CHANGES IN THE PATHOGENIC COMPOSITION, ATTACKING THE OIL SUNFLOWER IN BULGARIA.

Valentina ENTCHEVA

Dobrudzha Agricultural Institute – General Toshevo , 9520 BULGARIA

en4eva_v@yahoo.com

ABSTRACT

The sunflower development has been greatly hindered by the sunflower diseases. In the past ten years, we have been monitoring a shift from diseases that have been labeled highly significant, to such with a more sporadic nature. Due to the purposeful breeding work, the scientific community has created hybrids, resistant to leaf pathogens such as: gray spots (Phomopsis helianthi Munt.-Cvet. et al.), mildew (Plasmopara helianthi Novot.) and parasite broomrape (Orobanche cumana Wallr.). By contrast, the extreme temperature heights, during the vegetation period, well reduced the development and distribution of the black spots (Phoma macdonaldii Boerema). The climate change led to a high peak in the brown spots (Alternaria sp.) and charcoal rot (Macrophomina phaseolina (Tassi) Goid advancement. Every past year we notice an increase on the macrophomina attacks. Research shows that the infection in some selection materials can go as high as 50%. This tendency of pathogenic adjustment requires a rapid restructuring of the selection program to prevent declines in the production of sunflower.

Key words: sunflower, climate, pathogens.

INTRODUCTION

The Earth's climate is in constant change, and so has the crops' development conditions. A crop moves from one phase to another in its development, as a result from reaching certain temperature sums. In the recent years we have been constantly speaking of a drastically changing climate, mainly referred to as the Global Warming. (Aleksandrov V. et all. 2010) has made an extensive research on the climate changes in the last few decades in Bulgaria. Some conclusions drown from this research are that the rise of air temperatures during the XX century has been the highest in comparison with previous centuries, as the 1906-2005 year period, the medium air temperature has been 0.74^{o} C higher. The year with the highest temperatures is 2009. From the beginning of XX century, the rain over North Europe has risen with 10 to 40%, while the rain over some regions in South Europe (Bulgaria amongst them) has declined up to 20%. The most notable drought was during the year 2000. In some regions the agrometherological conditions has caused a decline in the vegetation period up to and below 90 days. Those regions include Dobrudzha and the south regions of northwest Bulgaria. The data from the phenological observations suggests that plants vegetation gets ahead of its normal course with 7-15days in the different climate regions, which without a doubt, proves that the climate has warmed during the last 30 years. The rise of temperature and diminution of rain has greatly affected the pathogenic composition attacking the crops, sunflower included. Growth cycle of these pathogens is closely associated with both the temperature and the atmospheric and soil moisture (Mari M and C.Martini, 2015), (M.Pautasso et al. 2012). The purpose of this study is to track changes in the pathogenic composition, attacking the oil sunflower in Bulgaria over the past two decades.

