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POSSIBLE RESPONSES OF PLANT PATHOGENS TO GLOBAL CLIMATE CHANGE

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Abstract: In this study are reviewed the general consequences are review in this study of the influences of glasshouse-effect elements on the plant pathogenic microbes and the presumably responses of plant resistance to abiotic stress. The climate change includes the increasing weather extremities that are growing the changeability and frequency of extraordinary meteorological events. The increased CO_2 concentration and the global climate change can contribute to the accelerated plant onthogeny, the severity of disease symptoms and caused damages. On the other hand, changes will have effects on flora elements and change pathogenic features of pathogens as well. Arising temperature might initiate the moving away of climates zones including agricultural production toward poles. Not only the vegetation but the pests also will follow these movements. The effects of the above-mentioned two main factors are fare-reaching, partly might be stimulative, in other cases obstructive. For this reason the scientific forecasting of the resultant forces are rather complicated. Furthermore the displacement of regions of agricultural and natural niche might elicit the changes of plant production species relate to their pathogens. These global changes can contribute to the occurrence of new diseases, insects, and weeds which might change the former natural plant societies in conflict with more aggressive species and/or varieties.

Key words: climate change, biodiversity, diseases, pests, *Puccinia xanthii*

Observed global trends

The first warning signs of global climate change and ecological changes appeared more than 20 years ago. The Intergovernmental Panel on Climate Change (IPCC) declared the facts in 1996: the average temperature has arisen in the latest 50 years by 0.6°C, and as a consequence of uncontrolled human activity it may arise by 1.5-5.5°C in the next 100 years [33]. The study analyzed the expectable changes on different continents, increasing deserts, arising sea-levels. Stopping of Gulf-Stream will happen because of thawing glaciers and polar icebergs moreover rains which causes dilution of seawaters and consequently the stream breaks down.

A self-induced process has started by thawing polar ice which is capable to reflect 80-90% of sunbeams as the seawater can do this in only 10-20%, so the thawing proceeds. During the previous ice-age cca. 15 thousand years ago, the average global temperature was less by 3-5°C compare to present one [20].

Eleven of the last 12 years (1995-2006) rank among the 12 warmest years since recording of global surface temperature began in 1850. An increase in the globally averaged surface temperature by 0.74°C (± 0.2°C) has occurred over the 20th century. The warming trend for the last 50 years is nearly twice that of the past 100 years, at an average warming rate of 0.13°C (± 0.03°C) per decade.

Global average sea-level has risen by an estimated 0.17 m over the 20th century. The rate of sea level rise has increased in recent years. In the period 1961 to 2003 the rate of sea-level rise was about 0.18 m/century, but in the more recent period of 1993 to 2003 this rate has increased to about 0.31 m/century. To date, the world's oceans have absorbed about 80% of the heat in the atmosphere, causing seawater to expand, contributing to sea-level rise. There has also been a global decrease in ice and snow cover, which likewise contributes to sea-level rise.

The mathematical models show that due to the expectable emissions of glasshouse effect gases and aerosols the average temperature of globe will increase with 1.4-5.8°C by 2100 [16, 33].

Causes and effects of climate change

Climate change has been caused by the release of greenhouse gases into the atmosphere. Atmospheric concentrations of CO_2 have increased by 35% since 1750, and are currently at concentrations unprecedented over the last 650,000 years. Approximately three-quarters of this are due to the burning of fossil fuel, while the rest is predominantly due to land-use change (such as deforestation). Volumes of CO_2 emissions continue to increase – emissions from fossil fuel use during the 1990's averaged at 6.4 GtC[1]/year, and increased to 7.4 GtC/year for the period 2000-2005 [24] (Fig. 1).

