Global Climate Change Impacts on Crop Production in Hungary

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Summary

Global climate change is one of the major issues today. There is a continuous rise in temperature escorted by the increasing frequencies of weather anomalies. In Hungary two facts can be observed: the ascending levels of temperature rise, with a magnitude of 1 ^oC and the annual precipitation decrease. Human activities are significantly altering the natural carbon cycle. Long-term rise in atmospheric CO_2 affects crop production regarding both adaptation and mitigation. The negative effects of climate change can be limited by changing crops and crop varieties, improved water-management and irrigation systems, adapted plant nutrition, protection and tillage practices, and better watershed management and land-use planning. The global potential of carbon sequestration through crop production, land use and soil management practices may offset one-fourth to one-third of the annual increase in atmospheric CO_2.

Key words

carbon sequestration, climate change, crop production, soil condition

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Introduction

Climate change impacts are a major threat. The continuous rise in temperature escorted by the increasing frequencies of weather anomalies is a global process. In Hungary two facts can be observed in the Carpathian basin: in first place the ascending levels of temperature rise with a magnitude of 1°C. The other is the decreasing trend-line of annual precipitation according to which rainfall was diminished by 83 mm during one century (Fig 1). Human activities are significantly altering the natural carbon cycle. During the past two centuries human activities such as the burning of fossil fuels and deforestation have accelerated, and both have contributed to a long-term rise in atmospheric CO_2. The Ministry of Environment and Water in cooperation with the Hungarian Academy of Sciences has launched a three year project (vahava) between 2003 – 2006. The primary objective of the research was to analyse the changing nature of harmful or favorable meteorological effects with the goal to prevent the harmful effects, and make the best use of the favorable ones. This work should lead to determination of the economical, technical, and social factors, which may be relevant to damage control. The present paper will give some information regarding the results of the work of the crop production team of the project.

Material and methods

The main objectives of the project: exploration of complex impacts of reliable scenarios on climate change; response suggestions and proposals, as well as emergency programmes which may prevent or lessen undesirable effects on national and regional levels.

The main characteristics of methodology are: large-scale system synthesis, interdisciplinary and multisectoral approach, and broad spectrum partnership relations. The agronomic faculties and agricultural research institutions of the country were involved in the crop production research team, which was coordinated by the Szent Istvan University, Institute of Crop Production.

In planning the project, the IPCC scenarios were used as a start-point. The most likely pattern of climate change in the region including Hungary is characterized by the following assumptions: gradual warming will be noticeable, and the climate of the country may assume a more pronounced Mediterranean character; annual precipitation further declines, particularly in summer; the frequency and intensity of extreme meteorological events increase. The main research fields were the evaluation of the evapotranspiration budget of major field crops in relation with agronomic technologies and soil condition, and the carbon sequestration of crop biomass produced.

Results and discussion

Hungary is a country exposed to continental and Mediterranean climatic effects. It would mean that the area is suitable for the cultivation of most crops. Heat amount is in optimum even for subtropical annual plants like maize, and precipitation, which ranges from 300 mm to 700 mm, enables this country to run a successful crop production.

Most important climatic factors are light, heat, and precipitation. Light is one of the most important factors in the life of plants. The main characteristics are the quality (spectra), intensity and duration, temperature and heat. All crops require an optimum amount of heat during their life cycle. In Hungary the average heat amount is 3608 °C annually. According to the geographic location this may vary for ±5-10 %. The direct impact of temperature can be detected in most of life processes: photosynthesis, respiration, transpiration, water inhibition, and mineral uptake. Precipitation is the major source of natural water

