**Simulation of crop productivity in Seyhan Plain under changing global climate using the SWAP model**
**(Establishment of maize crop parameters in the SWAP detailed crop model)**

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## 1. Introduction

The effect of climate change on the crop productivity is investigated by the experimental method using a growth chamber or by the numerical method using a crop model.

The objective of this research is to estimate the crop parameters for maize in a detailed crop model, which is integrated into the SWAP model, using the field maize data in Adana. Then, in order to investigate the validity of crop parameters obtained by this research, we simulate the crop growth of first and second crop maize in 2003 and compare simulated values and measured data for LAI and cumulative dry matter weight.

## 2. Material

Maize filed experiments were conducted in 2003 at commercial filed located 40km south from Adana, Turkey to obtain crop data which are required to simulate the crop growth by the SWAP model. Maize (Pioneer31G98) was used for the experiments. Filed experiments were conducted two cropping seasons. Planting – harvest dates of first and second crop maize in 2003 (2003F and 2003S)and second crop maize in 2004 (2004S) were April 6 – September 10, June 19 – November 8 and June 28 – October 25, respectively.

## 3. Results of filed experiments

Fig.1 shows the dry root weight profile for 2003F and 2003S. As shown in this figure, dry root weight decreased with the soil depth, and the maximum root depth of 2003F and 2003S was 100cm depth and 80cm depth, respectively. Then, dry root weight concentrated in the range from ground surface to about 40cm depth.

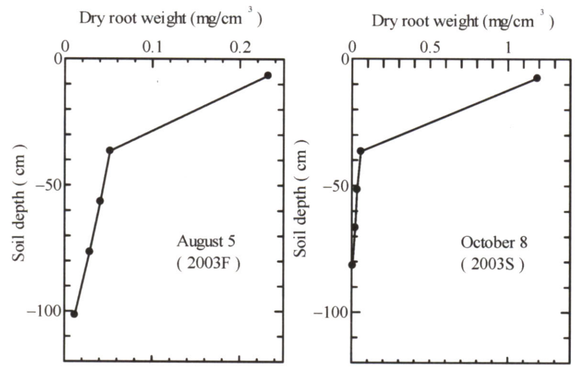


**Fig.1** Dry root weight profile

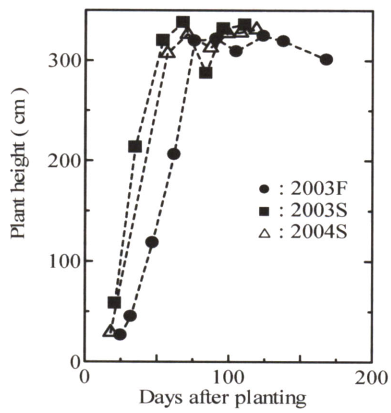


**Fig.2** Temporal variation of plant height

Fig.2 shows the temporal variation of plant height. As shown in this figure, the maximum plant height of 2003F was about 320cm before and after 100days from planting. On the other hand, in the case of 2003S and 2004S, it was about 330cm before and after 75days from planting.

Figs. 3 and 4 show the temporal variation of LAI and the cumulative dry matter weight. As shown in these figures, the maximum LAI values increased to the range from 6.0 to 6.5. The cumulative dry weight of 2003F was about 38.2 ton/ha after 170 days from planting, and one of 2003S and 2004S was about 28.0 ton/ha after 100 days from planting.

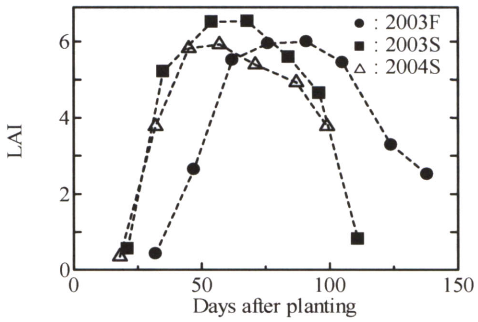


**Fig.3** Temporal variation of LAI

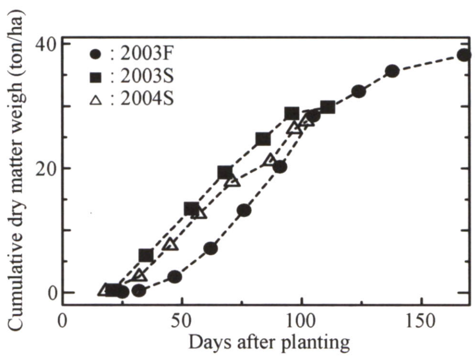


**Fig.4** Cumulative dry matter weigh

**Table 1** Phenology in 2004S

| | |
|---|---|
| Sowing | June 28 |
| Emergency | July 5 |
| Anthesis | August 24 |
| Maturity | October 14 |
| Harvest | October 25 |

