LONG-TERM COMPREHENSIVE AGRO-CLIMATIC EVALUATION

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In the last two decades a vegetation season in the Czech Republic (Central Europe) was prolonged about 15 to 25 days. It causes (i) an increasing risk of winter crops damage by frosts in the beginning of vegetation, (ii) a risk of occurrence of the days with the temperature below 0 °C without a snow cover (problems with overwintering), (iii) overgrowing plants during the autumn. A snow cover and its effect on agriculture have been generally underestimated by impacts studies of the climate change. An occurrence of the days with temperature below 0 °C without a snow cover was evaluated for the periods of 1961–1990, 1981–2010 and 1991–2010. Basic databases included daily data from 73 climatological station regularly distributed in the whole Czech Republic. Categories of the days with temperature below 0 °C without a snow cover were defined as the episode with snow cover lower than 5 cm and with minimum air temperature below -5 °C, -10 °C and -15 °C. Spatial evaluation was carried out for two seasons 1961–1990 and 1981–2010. Their comparison showed apparent decrease of the days with the temperature below 0 °C without a snow cover in the second season in majority of areas. In connection with risks of plants overgrowing of winter crops during the autumn, „autumn vegetation days" (AVD) for winter crops were defined (i.e. the days with maximum air temperature in 2 m exceeded 5 °C and precipitations were simultaneously normal or above normal). Number of AVD were analysed for period 15.8.–31.12. for each year in period 1961–2010. Average AVD values were 36.22; 35.26; 34.42; 40.95 a 37.27 for decade period. Increasing of AVD during two last decades was found.

Keywords: growth stages, overwintering, term of sowing, air temperature, precipitations, snow cover

INTRODUCTION

Actual impacts of climate change on plant growth based on bioclimatic assessment in the Czech Republic describe for example Středa et al. (2009), Ullmannová et al. (2013), Hofbauer et al. (2011), Středa et al. (2011) and others. Assessment of phenological data from the period 1940–2008 detected earlier onset of phenophase beginning of flowering about 13 days, i.e. 2 days per decade. Growth and development of winter crops is significantly affected by snow cover and its parameters. In the last ten years (since 2000) the number of days with snow cover occurrence as well as with snow depth exceeding a certain value have decreased. In addition the amount of new snow and both monthly and seasonal maximum snow depth have been also reduced (Tolasz et al. 2007). Snow cover and its properties cannot be affected by the farmer. However, they may significantly influence the varieties of planted crops (in relation to their winter and frost resistance). Therefore, a snow data are important supporting information within agrometeorological characteristics of the area.

MATERIALS AND METHODS

The risks of winter crops damage by frost in periods 1961–1990, 1981–2010 and 1991–2010 were evaluated with daily data from 73 meteorological stations of Czech Hydrometeorological Institute (CHMI). Critical periods were defined as episodes:

i) with snow depth less than 5 cm and the minimum daily temperature (Tmin) lower than -5 °C simultaneously; ii) snow depth less than 5 cm and the minimum daily temperature lower than -10 °C simultaneously; iii) snow less than 5 cm and the minimum daily temperatures (T_{min}) lower than -15 °C simultaneously. Spatial delimitation of risk of plant damage by frost was carried out for the territory of South Moravia with GIS ArcView software – interpolation based on the altitude.

Optimal moisture and thermal demands of winter crops were applied to set so-called. "Autumn Vegetation Days" (AVD). Key indicators for AVD determining are conditions when the plant still receives nitrate nitrogen (temperature above 5 °C) and when increasingly create aboveground biomass (sufficient precipitation). As AVD thus they were considered days with at least normal or higher precipitation when the maximum air temperature at 2 m above the ground was equaled or exceeded 5 °C. The precipitation normality was evaluated by comparing the 10day precipitation totals with normal precipitation totals of 1961–1990. Number of AVD was assessed for the period from August 15 to December 31 or since first occurrence of continuous at least a five-day with maximum daily temperature below 5 °C. The evaluation dealt with CHMI technical data series 1961–2010 (Skalák et al. 2008).