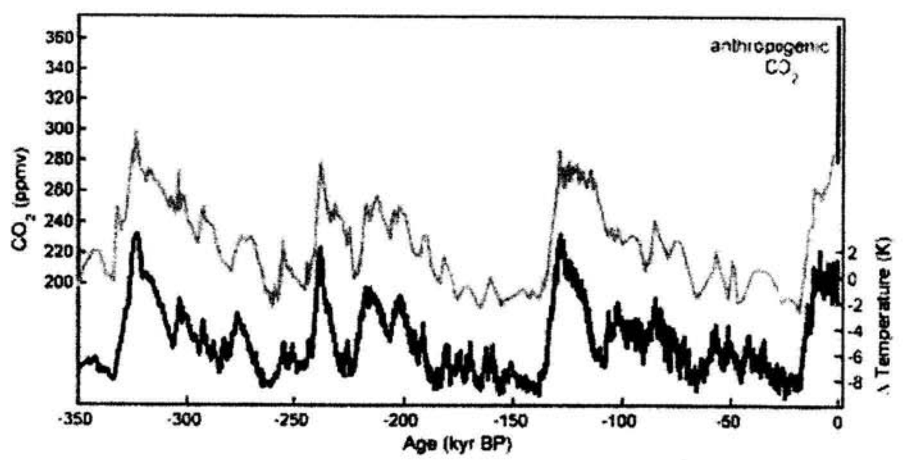

Fig. 1: Records of CO_2 (upper) and temperature (lower) over the past 350,000 years from the Vostok ice core are shown. The recent anthropogenic rise in CO_2 is marked on the right edge. Source: Rahmstorf, S. et al. (2004) [25]

Climate change is a global problem, with global causes and effects. Preventing dangerous man-made climate change and dealing with the impacts that now cannot be avoided requires efforts by all countries, consistent with their responsibility for greenhouse gas emissions, their capacity to take action, and the effects they will experience. The climate change is the greatest long-term challenge facing the world today (Fig. 2). There is strong and indisputable evidence that climate change is happening and that man-made emissions of carbon dioxide and other greenhouse gases are its main causes. The ten warmest years globally, since formal records began in 1861, have all occurred since 1994. If left unchecked global average temperatures could be as much as 5°C higher by the end of this century, with a devastating impact on our economy and natural world, and above all, in the most vulnerable developing countries.

A lot of researcher warned that climate change is not the same with global warming. Climate change includes changeable weather, so weather extremities will occur more frequent and increased [8, 12, 22, 26, 31].

Mountain glaciers generally have been shrinking and are projected to lose about 25% of their mass worldwide by the middle of the 21st century. In the European Alps, about half of the original ice volume has been lost since 1850; (as much as 95% of the existing glacier mass).

[1] Gigatons Carbon

Deforestation caused by the unsustainable harvesting of timber and the conversion of forests to other land-uses leads to significant emissions of this stored carbon back to the atmosphere. Deforestation alone currently accounts for 18% of global emissions of carbon dioxide. Forests and woodlands can also be managed as a sustainable source of wood – an alternative and less polluting energy source to fossil fuels, and a low-energy construction material. The challenge for us now is to protect what we have, and to make sure we can adapt to the new threats and opportunities that climate change will bring while still maintaining and expanding a sustainable forest and woodland resource [32].

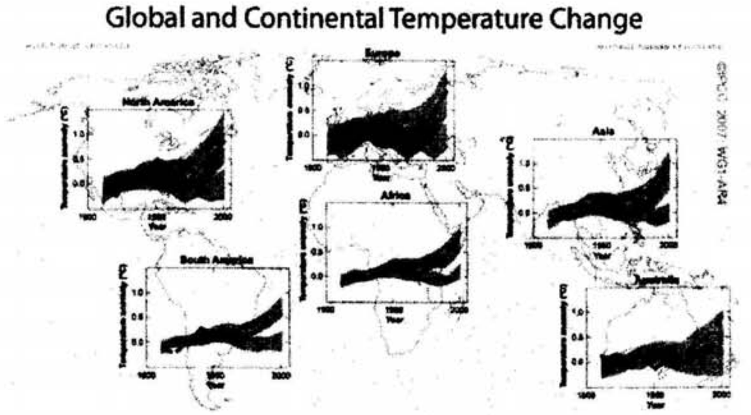

Fig. 2: The temperature anomaly on continents between 1900 and 2000 years. Source: Fishlin, A. (2007) [7]

