



Soybean and maize simulation under different degrees of soil erosion

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Soil erosion has influenced land productivity in the black soil region of northeast China, one of the most important food production area in China. It is necessary to quantify the erosion–productivity relationship. The objectives of this study were to simulate the effects of soil erosion on crop growth and soil water variations, and to analyze the causes of yield reduction using the Agriculture Land Management Alternatives with Numerical Assessment Criteria (ALMANAC) model. The ALMANAC model was calibrated for soybean and maize using plot experiments conducted in 2006 and 2016. Data from eighteen field sites were selected from 2011 to 2016 for model evaluation and the analysis of erosion effects, including soil properties for eighteen sites, grain yields during the harvest time, leaf area index and soil water content every ten days during growing periods. The ALMANAC model accurately simulated crop growth, crop yield, and soil water content under various degrees of soil erosion. Simulated and measured results showed that crop growth and soil water movement were significantly affected by soil erosion. For “moderate” and “severe” erosion, average soybean yields were reduced by -4.23 and 23.47%, and those of maize were reduced by 10.37 and 25.40%, respectively, compared with the yields obtained for “light” erosion. The maximum leaf area index (LAI_{max}) values for “light,” “moderate,” and “severe” erosion were 100, 98.02, and 78.09% for soybean, and 100, 98.43, and 86.65% for maize, respectively. No significant differences were observed in the root weights (RWs) of soybean and maize for “light” and “moderate” erosion. However, the RWs of soybean and maize decreased by 15.31 and 17.63%, respectively, under “severe” erosion compared to that of “light” erosion. Simulated water use efficiencies (WUEs) for “light,” “moderate,” and “severe” erosion sites were 4.84, 4.97, and 4.66 kg ha⁻¹ mm⁻¹ for soybean, and 24.30, 25.47, and 22.11 kg ha⁻¹ mm⁻¹ for maize from “light” to “severe” erosion. The parameters of the ALMANAC model for soybean and maize derived in this study are similar to these reported previously, and can be used for sites with similar soils, crop hybrids, and weather conditions. Our results show that “severe” erosion has a significant effect on LAI_{max}, RW, grain yield, and WUE values for soybean and maize. The primary causes of yield reduction in eroded soils were decreased emergency rate and increased water stress.