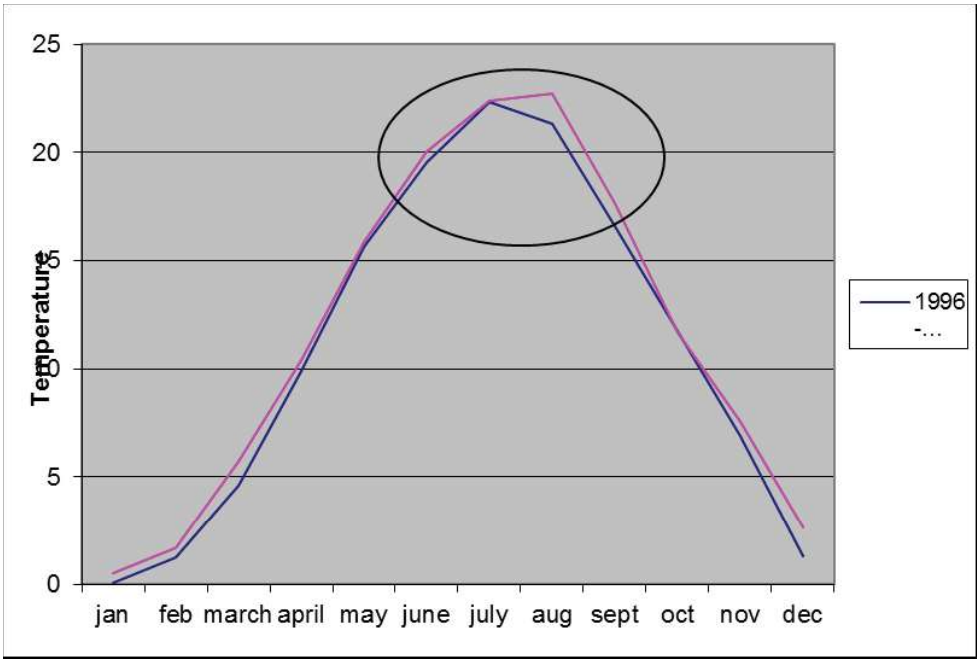
MATERIAL AND METHOD

The investigation was carried out in artificial infection field of Doubrudja Agricultural Institute. During the vegetation period we have established the extent and the type of damage caused by economically important diseases. When a new set of diseases appear, they are registered in the appearing country, and scientific community begins their reporting starting the next year. The data used for the period 1996-2015, is taken from the annual reports of the author (unpublished data). Data for temperature and precipitation fallen is divided into two decades 1996 – 2005 and 2006 – 2015. They are obtained from the weather station located on the territory of Doubrudja Agricultural Institute - General Toshevo.

RESULT AND DISCUSSION

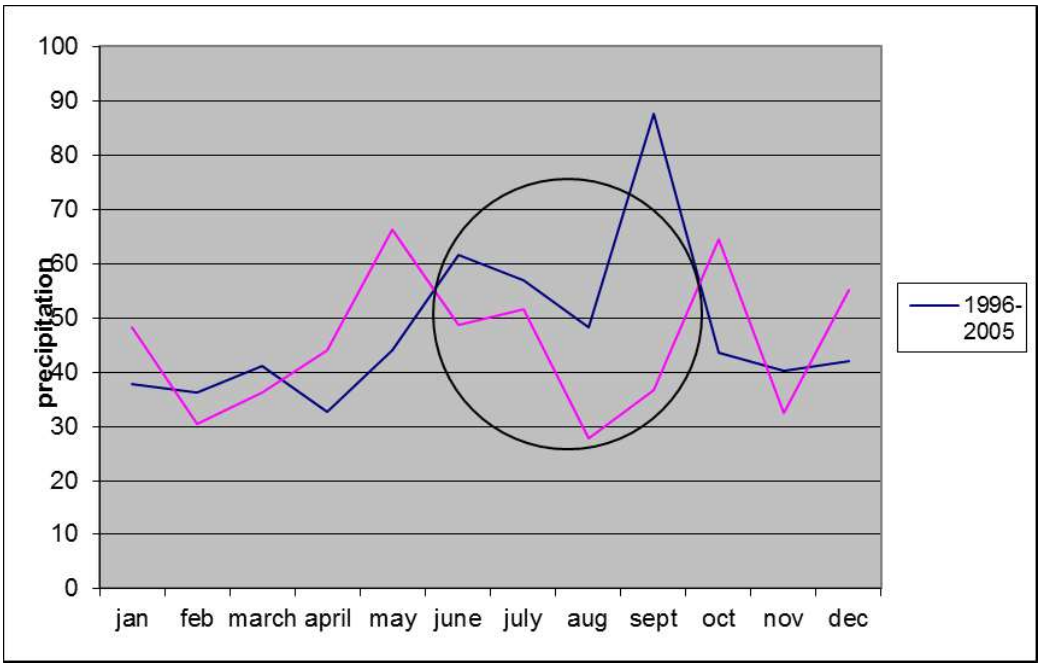
It is a fact that climate change has direct effects on the plant pathosystems. In the last two decades, the DZI science department has estimated a temperature increase (approximately 0.8°C-1°C) and soil moisture decrease, especially in the active vegetation period of sunflower when it is most prone to diseases attack. Plant pathologists have always considered environmental influences in their studies of plant diseases: the classic disease triangle emphasizes on the interactions between plant hosts, pathogens and the environment. (Garrett 2008; Klopfenstein et al. 2009; Grulke 2011 Coakley (1995) stated that disease development may increase, decrease or remain stable depending on the host-pathogen interaction. Any change in the ecosystem can affect plant diseases, as plant disease is the result of the interaction between a susceptible plant, and a virulent pathogen and the environment.