Extreme regional climate changes

In reality, the average climate change will be affected most greatly by changes at the extreme end of the range of weather experienced. In the case of temperature, for example, the mean temperature may only shift by a few degrees (Fig. 3). However, this shift will be 'produced' by a decreasing number of cold days, and an increasing number of hot days, most likely accompanied by hotter maximum temperatures than have been previously experienced in the area. It is the extreme weather events (such as longer periods of drought) that have the greatest implications for adaptation.

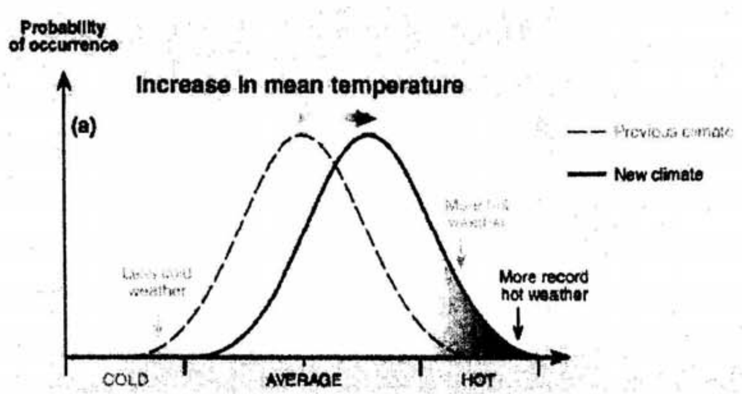

Fig. 3: Illustrative diagram of the effect of climate change on mean and extreme temperature. The increased number of hot day records shift the new climate curve toward a higher value. Source: IPCC Synthesis Report, Watkins et al. 2001 [29]

Impacts on biodiversity

Climate change is likely to have considerable impacts on most or all ecosystems. The distribution patterns of many species and communities are determined to a large part by climatic parameters; however, the responses to changes in these parameters are rarely simple.

Shifts in distribution of plants and animals

At the simplest level, changing patterns of climate will change the natural distribution limits for species or communities. In the absence of barriers it may be possible for species or communities to migrate in response to changing conditions. Vegetation zones may move towards higher latitudes or higher altitudes following shifts in average temperatures. Movements will be more pronounced at higher latitudes where temperatures are expected to rise more than near the equator. In the mid-latitude regions (45 to 60°), for example, present temperature zones could shift by 150 - 550 km.

In addition to causing a warming effect, increased concentrations of atmospheric carbon dioxide are known to increase rates of photosynthesis in many plants, as well as to improve water use efficiency. In this way the climate changes may increase growth rates in some natural and agricultural communities [33].

There is increasing evidence that traits other than photosynthetic metabolism are more important in determining the response to elevated CO_2 of different species under field conditions [4, 5, 18, 19]. For example, increased levels of CO_2 are likely to result in increased water-use efficiency in many species. Increased water-use efficiency may help many plants and trees resist the extremes of heat and drought that may occur more frequently in southern Europe and the Mediterranean region [30].

Barriers to movement

In most cases natural or man-made barriers will impact the natural movement of species or communities. Arctic tundra and alpine meadows may become squeezed by the natural configuration of the landscape, while these and many other natural systems may be further confined by human land-use patterns. Many national parks and protected areas are now surrounded by urban and agricultural landscapes which will prevent the simple migration of species beyond their boundaries [33].

In developing countries, climate change may lead to an increase in lands that are arid and suffering moisture stress. In Africa, for example, there are 1.1 billion hectares of land with growing period of less than 120 days. Climate change could, by 2080, result in an expansion of this area by 5 - 8 percent, or by about 50 - 90 million hectares, FAO said [21].

Changing patterns of precipitation and evaporation

Rainfall and drought will also be of critical importance. Extreme flooding will have implications for large areas, especially riveraine and valley ecosystems. Increasing drought and desertification may occur in tropical and sub-tropical zones, and at least one model has predicted a drying out of large parts of the Amazon [33].

