reduce the fecundity of planthoppers like *Nilaparvata lugens* and *Laodelphax striatellus* on rice, as well as of the English grain aphid *Sitobion av.*, after a brief mention of less damage to biochar-treated pepper *Capsicum annum* by the broad mite *Polyphagotarsonemus lat*. Several theories have been put out to explain the detrimental effects of biochar. According to the first, using biochar increases plant resilience to herbivores that is brought on by herbivory. When two rice cultivars are attacked by the white-backed planthopper *Sogatella furcifera*, for instance, biochar amendment raises the level of jasmonic acid in the rice (Waqas et al., 2018). In wheat plants treated with biochar and subjected to *Sitobian avenae* injury, defense-related genes are upregulated (Chen et al., 2019). Another theory postulates that biochar additions may prevent sap-feeding insects from using their stylets to probe or feed by changing the chemical composition of the host plant (Hou et al., 2015; Chen et al., 2019). It is well knowledge that nutritive components in plants affect how well herbivorous insects feed. According to Schoonhoven et al. (2005), some elements, like nitrogen, encourage probing and feeding while others, like silicon, hinder it. There is considerable interest in using biochar to manage insect pests. As it has also been demonstrated that using biochar has a detrimental impact on infections, the biological features of biochar may be unavoidable. However, the impact of biochar varies depending on the feedstock we use and the soil conditions we utilise. Therefore, it is necessary to do laboratory research to determine whether applying biochar to a crop under field settings will have any negative consequences on agricultural yields. The major ways that biochar affects insects are via changing how plants absorb nutrients and by triggering chemical defences. These herbivory-induced defence responses in plants are frequently dependent on the herbivore species, the plant species and genotype within the species, the climatic conditions in which plants are produced, the number of herbivore species attacking the plant, and the herbivore species' feeding habits. Before recommending a substance for use in agricultural and IPM programmes, it must always be evaluated for environmental safety and its effect on beneficial creatures.

Mode of action of biochar in insect control

a) **Increased silicon uptake**: Silicon (Si) availability in soil and uptake by rice plants increases (Liu et al., 2014). This is the mode of action of biochar on insect control. by the influx and efflux (LSi1 and LSi2, respectively) of the Si transporter genes (Ma et al., 2006, 2007). Due to silica deposition, primarily in the form of opaline phytoliths, in a variety of tissues, including epidermal silica cells, plant tissues exhibit physical resistance in the form of decreased digestibility and/or increased hardness and abrasiveness (Reynolds et al., 2009). A variety of insect herbivores have now shown that this impact exists (Teixeira et al., 2017).

b) **Reduce nitrogen uptake**: Biochar, for instance, has a greater ability to reduce soil nitrogen losses even if it is not a typical N fertiliser (Xie et al., 2013). This suggests that biochar has the ability to retain nitrogen. So, the uptake of N by plants can be decreased if biochar is applied to N-deficient soils, such as the soils found in paddy fields. According to Liu et al. (2014), biochar amendment can lower the nitrogen content of rice. We therefore predict that decreased nitrogen and likely other nutrient contents in rice plants as a result of biochar amendment may affect the rice leaves' suitability as feeding for *C. medinalis* larvae. Chemical defences induced Si content increases in the host plant can improve both physical and chemical defences brought on by herbivory (Kessler, 2016). via increasing the production of protective enzymes or perhaps by increasing the release of volatile plant compounds (Kessler, 2016). Si can activate the herbivore defence mechanisms in rice that are mediated by jasmonic acid (JA) (Ye et al., 2013). And over the course of feeding, biochar amendment causes an overexpression of four defense-related genes (Chen et al., 2019). Jasmonic acid (JA) is one of the main phytohormones involved in biotic stress tolerance; for example, it produces volatiles to kill herbivores indirectly by luring in their natural predators or directly by creating toxic chemicals to fend off intruders. According to Viger et al. (2014), a different explanation for how plants respond to the application of biochar includes greater plant development at the expense of downregulating defense-related genes (in Arabidopsis and lettuce).

c) Upon direct interaction: The material may be abrasive to an insect's cuticle due to the physical makeup of biochar and its ability to trap water (Abit et al. 2012), which raises the risk of dehydration. Second, smaller particles had a more pronounced impact on ant survival and longevity, while not being statistically significant. Touching biochar causes it to disintegrate into progressively smaller pieces. They can also impede breathing by getting inside an insect's spiracles.The application of biochar to soils has been proposed as a viable strategy for reducing greenhouse gas emissions.

- It enhances the soil's characteristics.
- It is regarded as one among the nutrients required for plant growth and the production of biochemical components.
- It boosts plant output and enhances the health of the plants.
- It is crucial in preventing the spread of plant diseases.
- Herbivory by sap-feeding insects may be negatively impacted by the addition of biochar to soils.

CONCLUSION

There is considerable interest in using biochar to reduce insect pests. As it has also been demonstrated that using biochar has a detrimental impact on infections, the biological features of biochar may be unavoidable. However, the impact of biochar varies depending on the feedstock we use and the soil conditions we utilise. Therefore, it is necessary to do laboratory research to determine whether applying biochar to a crop under field settings will have any negative consequences on agricultural yields. The major ways that biochar affects insects are via changing how plants absorb nutrients and by triggering chemical defences. These herbivory-induced defence responses in plants are frequently dependent on the herbivore species, the plant species and genotype within the species, the climatic conditions in which plants are produced, the number of herbivore species attacking the plant, and the herbivore species' feeding habits. Before recommending a substance for use in agricultural and IPM programmes, it must always be evaluated for environmental safety and its effect on beneficial creatures.

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