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

Masumi KORIYAMA[1], Tomohisa YANO[2] and Tomokazu HARAGUCHI[3]

[1, 3] Faculty of Agriculture, Saga University1 Honjo-cho, Saga 840-8205, JAPAN

[2] Faculty of Engineering, Kyushu Kyouritsu University

1-8 Jiyugaoka, Yahata-nishi-ku, Kitakyushu 807-8585, JAPAN

e-mail: [1] kooriyam@cc.saga-u.ac.jp

1. Introduction

Seasonal patterns of solar radiation, temperature, air humidity and precipitation are main determinants for agriculture. Climate change following global warming interacts with agriculture though various direct and indirect processes. The purpose of this study is to predict the future changes of water balance components and productivity for maize in the Cukurova region, Turkey by using the predicted climate change data.

2. Material and method

The predicted climate data were supplied by the climate subgroup of ICCAP, i.e. control present climate data and pseud warming climate data for the period of 1994-2003 in Adana. The future changes of water demand and productivity for maize were simulated by the SWAP model developed in the Netherlands (Kroes *et al.*, 1999). Maize growth was simulated using a detailed growth model of SWAP, which was parameterized with the measured phenology data of second crop maize in 2004.

3. Crop parameters

Main crop parameters in a detailed crop growth model of SWAP obtained by the field data in 2004 were temperature sum from emergence to anthesis (T_{sum1}), temperature sum from anthesis to maturity (T_{sum2}), specific leaf area (SLA), maximum root depth and crop height.

T_{sum1} and T_{sum2} are one of important crop parameters, because development rate of crop depends on temperature. Van Heemst (1988) reported that the required cumulative daily temperatures for development stages of maize were 900-1300℃ for T_{sum1} and 700-1100℃ for T_{sum2}, respectively. In this simulation, both T_{sum1} and T_{sum2} were assumed to be 900℃.

In the crop growth stage the maximum increase in leaf area index (LAI) is determined by SLA. A constant value of 0.016m²/g throughout the growing season was reported for maize (Farre *et al.*, 2000). However, as shown in Fig 1, SLA values decreased with the progress of DVS. Thus, we determined SLA values during the growing season based on the measured data. Maximum root depth was assumed to be 1.2m and crop height used to determine the potential crop evapotranspiration.

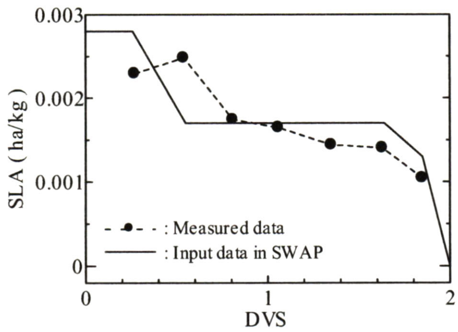

Fig.1 Relationship between development stage of crop (DVS) and SLA.

4. Simulation results

Fig.2 shows the comparison of measured and simulated values for LAI and biomass of second crop maize in 2003 and 2004. As shown in this figure, simulated values of biomass and LAI agreed approximately with measured ones.

The average values and standard deviations of the water balance components, yield, growing days and water use efficiently (WUE) for second crop maize in Adana for the periods of 10 years using the created climate data are presented in Table 1.
Irrigation amount was calculated under the optimal irrigation condition. The annual

average temperature for 10 years of pseud warming climate data was about 1.38℃ higher than one of control present climate data.

Irrigation amount and evapotranspiration (ET) were projected to increase by about 1.7% and 2.4%, respectively, due to temperature rise in the future.

Maize yield decreased by about 22.8% due to reduction of growing days following temperature rise. High temperature accelerates the phenology of plants and results in quicker maturation. In this simulation, duration of growth period

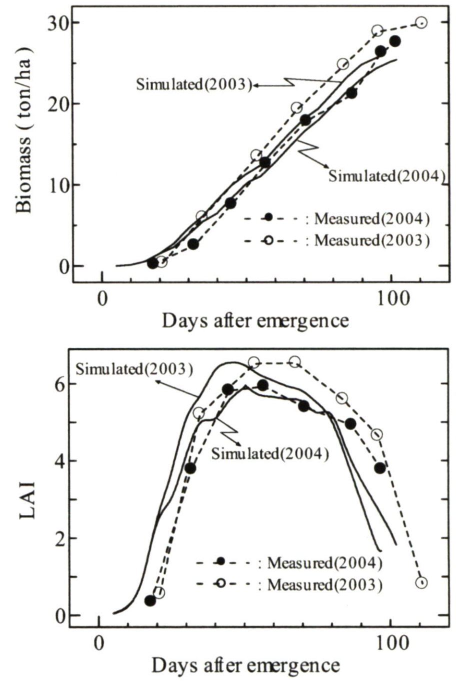

Fig.2 Comparison of measured and simulated values for biomass and LAI in 2003 and 2004.

Table1 Calculation of water balance components, yield, growing days and WUE of second crop maize

Climate data	Precipitation (mm)	ET (mm)	Irrigation (mm)	Yield (ton/ha)	Growing days	WUE (kg/mm)
Control present	56.9±36.6	694.0± 119.0	770.7± 144.1	9.81±2.02	100.0±2.7	33.9± 10.3
Pseud warming	46.8±30.8	710.9± 124.8	783.7± 122.3	7.57±2.35	95.4±2.7	26.2± 10.2

became shorter by about 5 days. WUE decreased by about 22.8% due to more decrease in biomass in spite of increase of transpiration.

5. Conclusions

In this study, parameterization of a detailed crop growth model of SWAP for maize was done based on the experimental data in 2004. And, future changes of water balance components and yield for second crop maize were simulated using the created climate data. Simulation values of biomass and LAI for second crop maize in 2003 and 2004 agreed approximately with measured ones. ET and irrigation amounts for second crop maize were projected to increase by 1.7% and 2.4%, respectively, due to temperature rise. However, maize yield were projected to decrease by 22.8% due to reduction of growing days following temperature rise.

References

Kroes, J. G., van Dam, J.C. and Huygan, J. (1999). Technical document 53, DLO Winard Staring Centre, Wageningen.

Van Heemst, H.D.J.(1988). Plant data values required for simple and universal simulation models. Wageningen, The Netherlands, Simulation reports CABO-TT,No16,100pp.

Farre.I, M.van Oijen, P.A.Leffelaar and J.M. Faci. (2000). Analysis of maize growth for different irrigation strategies in northeastern Spain. European of Journal of Agronomy. 12. 225-238.