WATER AVAILABILITY OF FIELD CROP SPECIES IN HUNGARY

Tarnawa Á., Kende Z., Kassai M.K., Jolánkai M

Agronomy Institute, Hungarian University of Agriculture and Life Sciences MATE, Gödöllő

jolankai.marton@uni.mate.hu

Abstract

Water budget of cropping systems is driven by various factors from among which temperature and precipitation patterns are the most influential. The annual mean temperature in most parts of Hungary is between 10 and 11 °C. The spatial distribution of temperature is primarily influenced by the geographic position. The annual precipitation amount in Hungary is 500–750 mm with remarkable differences between different regions. The spatial distribution of the annual precipitation amount is affected by the altitude and the distance from marine ecosystems.

Inefficient water availability of live systems ranges from scarcity to drought. Drought is a physiological water stress causing irreversible changes in live structures. Drought can only be handled by appropriate management techniques, by reliable land use and cultivation of crop species suitable for the climatic conditions. The identification of drought can be assessed only by polyfactorial methods. The present study focuses on drought processes and evapotranspiration patterns of the major field crop species of Hungary providing evaluation of their climatic vulnerability.

Material and methods

An assessment study has been conducted at the MATE University, Gödöllő to evaluate and identify the main factors of drought regarding field crop species. In the survey databases of the Hungarian Meteorological Service (OMSZ) and the Ministry of Agriculture have been used. The use of drought indices was based on the research results of the European ADAM project while the evapotranspiration patterns of crop species have been determined in accordance with the crop production evaluations of the VAHAVA. In the study twelve crop species (Sugar beet *Beta vulgaris*, spring and winter barley *Hordeum vulgare*, winter wheat *Triticum aestivum*, maize *Zea mays*, sunflower *Helianthus annuus*, field peas *Pisum sativum*, potato *Solanum tuberosum*, alfalfa *Medicago sativa*, oil seed rape *Brassica napus* and oats *Avena sativa*) were involved. Evapotranspiration monthly water consumption data were compared to precipitation means, and monthly water availability budgets were identified. The water availability budget modelling has been done at the MATE AgronomyInstitute.

Figure 1
Annual mean temperature in Hungary (40ys mean)
Source OMSZ

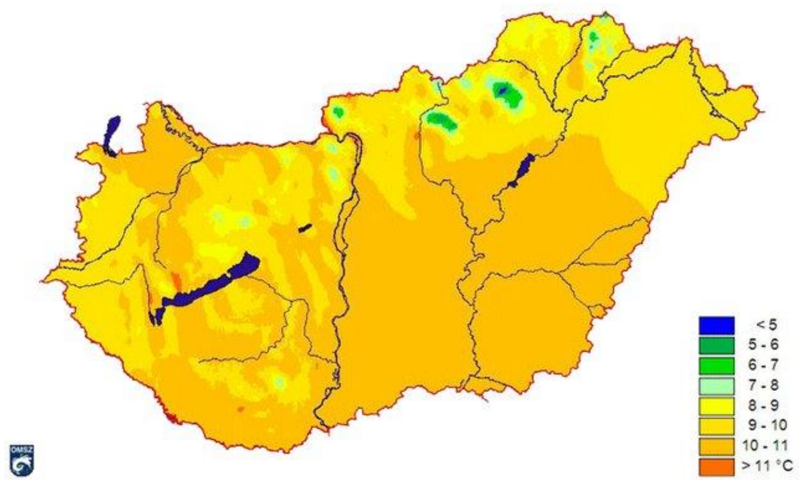
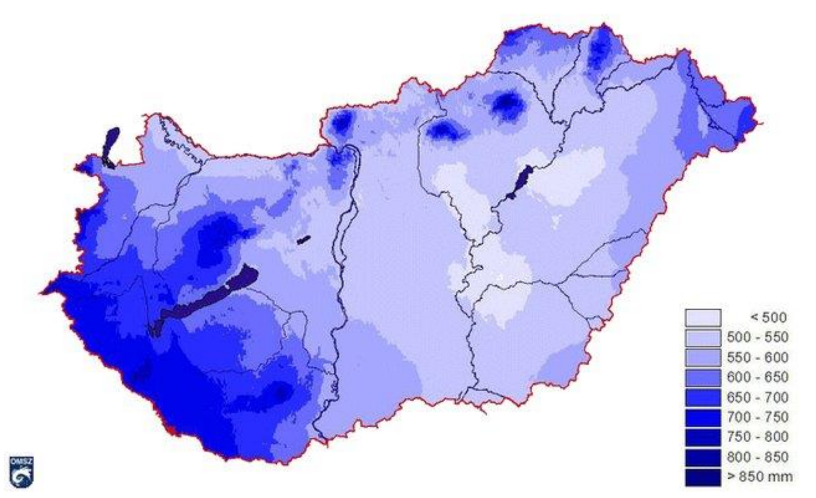