**Table 2** Main crop parameters to be adjusted in a detailed crop model.

| |
|---|
| * Temperature sum for the development rate of crop |
| * Specific leaf area |
| * Life span of leaves at optimum conditions |
| * Initial total crop dry weight |
| * Conversion of assimilates into biomass |
| * Fraction of dry matter increase partitioned to organs |
| * Maintenance respiration |
| * Reduction factor for senescence |

## 4. Parameterization of a detailed crop model in the SWAP model

The SWAP model contains two crop models. That is, a detailed crop model and a simple crop model. A simple crop model mainly simulates the water balance in crop cycle, but cannot simulate the crop growth. On the other hand, a detailed crop model can simulate the crop growth, but detailed crop growth data need to be specified. In order to simulate the change of crop growth and crop productivity following climate change, we use a detailed crop model.

Maize crop parameters were estimated form the reliable detailed crop growth data in 2004S. Table 1 and Table 2 list the main phenology of 2004S and the main crop parameters to be adjusted in a detailed crop model, respectively.

Temperature sum and specific leaf area are one of the important factors in the crop parameters. Because the development rate of crop can depend on temperature, appropriate temperature sums should be defined to determine the development stage of crop. In the crop growth stage the maximum increase in leaf area index is determined by the specific leaf area. So, the specific leaf area of maize need to be specified in each development stage.

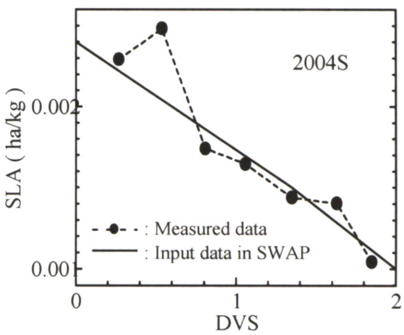


**Fig.5** Relationship between DVS and SLA in 2004S

Fig.5 shows the relationship between development stage of crop (DVS) and specific leaf area (SLA) in 2004S. As shown in this figure, SLA decreased with increasing DVS. In this simulation, we defined the relationship between DVS and SLA ((DVS, SLA)) as (0, 0.0024), (1.35, 0.0015) and (2.0, 0.001).

Applied irrigation depth and date to 2004S are listed in Table 3.

**Table 3** Irrigation schedule in 2004S

| Date | Irrigation depth (mm) |
|---|---|
| July 1 | 44 |
| July 6 | 52 |
| July 28 | 160 |
| August 11 | 102 |
| August 26 | 127 |
| September 14 | 138 |