Fig.1 Average monthly temperature for the periods 1996-2005 and 2006-2015



When we examine two decades of data and compare the temperature and the precipitation during the sunflower's active vegetation (June, July, August), we clearly notice a tendency of temperature rise and reduction of precipitation in the 2006 – 2015 time period. This enviornmental change has let to shift in the sunflower's pathogenic composition.

Fig.2 Amount of precipitation in the periods 1996-2005 and 2006-2015



Moreover, some aspects associated with climate changes, such as the increase of temperature and changes in precipitation and moisture can have some effects on the fitness (number of generations, the sexual reproduction) of plant pathogens, extending the amount of time available for their reproduction and dissemination.

Table 1. Changes occurred in the distribution and aggressiveness of pathogens on sunflower

Fungy	1996 - 2005	2006 - 2015
Plasmopara helianthi	strong attack in the field	Decreased attack on pathogen
Phomopsis helianthi	Medium to strongly attack	Reduce the intensity of attack
Botritys cinerea	Average intensity of the attack usually at the end of the growing season	Long and hot autumn with a single infested plants
Alternaria sp.	Medium attack	Moderate to severe infestations in some years
Phoma macdonaldii	Medium attack	Moderate to severe infestations in some years
Albugo tragopogonis	Singal plants	Spread throughout the country
Puccinia helianthi	From low to middle attack	Medium to strongly attack
Rizopus sp	Low attack	Increased severity of pathogen
Macrophomima phaseolina	Low attack	Increased severity of pathogen
Verticilium dahliae	Low attack	Increased severity of pathogen

Plasmopara helianthi is an important disease on sunflower in Bulgaria. The last decade its primary appearance on sunflower fields has decreased because of the presence of effective fungicides, but the secondary infection, by the same pathogen, is commonly observed. Probably the climate change affects the host's biology and this indirectly influenced its response to pathogen attacks. Probably higher temperatures produce an elongation on the vegetative season and the consequent increase of secondary infections on leaves. The same result was observed by (Richerzhagen et al., 2011) in *Cercospora beticola* causing leaf spot on sugar beet in southern Germany. (Richerzhagen et al., 2011) suggest that due to an annual mean temperature increase by approximately 0.8°C-1°C in the last century the leaf spot attacks has risen.

According (Coakley et al., 1999) higher winter temperatures might increase pathogen survival on crop residues accumulating the amount of initial inoculum to infected subsequent crops. It is not excluded that this is due to severe attack by *Alternaria sp.* Our deductions and results are similar. We have observed amplification in the procent of attacks during the last two decades. (Encheva V, 2007).

The increase of temperature contributes to the spread of pathogens in some new geographical areas, where the pathogens can encounter new potential hosts. Initially we observed the disease *Albugo tragopogonis* Schr. (*Encheva and all*.2000) in *2000.* During the last decade we estimated its attack on the whole Bulgarian territory. The same goes to another disease spread in Bulgaria: *Rhizopus sp*. (Encheva V and N.Nenov 2004).

The increased temperatures in winter and spring can assist the maturation of ascospores and their release, forcing an early start of the disease management. The general increase in temperature produces an extension of the vegetative season, exposing crops to higher infections. (*Phoma macdonaldi* and *Puccinia sp*.). This leads to a divergence cycle of both the disease and the host plant development. The climate change largely influence the manifestations of one or more fungal diseases.