Rapid changes

Rates of change will also be important, and these will vary at regional and even local levels. The maximum rates of spread for some sedentary species, including large tree-species may be slower than the predicted rates of change in climatic conditions [33].

Species interaction

In many cases further complications will arise from the complexity of species interactions and differential sensitivities to changing conditions between species. Certain species may rapidly adapt to new conditions and may act in competition with others.

Shifting seasons

Changes in seasons are already being noticed in many temperate regions. Birdsong is being reported earlier and spring flowers are emerging when it was once winter (Fig. 4).

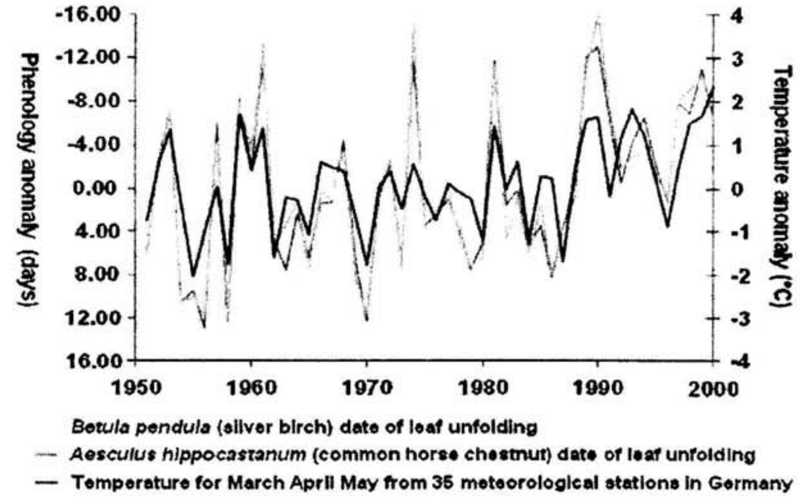

Fig. 4: Springs begin earlier. The leaf unfolding dates of trees in Germany relate in temperature increase. Source: Menzel, A. 2003 [23]

In agricultural landscapes changes in the length of growing seasons may improve productivity in mid-latitudes and increase the potential for arable crops at high latitudes. Negative impacts may include increased ranges of insect pests and diseases, and failure of crops in some regions from drought or flooding.

The coastal margins

On the relatively narrow habitats of the coastal margins, especially where these are backed by areas of intense human use, rising sea levels may lead to the squeezing out of important coastal habitats.

Warmer oceans

Rising sea temperatures will further affect the distribution and survival of particular marine resources. Corals have already shown an extremely high sensitivity to minor increases in temperature, while other studies have shown dramatic changes in the distribution and survival of the Pacific salmon in the late 1990s [33].

Water quantity – water resources

One of the greatest effects of climate change is likely to be the availability of water. There will be escalating competing pressures from agricultural users, electricity generators (potential increase in demand for hydro-generation as a zero-emission energy source), domestic users (increased water use in hotter weather), and the need to protect instream values, including against the increased risk of drought and other effects of climate change. The pressure on water resources will be exacerbated by increased evapo-transpiration, the desire for greater water takes to maximize the production potential of the warmer climate, and the need to counter the increased intensity and frequency of droughts.

Impact on animal diseases

Climate change not only has an impact on food security, but is also likely to influence the development and intensification of animal diseases and plant pests. Most pests and diseases act locally but have global implications, in particular because of modern trade patterns and human mobility. In a globalizing world, agriculture will have to adapt to an accelerating stream of new pests and diseases caused by changing ecological conditions resulting from climate change, and strongly intensified by increased international trade and mobility. Temperature changes, as well as increased air pollution, can enhance human disease patterns, as does the spread of trans-boundary animal diseases with their relationship to pathogens potentially dangerous to humans. Avian flu is the most recent example [21].