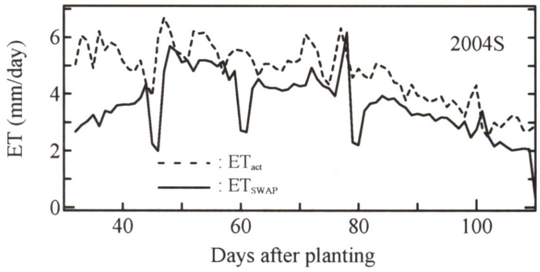


**Fig.8** Comparison of $ET_{act}$ and $ET_{SWAP}$ in 2004S

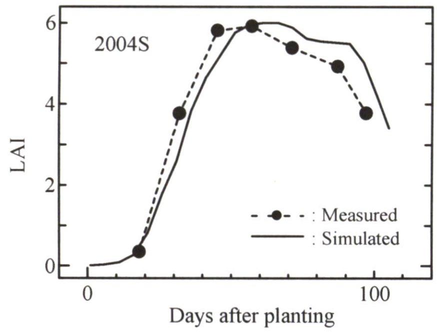


**Fig.6** Comparison of measured and simulated values for LAI in 2004S

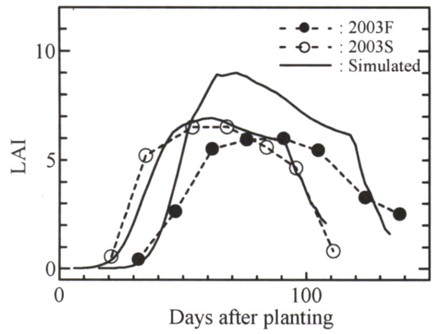


**Fig.9** Comparison of measured and simulated values for LAI in 2003F and 2003S

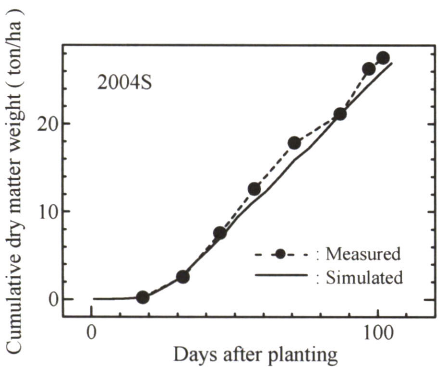


**Fig.7** Comparison of measured and simulated values for cumulative dry matter weight in 2004S

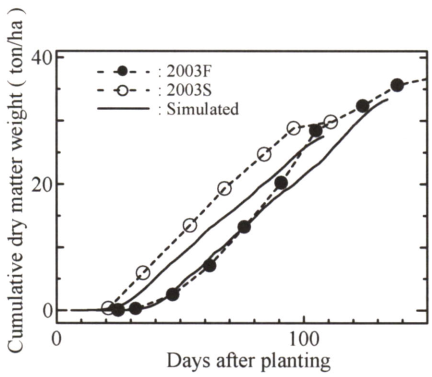


**Fig.10** Comparison of measured and simulated values for cumulative dry matter weight in 2003F and 2003S

## 5. Simulation results of crop growth

Figs.6 and 7 show the comparison of measured and simulated values for LAI and cumulative dry matter weight in 2004S. As shown in these figures, the simulated values agreed well with the measured data.

Fig.8 shows the temporal variation of measured evapotranspiration data (ETact) and simulated evapotranspiration values (ETSWAP) in 2004S.

As shown in this figure, although ETSWAP underestimated ETact slightly as a whole, ETSWAP reproduced well the variation of ETact. In order to investigate the validity of crop parameters that adjusted using the crop growth data of 2004S, we simulated the crop growth in

2003F and 2003S.

Figs.9 and 10 show the measured and simulated values for LAI and cumulative dry matter weight in 2003F and 2003S. As shown in theses figures, the simulated cumulative dry matter weight agreed substantially with the measured data in 2003F and 2003S. On the other hand, although the simulated LAI values agreed well with the measured data in 2003S, those of 2003F were larger than the measured data. We consider that this difference in LAI is caused by the difference in SLA in early DVS between first and second crop maize. That is, because SLA in early DVS of 2003F was lower than one of 2003S and 2004S, the simulated LAI values of 2003F were larger than the measured data. From now on, it is necessary to adjust the crop parameters using many phenology data.

## 6. Conclusions

In this research, maize crop parameters in a detailed crop model were estimated using the field data of 2004S in Adana. Then, we simulated the crop growth of 2004S by the SWAP model and compared simulated values and measured data. Consequently, the simulated values for LAI, cumulative dry matter weight and ET agreed substantially with the measured data. Next, we simulated the crop growth of 2003F and 2003S using the crop parameters adjusted by the field data of 2004S. As a result, although the simulated values of LAI and cumulative dry matter weight in 2003S agreed with the measured data, the simulated LAI values in 2003F were larger than measured data. It was considered that the result was mainly caused by the difference in SLA in early DVS between first and second crop maize.

From now on, we are planning to adjust the crop parameters using many phenology data. After adjustment of crop parameters, we will simulate the crop growth of maize using RCM pseudo warming run and will be done to predict water balance and crop production in first and second crop maize following climate changes.