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Sustainable weed control through fatty acids as bioherbicide: A study on photosynthesis inhibition and seed germination

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Abstract

Resource accessibility has become increasingly scarce as the global population grows, making sustainable food production more challenging. Weeds are a significant biotic constraint to food production, as they compete with crops, reducing agricultural output and increasing external costs. Synthetic herbicides have been the primary method for weed control; however, their harmful environmental effects require sustainable alternatives. Fatty acid compounds, primarily derived from glyceric plant oils, are one such alternative. These natural products have low ecotoxicological side effects and high biodegradability, making them promising alternatives to chemical herbicides. This study aimed to evaluate the herbicidal effects of an oil-in-water emulsion preparation containing various fatty acid compounds on the photosynthesis of green beans and germination of tomato seeds as model plants. In the first phase, a laboratory experiment assessed the inhibitory effect of fatty acids with different carbon chain lengths on tomato seed germination. In the second phase, greenhouse experiments were performed using green beans to determine the phytotoxicity of the compounds. The results showed that pelargonic acid had high phytotoxic effects on green beans at concentrations of 1% and higher, whereas caprylic acid was effective even at lower concentrations (0.5%). Both compounds exhibited signs of damage at the lowest concentration (0.1%) and death occurred as the concentration increased. Linseed oil (containing linolenic acid as the main fatty acid) also showed the potential to exert different levels of phytotoxicity but not as strongly as other compounds. The experiments showed that the dose and length of the carbon atom chain of the fatty acids could determine the effect intensity. Our study emphasised the potential of fatty acid derivatives as pre-and post-emergence herbicides for sustainable weed control. By incorporating these natural compounds into integrated weed management strategies, farmers can reduce crop stress and promote sustainable food production to meet the demands of the growing population.

Keywords: Biorationals, integrated weed management