CO_2 effects on crops and yields

Greater concentrations of CO_2 generally result in higher photosynthesis rates and may also reduce water losses from plants. Photosynthesis is enhanced when additional carbon is available for assimilation and so crop yields generally rise.

The actual response to increased CO_2 differs among crops. Most commercial crops including wheat, rice, barley, oats, potatoes, and most vegetable crops, tend to respond favourably to increase CO_2, with a doubling of atmospheric CO_2 concentration leading to yield increases in the range of 15-20%. The crop models used in this assessment assume a CO_2 fertilization effect in this range, and also assume that sufficient nutrients and water will be available to support these increases. Other crops including corn, sorghum, sugar cane, and many tropical grasses, are less responsive to increases in CO_2, with a doubling of its concentration leading to yield increases of about 5%.

In situations where crop yields are severely limited by factors such as nutrient availability, an enduring CO_2 fertilization effect is very likely to be of only minor importance [1].

Impacts on pests and diseases

The implications of climate change for pests and diseases of agriculture and woodland are difficult to predict. This is because there is a fine balance between pests and disease causing organisms (known as pathogens) and their host plants. It is possible however to make two generalizations: stressed plants are more susceptible to insect pests and diseases, and the majority of insect pests are likely to benefit from climate change as a result of increased summer activity and reduced winter mortality. Some insect pests that are currently present at low levels, or that are not considered a threat at this time, may become more prevalent. In addition, the 'effective' range of existing pests or pathogens may change, including a northwards expansion of those with a southern distribution and the likely appearance of some from other countries.

For some pests and diseases, likely trends cannot be predicted even on the basis of expert judgement; in this category, and of particular concern, is *Phytophthora ramorum*, the agent responsible for sudden oak death. The higher level of uncertainty associated with the biology of fungi compared to insect pests is reflected in the less specific predictions of future trends in the incidence of fungal diseases and disorders [32].

Insect pests

- Climate change is likely to alter the balance between insect pests, their natural enemies and their hosts; predictions of the impact of climate change on insect damage difficult to make.
- One of the most important effects of climate change will be to alter the synchrony between host and insect pest development, particularly in spring, but also in autumn; the predicted rise in temperature will also generally favour insect development and winter survival, although there will be some exceptions.
- The green spruce aphid is one example of an insect that is likely to benefit from the increase in winter survival, leading to more intense and frequent tree defoliation.
- Modelling work suggests that under a warmer climate, exotic pests could establish populations in Europe, and that climatic warming could make forests susceptible to damage.
- Rising atmospheric CO_2 concentrations may lead to a decline in food quality for plant-feeding insects, as a result of reduced foliar nitrogen levels.
- The planting of exotic plant species may exacerbate the beneficial effects of climate change on insect pests, as the natural predatory fauna may not be present to limit population growth.
- Changes have already been observed in the distribution of native European butterfly populations, with northern ranges extended and southern ranges reduced.

Fungal diseases

- The effects of predicted climate change on fungal diseases of plants can, to some extent, be judged by analyzing the existing roles of climate and of fluctuations in weather; it is, however, more difficult to predict the effects of climate change on host - pathogen relationships than on the individual organisms.
- The impact on those pathogens whose reproduction or dispersal is clearly affected by temperature is relatively predictable.
- Warmer summers may in particular favour certain thermophilic fungi which have important implications for plant breeding programmes.
- Insect vectors of pathogens such as the fungi causing Dutch elm disease (*Ophiostoma ulmi, O. novo-ulmi*) are likely to respond to warmer summers by extending their geographic ranges and hence the ranges of disease incidence.
- The likely effects of higher year-round temperatures have been modelled in the case of *Phytophthora cinnamomi*, a very widespread fungus which causes root and stem-base diseases of a wide range of broadleaved and coniferous species. The models show a probable significant increase in the activity of this fungus across Europe in general.
- Warmer winters may increase the activity of some weak pathogens which are active only when the host is dormant.
- An increased incidence of summer drought would probably favour diseases caused by fungi whose activity is dependent on host stress, particularly root pathogens.
- A reduction in the number of summer rain-days may reduce the incidence of various foliar diseases. Generally, however, it is difficult to predict the impact of climate change on pathogens whose reproduction or dispersal is strongly affected by rainfall or humidity.
- The protective effects of mycorrhizas against various root diseases may be altered by changes in the relative fitness of different mycorrhizal fungi under conditions of altered soil temperature or moisture regime [32].

