V. CONCLUSIONS

This study provides the first data on the phenology, growth, and reproductive output of wild C3 and C4 species affected by a simultaneous increase in temperature and CO_2 under field-like meteorological conditions.

These data were obtained in the TGC and CTGC, which were recently built to study the effects of elevated temperature and CO_2 on plant growth under more realistic conditions than previous experiments allowed for. The global warming conditions were simulated throughout the full plant growth period. The TGC and CTGC facilities easily accommodated physiological and ecological responses to the elevated temperature and CO_2 under real field conditions. Current knowledge about the processes and the quantities of trace substance exchanges between the atmosphere and the ecosystems are often based on short-term flux measurements (mostly temporal and spatial scales or only CO_2-elevated conditions). However, the information from the experiments conducted with the TGC and the CTGC can serve to answer many questions, particularly regarding plant production or canopy photosynthesis models and models describing the net carbon balance of an ecosystem which requires data sets of higher temporal and spatial resolution.

The CO_2 fertilizer effect on the growth of C3 plants would not be fully stimulated, at least during the vegetative stage, because plants would be grown by advanced plant phenology thermal conditions similar to current atmospheric conditions. However, this shifted phenology confers upon the C3 plant population high growth ability under low temperatures. On the other hand, the higher temperature during the summer resulted in a clear decrease in the growth rate for C3 species under current CO_2 concentration conditions. However, the elevated CO_2 would fully compensate for the negative effect of high temperatures, which mainly resulted from sustaining relatively higher *NAR* and *LAI*. This advantage will enable the *C. album* to construct a stand structure composed of various sizes, which could allow for the efficient acquirement of resources. As a result, productivity and reproductive output of the C3 species greatly increases with the simultaneous increase in temperature and CO_2.

On the contrary, the C4 plant populations showed no response or even a negative response to elevated temperature and CO_2 in the productivity of dry-matter production and reproductive output. These outcomes, due to low or almost identical thermal conditions, were ensured from advanced phenology. Although the decrease in the productivity of the C4 plant populations would be compensated by elevated CO_2,this effect was very slight in comparison with its importance in the C3 species.

Consequently, expansion of the area dominated by C3 species would accompany global warming. This interpretation is consistent with the finding that the change in C3 and C4 species' geographic distributions will be related to changing CO_2 concentration (Cerling *et al.*, 1993; Coie and Monger, 1994) and that C4 grass species will lose their competitive advantage over C3 grass species in elevated atmospheric CO_2 (Bazzaz, 1990; Bowes, 1993; Ehleringer and Monson, 1993; Wand *et al.*, 1999). C3 species can take advantage of elevated CO_2 and thereby improve their fitness and their competitive abilities in a C3/C4 co-occurring grassland (Patterson *et al.*, 1984; Zangerl and Bazzaz, 1984; Curtis *et al.*, 1989). The plants with the C3 photosynthetic pathway should gain dominance relative to those with the C4 pathway (Bazzaz, 1990; Poorter, 1993). The difference in response to global warming may shift the boundaries between C4-dominated and C3-dominanted regions. In the climate change accompanying simultaneous increase in atmospheric CO_2 and temperature, a C3 dominated-community would extend their current area because C3 species favor global warming more than C4 species do. The overall trend of increasing dry matter and seed production for C3 plants with increasing temperature and CO_2 suggests that the distribution and abundance of future C3 populations in a hotter and higher CO_2 world is likely to change.