In recent years, almost all sunflower vegetation goes by extremely high temperatures. They directly affect the development of pathogens in crops. Such widespread diseases, mainly occurring in areas with hot climate, are *Macrophomima phaseolina, Verticilium dahliae , Rizopus sp* . etc. Meanwhile the new climate situation limits the emergence of diseases such as *Phomopsis helianthi, Botritis cinerea.* There are fungal diseases like *Alternaria* that do not respond notable to weather conditions. Models predict in the mid-term a lower impact of oilseed rape diseases such as *Leptosphaeria maculans* and *Pyrenopeziza brassicae* (Fitt et al. 2011). The climate increase in Northern Germany, for example, facilitates the oil seed rape pathogens such as *Alternaria brassicae,* and *Sclerotinia sclerotiorum.* Indeed these new conditions not only threaten plant health but may in some cases exterminate the plant itself. It is predicted that *Verticillium longisporum* will be favoured by average increase in temperatures, particularly when taking into account a long-term (2071–2100) view (Siebold and von Tiedemann 2012).

CONCLUSIONS

The impact of climate change on plant diseases requires more research. The change of climate could alter stages and rates of development of the pathogen, modify host resistance and thus lead to transitions in host-pathogen interaction. Climate changes mostly affect agricultural production. Research on the climate change impact on plant disease has led to a new aim: to create a drought-resistant sunflower hybrid with genes that control diseases, conducive to high temperatures and low soil moisture.

LITERATURE

Aleksandrov V. (2010) Klimatichni problem Nacionalen institut po meteorologia i hidrologia – BAN, Sofia

Coakley, S. M., Scherm, H., Chakraborty, S. (1999). Climate change and plant disease management. Ann. Rev. Phytopathol. 37: 399-426.

Entcheva V 2007 Projvlenie na listni I stableni patogeni po slanchogleda v perioda 1999-2006 Field crops studies, vol.IV, N 1 175-180

Entcheva V and N.Nenov 2004 Izsledvane varhu suhoto gniene po slanchogleda (*Rhizopus sp*.) prez 2003 г Научни съобщения на СУБ кл. Добрич, vol 6, N 1 , 56 – 60

Encheva V., Shindrova P and Kiriakov I 2000 *Albugo tragopogonis* Schr. – nov pathogen po slanchogleda v Balgaria Nauchni saobshtenia na SUB Dobrich vol 2, 123 – 128

Fitt, G. P. (2011). Critical issues in pest management for a future with sustainable biofuel cropping. Current Opinion in Environmental Sustainability, 3, 71–74. Siebold, M., & von Tiedemann, A. (2012). Potential effects of global warming on oilseed rape pathogens in Northern Germany. Fungal Ecology, 5, 62–72.

Garrett, K. A. (2008). Climate change and plant disease risk. In D. A. Relman, M. A. Hamburg, E. R. Choffnes, & A. Mack (Eds.), Global climate change and extreme weather events: understanding the contributions to infectious disease emergence (pp. 143–155). Washington, DC: National Academies Press.

Grulke, N. E. (2011). The nexus of host and pathogen phenology: understanding the disease triangle with climate change. New Phytologist, 189, 8–11.

Klopfenstein, N. B., Kim, M.-S., Hanna, J. W., Richardson, B. A., & Lundquist, J. (2009). Approaches to predicting potential impacts of climate change on forest disease: an example with Armillaria root disease. USDA Forest Service, Rocky Mountain Research Station, RMRS-RP-76, pp. 16

Richerzhagen, D., Racca, P., Zeuner, T., Kuhn, C., Falke, K., Kleinhenz, B., Hau, B. (2011). Impact of climate change on the temporal and regional occurrence of Cercospora leaf spot in Lower Saxony. J. Plant Dis. Prot. 118: 168-177.