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Effect of Temperature on Crop Water Use Efficiency: Case Study in the Northeast of Iran

Alireza Koocheki, Mehdi Nassiri Mahallati, Zare Hossein, Sara Asadi

Ferdowsi University of Mashhad, College of Agriculture, Department of Agronomy, Iran

Abstract

Water scarcity is one of the main challenging issues for supplying sufficient food in most part of the world. Moreover, water supply is under pressure from climate change. Therefore, it is essential to identify drivers for improving agro-ecosystem water use efficiency (WUE). This paper aims to estimate WUE for wheat, alfalfa, sugar beet and tomato in northeast part of Iran for a 20 years period (1990–2010) and evaluate the effect of temperature on WUE. Crop water use (CWU) was estimated based on potential evapotranspiration (Penman-Monteith) and crop coefficient. WUE was calculated as production per unit of water used by evapotranspiration. To simulate the effect of temperature on WUE three scenarios were supposed: 1, 2 and 3 °C increase in air temperature during observation period. Eventually, to evaluate WUE changes, WUE was scattered against the CWU. Results showed that WUE varied from 0.2 to 0.8 kg grain yield per m^3 water used for wheat, 0.4 to 1.4 kg above ground dry matter per m^3 for alfalfa, from 1.5 to 4.5 kg fresh root per m^3 for sugar beet and 1 to 5 kg fresh fruit per m^3 water for tomato. A polynomial model was fitted to show WUE trend against CWU. The highest WUE was obtained around 490, 850, 880 and 780 mm water used for wheat, alfalfa, sugar beet and tomato, respectively. To define upper and lower WUE variation, two boundary lines were fitted based on the model. Different agronomic managements are responsible for the gap between upper and lower boundary lines. Temperature increment up to 1 °C did not affect WUE of any models derived from the boundary lines for all the crops. Although 3 °C increase in temperature had a negligible impact on WUE in higher boundary line, WUE in lower boundary line decreased dramatically. Alfalfa was the most sensitive and sugar beet was the most tolerant crop to temperature increase in terms of WUE. Our results illustrated that by temperature increment, WUE gap widens and agronomic management will play an important role in this case.

Keywords: Climate change, evapotranspiration, food security, water use efficiency gap

Contact Address: Zare Hossein, Ferdowsi University of Mashhad, College of Agriculture, Department of Agronomy, 9177948974 Mashhad, Iran, e-mail: hossein.zr84@gmail.com