Plant pathogens recently appeared in Hungary related to warming

Incidence of new diseases appear because of plant hygienic, quarantine reasons and/or epidemic factors spreading across the borders, e.g. wild fire – *Erwinia amylovora,* 1995 [13]. Introducing pathogens by propagation materials, seeds, tubers, planting materials, e.g. potato brown rot – *Ralstonia solanacearum,* 2000 [24].

Tomato spotted wilt tospovirus (TSWV) occurred on tobacco fields and causing considerable losses since more than 30 years. Its spreading was contributed by *Thrips tabaci* which larvae pick up virions during their feeding, propagate in them and the adults capable transfer viruses in springs. During cold winters the populations of thrips decreased and limited the spreading of pathogen. *Frankliniella occidentalis*, another thrips vector of virus, was introduced in 1989 to Hungary. This species generally could not overwinter in open-air circumstances but under glasshouses and polythene tunnels they could, however recently confirmed the overwintering on field plants, vegetables and ornamental plants, moreover perennial weeds because of mild winters in Hungary. The spreading of TSWV strongly depends on climate elements and its importance can increase parallel to temperature arising. [9, 11, 14, 15].

The causal agent of brown rot of potato, *Ralstonia solanacearum* (syn.: *Pseudomonas solanacearum*), was introduced to Hungary by import seed potato from Holland [24], but epidemic of disease depends on hot summer weather. Although the pathogen was provisionally eliminiated by quarantine measures, hot summers and seed-potato import can ensure favourable circumstances to new epidemics.

Hot summers contribute to phytoplasma epidemics through their leafhoppers vectors gradation especially in paprika, tomato and tobacco plantations [10, 27].

Other causes of incidence of unusual diseases adaptation to the changed ecological circumstances (e.g. liking for hot weather and dry soils, drought and heat tolerance) like has happened with charcoal rot disease caused by a polyphagous fungus, *Macrophomina phaseolina* (synanamorph: *Rhizoctonia bataticola*) in sunflowers, maize, potato, paprika, bean, faba bean etc. in Hungary since 1970 [2, 28].

Endoparasitic powdery mildew of paprika (*Léveillula taurica*) frequently causes losses not only under glasshouses but even fields as well. Besides of endophytic powdery mildew fungus (*L. taurica*) the spreading of epiphytic ones on tomato (*Oidium neolycopersici*) is an increasing problem of Hungarian glasshouse tomato production since 1996 [6, 17].

New pathogens occurs not only in arable and horticultural crops but on weeds as well. The occurrence of rust fungus *Puccinia xanthii* on *Xanthium italicum* was first described in 2003 which indicate not only forges ahead a weed species in Hungary but also its pathogen [3].

***Quo vadis* policy makers?**

Under global climate change the ecological conditions might remain slightly touched only, if policy makers make adequate and responsible decisions decreasing the CO_2 emission without delay. There is a lately (2007) accepted plan for each EU countries to reduce the CO_2 emission by 20% until 2020. Trade with emission quota are neither ethical nor effective among different countries.

Otherwise global changes will contribute dramatically to the occurrence of new diseases, insects, and weeds which might change the former natural plant societies in conflict with more aggressive species and/or varieties.

In spite of changes the importance of the agricultural production does remain increasing not only in Hungary but in the Carpathian basin within the region.