Figure 2
Annual mean precipitation (40ys mean)
Source OMSZ



Results and discussion

Field crop species respond to water availability in accordance with their life cycle and fenophases. The results obtained suggest, that field crop species respond in a diverse way to drought phenomena. Winter crops tend to have a positive water budget during most of their life cycle, however spring crops rely on precipitation prior to the vegetation period, or they would need additional water supply in form of irrigation. Increasing drought due to climate change may induce alterations in the cropping structure.

Studies on climate change deal with scenarios that are calculating with no major changes in the precipitation patterns, however they suggest an evidence of radiation and temperature increment of an unprecedented rate for the region, the interaction of the two phenomena may lead to the reduction of water availability.

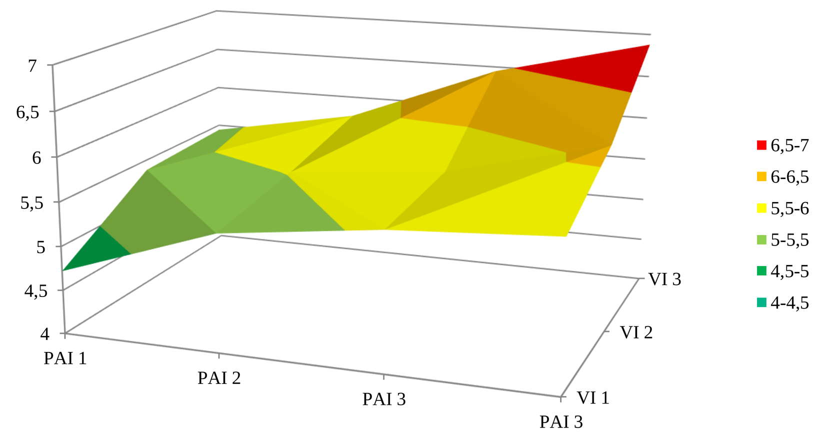
Conclusions

Evaluating water availability for field crops in relation with their evapotranspiraton patterns, it can be concluded, that field crop species respond in various ways to water scarcity phenomena. Winter crops tend to have a positive water budget during most of their life cycle, however spring crops rely on precipitation prior to the vegetation period. Aridity times vulnerability interctions provide a good indicator for crop site evaluation.