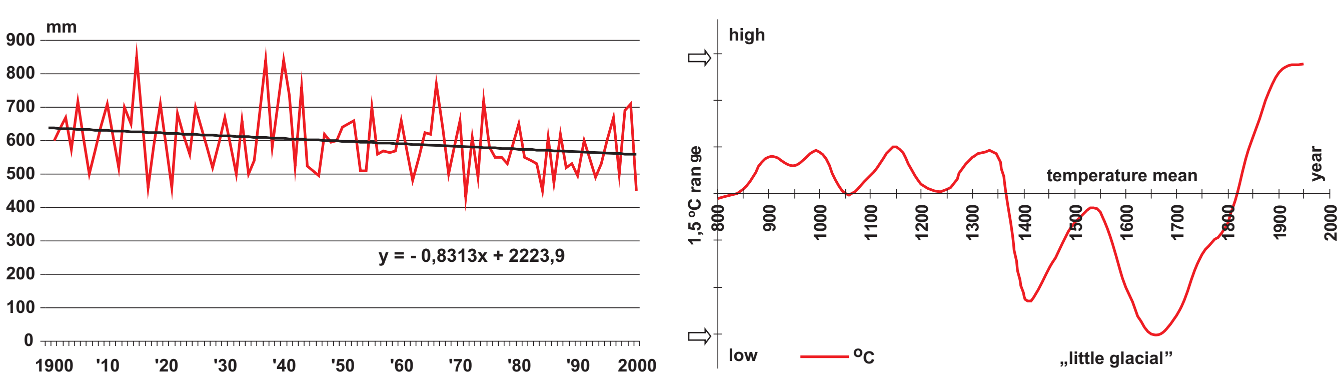

Figure 1. Amount of annual precipitation and temperature trends in Central Europe (Time range of precipitation refers to the 20th Century, temperature changes are calculated on mean values of the 11th-20th Centuries period. SourceVarga-Haszonits 2003)

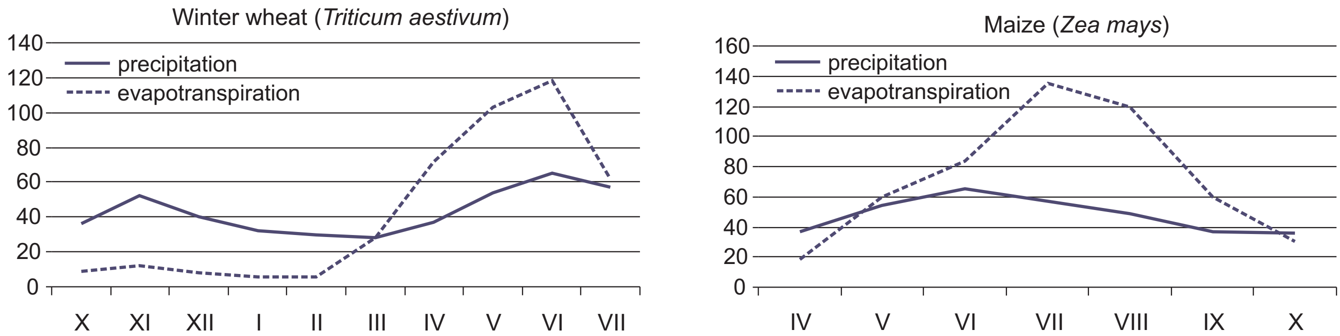

Figure 2. Evapotranspiration budget of field crops, mm/month, Gödöllő-Nagygombos, 40 years mean

