Development of a Supersonic Shockwave Loosening Device and Analysis of Shockwave Impact Efficiency

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Abstract

The root zone is the interface area between the soil and vegetation, which controls the movement of water, nutrients, and other substances into the plant. High soil aeration can enhance the growth of plant roots. In this paper, we design and develop a supersonic shockwave loosening device using a new supersonic shockwave generator, which operates repeatedly and generates high-pressure shockwaves above 900 kg/cm2. This shockwave soil loosening device can first drill a hollow spiral drill bit with holes into the soil and then drive high-pressure gas to impact the soil outside the drill bit to quickly increase the soil pores around the roots of crops and improve the aeration of the soil. In this study, we used a transparent tempered glass tank to conduct multi-directional shockwave impact observation experiments on water and 1:50 pectin to analyze the impact efficiency of high-pressure shockwaves. We also used eight pressure sensors to measure the shockwave impact range in pectin automatically. We found that when the tank volume was 5 L, the shockwave could generate an impact range of 20 cm in a pectin tank. Finally, since this type of shock wave loosening mechanism only impacts the soil in the root zone of crops and does not damage the soil surface, it can prevent the soil from being disturbed by large-scale tillage, thereby reducing the emission of carbon stored in the soil into the atmosphere, which will significantly reduce agricultural carbon emissions.

Keywords

Supersonic shockwave, soil aeration, soil loosening device, observation experiments, automatic measurement, agricultural carbon emission.