Advanced Report on Crop Productivity Sub-Group Activity

Kobata Tohru
Life and Environmental Science
Shimane University
Nisikawatu-cho, Matsue 690-8504, JAPAN
E-mail: kobata@life.shimane-u.ac.jp

1. Research Plan for the Sub-Group in 2006

1) Research Objectives

a: Estimation of the effects of climate changes on yields of dominant crops in Mediterranean zone by simulation models

b: Suggestions of cultivated correspondence to the impact of the climate changes.

2) Methodology and Materials

a: Evaluation of model reliability by comparison between observed and estimated data by models during past several decades in Adana.

b: Estimation of yield when the final estimated climate data in the future is input into the model.

c: Assessments of the possibility of cultivated correspondence under the changed climate.

3) Outcomes

a: The effects of climate changes on dominant crops in the Mediterranean zone.

b: Suggestions of cultivated correspondence to the impact of the climate change.

2. Summary of Individual Research

1) Development of a Simplified Process Model to Simulate Wheat Growth and Yield under Mediterranean Environments

T. Kobata, H. Nakagawa, M. Koc, C. Barutçular and T. Yano

We have developed a simplified process model to simulate wheat growth and yield under Mediterranean environments. When the soil water deficit and potential grain yield in spring wheat were calculated from climate data during past decades in Adana distiricts by the model, variation of grain yield not fine traced that of observed data. One of the reason is that soil water deficit is overestimated from our model, and second is that the model includes yet some improvements in parameter use. Third is that observed data reliability should be checked. We start to improve the problems.

2) Modeling the Wheat Growth under Drought-Prone Environments - Modeling the LAI growth and testing of SIMWINC -

H. Nakagawa, T. Kobata, C. Barutçular and M. Koç

We finalized the development of a model to SIMulate the growth and yield of WINter Cereals (SIMWINC), after making a sub-model for LAI growth. Then, we tested SIMWINC with data on the growth dynamics of LAI and biomass obtained from field experiments in Adana, Turkey in 2003/2004 and 2004/2005 growth seasons. The testing showed the ability of SIMWINC to simulate LAI and biomass growth under Mediterranean environments.

3) Combined Effects of Elevated Temperature and CO_2 Concentration on Maize Growth

T. Haraguchi, Y. Nakano, T. Yano and M. Koriyama

The experiment was conducted to evaluate the combined effects of air temperature and carbon dioxide (CO_2) on maize growth for the second straight year. The rise in CO_2 concentration caused the increase in biomass of shoot especially in that of stem. The increase in air temperature caused the reduction in biomass of shoot (leaf and ear). The effect of elevated CO_2 concentration and air temperature on dry matter weight of shoot would be expressed well with a function of the cumulative shortwave radiation.

4) Implications of Future Climate Change for Irrigation Water Demand in the Cukurova Region, Turkey

T. Yano, M. Koriyama, T. Haraguchi and M. Aydin

In order to predict future change of water demand in the Mediterranean climate regions of Turkey by using the predicted climate change data, simulation of water balance was done using the detailed crop growth subroutine of the SWAP model for double cropping systems of wheat and second crop maize. The future climate scenario was created based on the observed values and the change of predicted GCM data between present and future. Total evapotranspiration and irrigation amount for grass as a perennial crop for the period of 2070-2079 relative to those for 1994-2003 are projected to increase by 11 and 20%, respectively. However, those for wheat and maize as annual crops decrease by 5 and 7%, respectively unlike those for grass. The direct use of the original GCM data and the RCM data affected the calculated water balance components due to discrepancy between predicted values and observed ones of air temperature.

5) Evapotranspiration, Transpiration and Evaporation from Soil Surface in a Maize Field

H. Odani, S. Takeuchi, K. Sasaki, and T. Yano

Daily evapotranspiration (*ET*, mm/day) and mean latent heat fluxes for 30 min. of maize crop were calculated for 50 days of July 29 to Sept. 16, 2004. These values were determined by using the energy balance flux ratio method, the energy balance Bowen ratio method and the Penman-Monteith method. Transpiration (*T*, mm/day) of maize was obtained from the sap flow measurement during Aug. 7-16. Evaporation (*E*, mm/day) from soil surface was measured with the microlysimeter during Aug. 9-16). Values of $E+T$ were larger than values of *ET* by 12%. Next, the quantity of water vapor transferred laterally due to advection in the space of furrow under maize canopy was estimated. The sum of this quantity (E_A) and evapotranspiration (*ET*) were compared with the sum of evaporation (*E*) from soil surface and transpiration (*T*). $ET+E_A$ was smaller than $E+T$ by 7%.

6) Prediction of future change of water demand and productivity for maize following global warming in the Cukurova region, Turkey

M. Koriyama, T, Yano and T. Haraguchi

The future change of water demand and productivity of maize in the Cukurova region, Turkey were simulated by a detailed crop growth model of SWAP, which was parameterized with the measured phenology data of second maize crop in 2004. The predicted climate data were supplied by the climate subgroup of ICCAP, i.e. control present data and pseud warming data for the period of 1994-2003 in Adana. As a result of simulation, irrigation amount and ET were projected to increase by about 1.7% and 2.4%, respectively, due to temperature rise. Maize yield decreased by about 22.8% due to reduction of growing days with temperature rise.

7) Separate estimation of transpiration and evaporation from a maize field

S. Takeuchi, H.Odani and T.Yano

Observed data in the maize field in Adana in 2004 were analyzed. Evapotranspiration data were investigated with separation into evaporation and transpiration appropriately by considering occupied area of plants. It was considered that evaporated water from soil surface was horizontally transported through wind beneath the canopy. Potential transpiration and soil evaporation computed by the SWAP model agreed quite well with measured ones, while actual transpiration and soil evaporation before irrigation were not good estimated probably due to underestimate of the estimated hydraulic conductivity.