

## **Quantifying yield gap of wheat in water and nitrogen limit conditions in Shirvan region: model (Aquacrop & CERES-Wheat) and field experiment**

### **Abstract**

This research was carried out in order to simulation of wheat yield in water and nitrogen limit conditions in Shirvan region, using models of Aquacrop & CERES-Wheat. The goal of doing this research is evaluating these two models for simulating different parameters of growth and development, by manner of comparison of simulated parameters with field results, and evaluation of model accuracy in predicting phenologic stages and crop yield; and also quantifying effective factors in decrease of wheat potential yield (yield gap) in region. In order to obtain necessary data for calibrating and validating model, a field experiment was conducted as split plot using randomized complete block design with three replications in 2009-10 and 2010-11 on winter wheat (Sayonz cultivar). Irrigation treatments were composed of I<sub>1</sub>: optimum irrigation (field capacity (FC)), I<sub>2</sub>: 80% FC, I<sub>3</sub>: 60% FC and I<sub>4</sub>: no irrigation as the main plots. Nitrogen fertilizer was composed of N<sub>1</sub>: 0, N<sub>2</sub>: 100, N<sub>3</sub>: 175 and N<sub>4</sub>: 250 kg N/ha as the sub plots. The results obtained from simulation of phenological stages by CERES-Wheat model in experiments of the first year and the second year showed that normalized root mean squares error (RMSE<sub>n</sub>) of flowering, milking seed and physiological ripening stages in both years is less than 10%, that indicate model accuracy in simulation of phenological stages is very high. Although LAI development in both experiments was simulated well, but between observed LAI and simulated LAI there was much different. Seed yield RMSE<sub>n</sub> for the first year and the second year was equal to 8.95% and 9.11% respectively. Biomass RMSE<sub>n</sub> for the first year and the second year was equal to 5.03% and 5.30% respectively. These results show that seed yield and biomass was simulated well. The results of simulation by AquaCrop model showed that model simulates cover crop (CC), seed yield, biomass and water use efficiency (WUE) well, especially in treatment of optimum irrigation and consumption of complete nitrogen fertilizer. Comparison and evaluation of two models on the basis of R<sup>2</sup> and RMSE<sub>n</sub> indicators showed that CERES-Wheat model has simulated wheat yield (Sayonz cultivar) well and simulation accuracy of CERES-Wheat is better than AquaCrop model in Shirvan region. The final goal from doing this research was quantifying yield gap of wheat in region. For reaching to this goal a study was carried out as survey (in 20 farms selected in region) and field experiments. In this experiment the most important reduced and limited factors of yield were water, nitrogen and management factors. The results of the first year of research showed that potential yield (yield simulated by model in optimum condition), attainable yield (yield obtained in field experiments in optimum condition of management) and actual yield (yield average obtained by region farmers) was equal to 11075, 6647 and 5025 kg/ha respectively. Yield gap (potential yield – actual yield) created for wheat in region (Sayonz cultivar) about 5985

kg/ha was estimated. From this amount, water and nutrients as two limited factors led to decreasing 72.84% of potential yield. The thrice reduced factor of yield was introduced management factors as well as, so that this factor led to decreasing 27.16% of wheat yield. The results of the second year of experiment showed that potential yield, attainable yield and actual yield (yield average obtained by region farmers) was equal to 10439, 6579 and 4960 kg/ha respectively. Yield gap created for wheat in region about 5479 kg/ha was estimated. From this amount, water and nutrients as two limited factors led to decreasing 72.84% of potential yield. The thrice reduced factor of yield was introduced management factors as well as, so that this factor led to decreasing 29.55% of wheat yield. Also yield gap was estimated for a long time (2002-2011) in region. The simulation results showed that potential yield is variable from 5973.34 to 8850.49 kg/ha. Wheat actual yield on the basis of annual yield average was variable from 2511.09 kg/ha at 2002 to 4629.14 kg/ha at 2011 in Shirvan region. Yield gap average for a duration of 10 years showed that gap between actual yield average (3524.15 kg/ha) and potential yield (7223.69) is high (near to 48.78%). Researchers stated that water, nitrogen, unsuitable sowing date, pests, diseases and weeds are from the most important factors created yield gap between actual yield and potential yield in region. At the last can conclude that with recognizing effective factors in yield gap, and optimizing them, wheat yield would increase exceedingly in region.

**Key words:** Wheat, CERES-Wheat, AquaCrop, Potential yield, Actual yield, Yield gap