Table 1.
Aridity and vulnerability (PAI / VI) values for 12 field crop species

	PAI / VI	wheat	maize	winter barley	spring barley*	rye	oats	peas	sunflower	oilseed rape	alfalfa	sugar beet	potato	mean
		5,6	**7,3**	**5,8**	**5,7**	**6,7**	**5,8**	**6,3**	**6,1**	**6,4**	**7,6**	**7,7**	**6,5**	**6,5**
Békéscsaba	**5.47**	5,5	6,4	5,6	5,6	6,1	5,6	5,9	5,8	5,9	6,5	6,6	6,0	6,0
Budapest	**5.85**	5,7	6,6	5,8	5,8	6,3	5,8	6,1	6,0	6,1	6,7	6,8	6,2	6,2
Debrecen	**4.91**	5,3	6,1	5,4	5,4	5,8	5,4	5,6	5,5	5,7	6,3	6,3	5,7	5,7
Miskolc	**4.18**	4,9	5,7	5,0	4,9	5,4	5,0	5,2	5,1	5,3	5,9	5,9	5,3	5,3
Mosonmagyaróvár	**4.69**	5,1	6,0	5,2	5,2	5,7	5,2	5,5	5,4	5,5	6,1	6,2	5,6	5,6
Nagykanizsa	**3.79**	4,7	5,5	4,8	4,7	5,2	4,8	5,0	4,9	5,1	5,7	5,7	5,1	5,1
Nyíregyháza	**5.23**	5,4	6,3	5,5	5,5	6,0	5,5	5,8	5,7	5,8	6,4	6,5	5,9	5,9
Pécs	**4.22**	4,9	5,8	5,0	5,0	5,5	5,0	5,3	5,2	5,3	5,9	6,0	5,4	5,4
Siófok	**5.07**	5,3	6,2	5,4	5,4	5,9	5,4	5,7	5,6	5,7	6,3	6,4	5,8	5,8
Szeged	**5.88**	5,7	6,6	5,8	5,8	6,3	5,8	6,1	6,0	6,1	6,7	6,8	6,2	6,2
Szolnok	**6.02**	5,8	6,7	5,9	5,9	6,4	5,9	6,2	6,1	6,3	6,8	6,9	6,3	6,3
Szombathely	**3.79**	4,7	5,5	4,8	4,7	5,2	4,8	5,0	4,9	5,1	5,7	5,7	5,1	5,1
mean	**4.92**	5,2	6,1	5,4	5,4	5,8	5,4	5,6	5,5	5,7	6,3	6,3	5,7	5,7

Picture 1
The interaction between aridity and vulnerability representing the occurence in Hungarian regions.



References

Hulme M. – Neufeldt H. – Colyer H. – Ritchie A. /Eds/ (2009): Adaptation and mitigation strategies: Supporting European climate policy. The Final Report of the ADAM project. Tyndall Centre for Climate Change Researech, UEA, Norwich, UK.; Jolánkai M. – Birkás M. (2009): Climate change and water availability in the agro-ecosystems of Hungary. Columbia University Seminars. 38-39. 171-180 pp.; Jolánkai M. – Kren J. – Smutny V. – Birkás M. (2011): Land use system analysis approach. Proceedings. 46th Croatian – 6th International Symposium on Agriculture. Opatija. 102-106 pp.; Jolánkai M. – Tarnawa Á. – Kassai M.K. – Eser A. – Kende Z. (2021): Water footprint of the protein formation of six of field crop species. Environmental Analysis & Ecology Studies 8(3). EAES. 000686. 2021. DOI: 10.31031/EAES.2021.08.000686; Khalid N. – Tarnawa Á. – Kende Z. – Kassai M.K. – Jolánkai M. (2021): Viability of maize (Zea mays L) seeds influenced by water, temperature, and salinity stress. Acta Hydrologica Slovaca. 22. 1. 113-117 pp. DOI: 10.31577/ahs-2021-0022.01.0013; Láng I. – Csete L. – Jolánkai M. /Eds./ (2007): A globális klímaváltozás: hazai hatások és válaszok. A VAHAVA Jelentés. (*Global climate change: impacts and responses. The VAHAVA Report*). Szaktudás Kiadó Ház, Budapest.; OMSZ (20219: Meteorological overview of Hungary, https://www.met.hu/en/eghajlat/magyarorszag_eghajlata/altalanos_eghajlati_jellemzes ; OMSZ (2012): Some characteristics of the climate of Hungary 1901-2005. www.met.hu; Vermes L. /Ed./ (2011): Aszálystratégia (*Drought strategy*). Manuscript, VM, Budapest. 43 p.;

,

;

Acknowledgements

The authors are indebted receiving financial support for the recent research from the Hungarian project funds of the Government of Hungary.