REFERENCES

1. Anonymous, 2000, US Global Change Research Program. The National Assessment Synthesis Team http://www.usgcrp.gov/usgcrp/Library/nationalassessment/overviewagriculture.htm.
2. Békési, P., Vörös, J., Calvert, O.H., 1970, *Macrophomina phaseoli* in Hungary damaging sunflower, *Plant Dis. Reptr.*, **54**: 286-287.
3. Dávid, I., Harcz, P., Kövics, G..J., 2003, First report of *Puccinia xanthii* on *Xanthium italicum* in Eastern Hungary, *Plant Disease*, **87** (12): 1536.
4. Diaz, S., 1995, Elevated-CO_2 responsiveness, interactions at the community level, and plant functional types, *Journal of Biogeography*, **22**: 289-295.
5. Diaz, S., 1996, The effects of elevated CO_2 on root symbionts mediated by plants, *Plant and Soil*, **187**: 309-320.
6. Dormanns-Simon, 1997, Abstr. XII. Meet. *Eucarpia*, Jerusalem, 60.
7. Fishlin, A. et al., 2007, The contribution to the fourth assessment CLA Wg II. *WMO-UNEP*. IPPC.
8. Fowler, A.M., Hennessy, K.J., 1995, Potential impacts of global warming on the frequency and magnitude of heavy precipitation, *Natural Hazards*, 11: 283-303.
9. Gáborjányi R., Jenser G., Nagy Gy., 1993, A paradicsom bronzfoltosság vírus (TSWV) járványtani kérdései, *Növényvédelem*, (29): 543-547.
10. Gáborjányi, R., Horváth, J., Kovács, J., Kazinczi, G., 1998, Role of virus- and phytoplasma infections in pepper decline in Hungary: An overview, *Acta Phytopathol. Hung.*, **33**: 229-236.
11. Gáborjányi, R., Csilléry, G., Tóbiás, I., Jenser, G., 1995, Tomato spotted wilt virus: A new threat for pepper production in Hungary, *Eucarpia*, Budapest. Abstr.: 159-160.
12. Hennessy, K.J., Pittock, A.B., 1995, Greenhouse warming and threshold temperature events in Victoria, Australia, *International Journal of Climatology*, **15**: 591-612.
13. Hevesi M., 1996, Az *Erwinia amylovora* (Burill) Winslow et al. hazai megjelenése almán, Növényvédelem **32**: 225-228.
14. Jenser, G., Gáborjányi, R., Szénási, Á., Almási, A., Grasselli, M., 2003, Significance of hibernated *Thrips tabaci* Lindeman (Thysan. Thripidae) adults in the epidemic of tomato spotted wilt virus, *J. Appl. Entomol.*, **127**: 7-11.
15. Jenser, G., Gáborjányi, R., Vasdinyei, R., Almási, A., 1995, Epidemiological aspects of tomato spotted wilt virus infection in Hungary, *Tomato Spotted Wilt Conf.*, Taiwan.
16. Kattenberg, A., Giorgi, F., Grassl, H., Meehl, G.A., Mitchell, J.F.B., 1996, Climate models projections of future climate: 285–357. *In:* IPPC: Climate change 1995. Cambridge University Press, Cambridge, UK.
17. Kiss, L., 1996, Occurrence of a new powdery mildew fungus (*Erysiphe* sp.) on tomatoes in Hungary, *Plant Disease*, **80**: 224.
18. Körner, C., 1993, CO_2 fertilization: the great uncertainty in future vegetation development. 53-70. *In:* Solomon, A.M., H.H. Shugart (eds.) Vegetation dynamics and global change. Chapman and Hall, New York, NY, USA.
19. Körner, C., Pelaez-Riedl, S., Van Bel, A.J.E., 1995, CO_2 responsiveness of plants: a possible link to phloem loading, *Plant, Cell and Environment*, **18**: 595-600.
20. Kövics, G.J., 2004, Egy hazai találmány megvalósítása és társadalmi-tudományos háttere. A Pharmaplant növényvédő szer család. Bevezető előadás: elhangzott a „Találmány, technika és tudomány" rendezvényen, 2004. április 20., Budapest. (Plenary Conference lecture in Hungarian).
21. Kruse, M., 2005, Climate change could increase the number of hungry people. Severest impact in sub-Saharan Africa - *FAO Report*. http://www.fao.org/newsroom/en/news/2005/102623/index.html).
22. Mearns, L.O., Rosenzweig, C., Goldberg, R., 1997, Mean and variance change in climate scenarios: methods, agricultural applications, and measures of uncertainty, *Climatic Change*, **35**: 367-396.
23. Menzel, A., 2003, Phenological anomalies in Germany and their relation to air temperature and NAO, *Climatic Change*, **57**: 243-263.
24. Németh, J., Kovács, A., Galambos, Gy., Merő, F., Molnár, M., 2002, A *Ralstonia solanacearum* okozta burgonyahervadás és barnarothadás megjelent Magyarországon, *Növényvédelem*, **38**: 453-461.
25. Rahmstorf, S., Archer, D., Ebel, D.S., Eugster, O., Jouzel, J., Maraun, D., Neu, U., Schmidt, G.A., Severinghaus, J., Weaver, A.J., Zachos, J., 2004, Cosmic Rays, Carbon Dioxide and Climate, *Eos*, **85** (4): 38-41.
26. Riha, S.J., Wilks, D.S., Simoens, P., 1996, Impact of temperature and precipitation variability on crop model predictions, *Climatic Change*, **32**: 293-311.
27. Vicián, O., Süle, S., Gáborjányi, R., 1998, A sztolbur fitoplazma természetes gazdanövényei Magyarországon, *Növényvédelem*, **34**: 617-620.