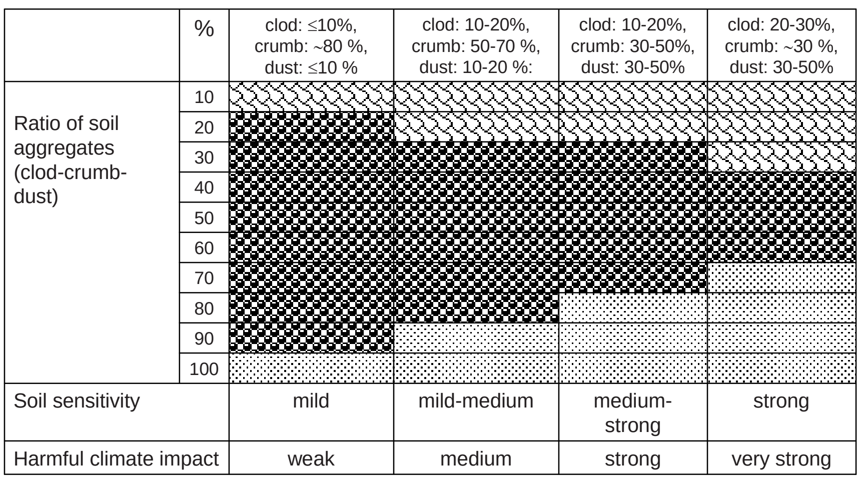

Figure 3.
Agronomic value of soil conditions

supply. There are two major characteristics of that; one is the amount of water (500-700mm is sufficient for all sort of crops) and the other is the distribution. In the summer, only 60-80 % of percipitation can be utilized by plants, since high evapotranspiration rates occur (Fig 2).

Soil factors highly influence the life of plants. Soil structure is composed of its ingredients, ie. organic and inorganic components, their amount, size, distribution and geometrical orientation. Soils as materials are made up of three phases; solid (organic and mineral), liquid (water and solutions) and gaseous materials. The geometric orientation of soil particles determines the soil texture. Soil is the medium that provides water and nutrients to plants. At this geographic latitude plants require 250-400 g of water to build 1 g of dry matter. This water/dry matter ratio is called the transpiration coefficient. Since cultivated plants produce far more dry matter compared to natural vegetation, consequently their water demand is higher as well. From the aspect of soil management water storage and supply abilities of soils of a certain field should be determined (Fig 3).

Atmospheric rise of CO_2 affects crop production regarding both adaptation and mitigation. The negative ef-

Table 1. Carbon content of some amino-acids, carbohydrates and polypeptides

	C wt	H wt	N wt	O wt	S wt	Mol weight	C %
glycine	24	5	14	32	0	75	32.000
alanine	36	7	14	32	0	89	40.449
serine	36	7	14	48	0	105	34.286
cysteine	36	7	14	32	32	121	29.752
phenylalanine	108	11	14	32	0	165	65.455
tyrosine	108	11	14	48	0	181	59.669
tryptophan	132	12	28	32	0	204	64.706
valine	60	11	14	32	0	117	51.282
threonine	48	9	14	48	0	119	40.336
methionin	60	11	14	32	32	149	40.268
leucine	72	13	14	32	0	131	54.962
isoleucine	72	13	14	32	0	131	54.962
proline	60	6	14	32	0	112	53.571
histidine	72	9	42	32	0	155	46.452
arginine	60	14	56	32	0	162	37.037
lysine	72	14	28	32	0	146	49.315
asaparaticacid	48	7	14	64	0	133	36.090
asparagine	48	7	28	48	0	131	36.641
glutamicacid	60	10	14	64	0	148	40.541
glutamine	60	10	28	48	0	146	41.096
carbohydrate	12	2	0	16	0	30	40.000
glutatione	120	17	42	96	32	307	39.088

fects of climate change can be limited by changes in crops and crop varieties, improved water-management and irrigation systems, adapted plant nutrition, protection and tillage practices, and better watershed management and land-use planning. The global potential of carbon sequestration through crop production, land use and soil management practices may offset one-fourth to one-third of the annual increase in atmospheric CO_2. Table 1 summarizes the carbon content of some essential plant compounds and substances. The annual carbon sink of plant biomass exceeds carbon source releases. Also renewable energy provides a chance for replacing fossil fuel uses.

Conclusion

The global potential of carbon sequestration through crop production, land use and soil management practices may offset one-fourth to one-third of the annual increase in atmospheric CO_2. Major conclusions of the study:

- Improved management techniques and practices may offset 1/3-1/4^{th} of annual CO_2 increase.
- Energy uses based on fossil fuel combustion should be controlled globally.

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