Developing a stress diagnosis system for evaluating drought tolerance of *Ambrosia artemisiifolia* L.

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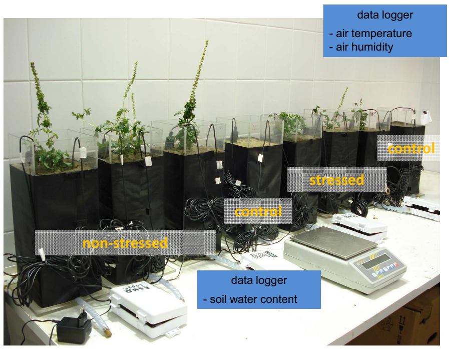
Introduction

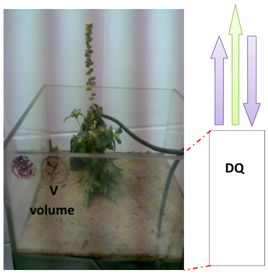
Common ragweed has invaded large areas and become number one agricultural weed in Hungary. We have been developing a stress diagnosis system for studying environmental stress tolerance of ragweed. Stress diagnosis systems functioning in climatic rooms under controlled light and temperature conditions are suitable for simulation of field conditions covering the whole lifetime of individuals and can provide precise data on plant response and soil water balance elements. Accurate calculations on soil moisture regime, evaporation, and transpiration are complementary to field experiment data, and may be used as input for simulation modelling of different climate conditions. Climate change scenarios developed for the Carpathian Basin for the nearest future predict further decrease in surface water resources and increased number of drought events. Studying species performance under altered weather conditions may help us predict future performance and spread of ragweed.

In this experiment, we imitated drought and non-drought precipitation conditions in the Great Hungarian Plain to get data on soil water balance elements and plant growth characteristics under water stress condition. This poster intends to introduce the experimental setup and the preliminary results of our study.



Soil water balance elements in the soil column

DQ • V = I - E - TR



TR - plant water uptake (calculated from the soil water balance equation)

I - irrigation water (according to the irrigation strategy)

E - evapotranspiration (calculated from changes in soil water content in control columns without plant)

DQ – changes in soil water content (measured)

V – volume of the soil column (known)

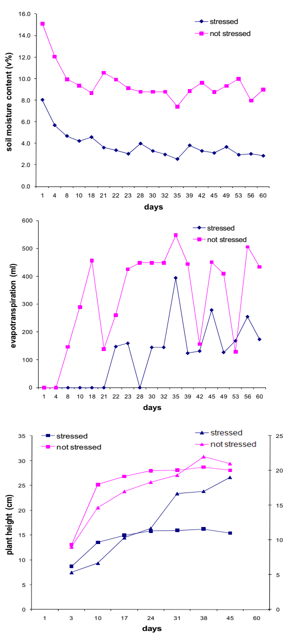
Methods

We applied two irrigation strategies to common ragweed individuals imitating drought and non-drought precipitation conditions in a soil column experiment. Soil columns were filled up with local soil of known bulk density and hydraulic properties. Levels of water supply were set according to Hungarian field data on precipitation during drought (8 v%) and non-drought periods (15 v% moisture content in the soil). Irrigation was applied when soil water content had decreased to lower boundary values (3 v% and 10 v%, respectively).

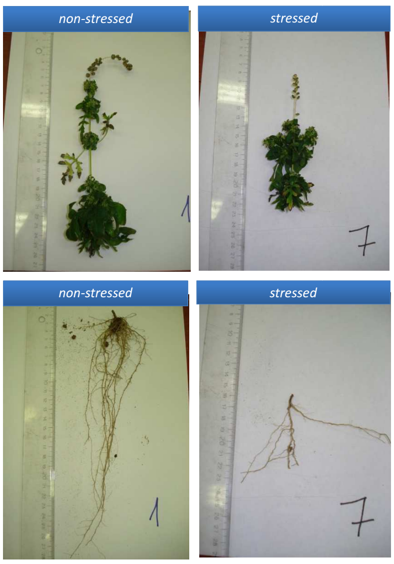
In this pilot project, we used stressed and non-stressed plants in three replicates. Seedlings were planted at the growth stage of two true leaves into the columns. The experiment ran 60 days (from 4 September to 3 November 2009) until the beginning of plant senescence. We measured soil water content and evapotranspiration to calculate soil water balance elements and phenological characteristics of common ragweed in response to stress and non-stress treatments.

Measured attributes

Soil parameters	**Plant growth**
At the beginning of the experiment	*Weekly*
Soil bulk density (set according to data measured on undisturbed soil samples)	Height and longest width of the individuals
Saturated water content (measured for four soil coloumns and on 100 cm3 soil samples in three replicates)	Number of leaves (larger than 2 cms)
Soil water retention curve (measured in three replicates from 100 cm3 soil samples)	Number of branches
Soil texture	Length of the longest branch
Soil organic matter content	Length and width of the largest leaf
	Total leaf area calculated by photographing and measuring each leaf larger than 2 cms
Continually	*At the end of the experiment*
Soil moisture content	N and P content of the plants
	Shoot mass
	Root length and mass
	Total length and mass of male flowers
	Seed mass and seed number



Soil water content, evapotranspiration in the experimental columns, and plant height and number of leaves of ragweed individuals (average of three replicates) in response to drought.



Typical shoot and root of non-stressed and stressed individuals after harvesting at the end of the experiment.

Preliminary results

Since there was no water limitation, soil water content and evapotranspiration of non-stressed individuals was higher than those of stressed ones during the whole experiment. However, it is difficult to make any assessment about the amount of water, consumed by plants and about their water use efficiency. For more exact evaluation of the results physically based soil water balance simulation model has to be adapted for the experimental conditions. After calculating plant water uptake, this information could be used as input data for ecological models, evaluating the effects of drought stress on plant biodiversity.

Despite pronounced drought stress, ragweed individuals were able to survive and produce a large amount of pollen and seeds. However, non-stressed individuals performed better in each measured plant attribute (total seed number, total weight, root and shoot weight and rooting depth) compared to stressed ones. Differences are pronounced despite low replicate number. Drought stress did not changed shoot/root ratio or seed weight significantly. Stressed individuals produced 20 per cent more seeds per total dry mass unit than non-stressed specimen.

	Mean		
	non-stressed	**stressed**	**p-level**
Seed number	127.67	90.33	*0.8273*
Average seed weight (g)	0.01	0.01	*0.8273*
Total dry weight (g)	2.73	1.31	*0.1266*
Dry root weight (g)	0.24	0.10	*0.0495*
Dry shoot weight (g)	2.49	1.21	*0.1266*
Shoot/root ratio	11.32	11.52	*0.8273*
Rooting depth (cm)	30.33	19.00	*0.5127*

Plant attributes at the end of the experiment (average of three replicates; p values show significant differences according to Mann-Whitney U test)

Conclusions

In future experiments, we will concentrate on plant development at different phenological stages. Up to nine replicates are going to be used in the experiment, and 1-1 plant will be analysed for moist and dry weight (leaves, stem and roots separately), root distribution and LAI approximately 4-5 times during the growing season.

We believe, that water balance element measurements could satisfactorily be completed with mathematical modelling of water fluxes in the soil-plant-atmosphere system. We concluded, that the constructed dataset is appropriate and could be used for defining initial and boundary conditions of such a model and for its successful parameterisation and calibration.

Our results may help investigate the effects of predicted climate change scenarios on the geographic ranges of common ragweed using simulation modelling and GIS approaches.