28. Vörös, J., Manninger, S., 1973, A *Macrophomina phaseolina* (Tassi) Goid. előfordulása kukoricán, Magyarországon, *Növényvédelem*, 9 (5): 193-195.
29. Watkins, T., et al., 2001, The third assessment report of the IPCC, Climate Change 2001: The Scientific Basis. http://www.applet-magic.com/IPCCprojections.htm
30. Watson, R.T., Zinyowera, M.C., Moss, R.H., Dokken, D.J., 2007, IPCC Special Report on The Regional Impacts of Climate Change. An Assessment of Vulnerability. http://www.grida.no/climate/ipcc/regional/index.htm
31. Wigley, T.M.L., 1985, Impact of extreme events, *Nature*, **316**: 106-107.
32. http://www.forestry.gov.uk/forestry/infd-6umkar
33. http://www2.wcmc.org.uk/climate/impacts.htm

RĂSPUNSURI POSIBILE ALE AGENŢILOR PATOGENI LA SCHIMBARILE GLOBALE ALE CLIMATULUI

(Rezumat)

În acest studiu sunt trecute în revistă consecinţele generale ale efectului de seră asupra microorganismelor patogene, precum şi răspunsurile posibile ale rezistenţei plantelor la stresul abiotic.

Schimbările climatice includ şi creşterea extremelor termice, care cresc împreuna cu modificările şi frecvenţa evenimentelor meteorologice. Creşterea concentraţiei de CO_2 şi schimbarea climatului global pot contribui la accelerarea ontogenezei plantelor, la severitatea simptomelor bolilor şi cauzează daune. Pe de altă parte, schimbările vor afecta elementele florale, caracterele patogenezei şi ale patogenului.

Temperaturile ridicate pot provoca extinderea spre poli a zonelor climatice inclusiv a suprafeţelor agricole Dar nu numai vegetaţia ci şi bolile plantelor vor urma aceste miscări. Efectele celor doi factori mentionaţi mai sus, actionează în unele cazuri devenind stimulative, în altele obstructive. Din această cauză prevederile ştiinţifice asupra forţelor rezultate, sunt destul de complicate. Mai mult, deplasarea regiunilor agricole şi a nişelor naturale poate determina modificarea productivităţii speciilor, raportată la patogenii acestora. Aceste schimbări globale pot contribui la apariţia unor boli, insecte şi buruieni noi, care pot schimba speciile din structura comunităţilor vegetale naturale anterioare, datorită competiţiei cu speciile şi/sau varietăţile agresive

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