RESULTS

During the period 1961–1990 was found out overall average number (averaged for all 73 stations) of 581 days with the minimum air temperature lower than -5 °C, and snow depth 5 cm and lower. Average annual number per station was 19.4 days. The overall average number in the period of 1981–2010 was 555 days, i.e. 18.5 days per station per year (in the period 1991–2010 also 18.5). For example after the winter of 2002–2003 with the average number of such days above 32.8 (the second highest number in the period 1961–2010) the areas of winter crops ploughed-in amounted locally to 80 %.

Days with a minimum day temperature of -10 °C or lower and snow depth 5 cm or lower in 1961–1990 were recorded 150, i.e. on average 5 days per year and station. During the period of 1981–2010 it was 141 days, i.e. 4.7 days per station annually (in the period 1991–2010 it was 4.8 days).

In 1961 to 1990 the overall average number of days with minimum daily temperature of -15 °C or lower and snow depth 5 cm or lower was 28.3 per station, i.e. 0.9 days per year and station. In the period of 1981–2010 total of such days was 24.9, i.e. 0.8 days per station annually (in 1991–2010 it was 0.9 days).

Fig. 1 and 2 represent regions with risks of crops damage by frost for the territory of South Moravia for two periods: 1961–1990 (normal period) and the period of 1981–2010. Decreasing risk is obvious in the second season. It is given mainly by warmer climate – especially in the case of -10 °C and -15 °C; and supported by decreasing snow cover parameters.

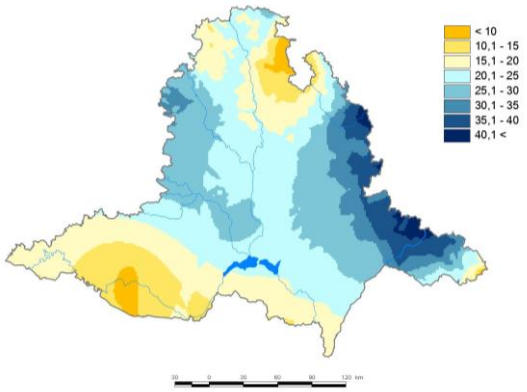

Fig. 1 Number of days with T_{min} below -15 °C and snow depth lower than 5 cm, 1961–1990.

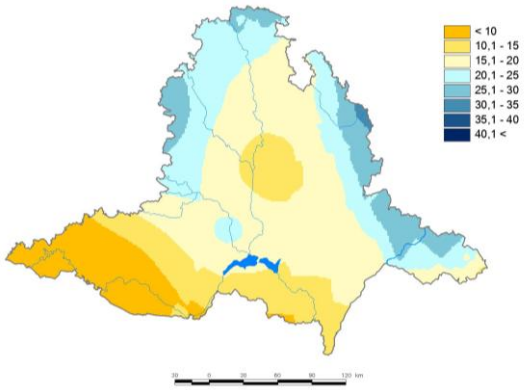

Fig. 2 Number of days with T_{min} below -15 °C and snow depth lower than 5 cm, 1981–2010.

On the base of described methodology were counted 10year average values of winter crops AVD. Fig. 3 shows increase of AVD number within last two decades. The lowest annual average amount of AVD (34 days) were found out in 1981–1990.

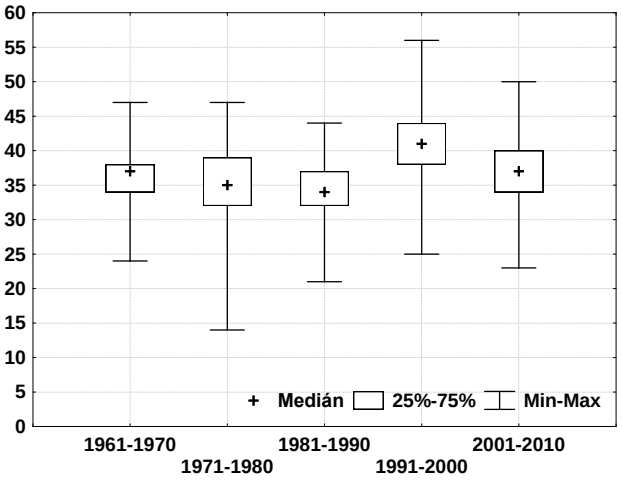

Fig. 3 10year statistics of AVD occurrence

Statistical outputs enable creation of map of annual average amount of AVD distribution in particular 10year periods. It is thus possible to determine the most risky areas from the viewpoint of autumn weather course and its impact on agricultural crops (Fig. 4 a 5).

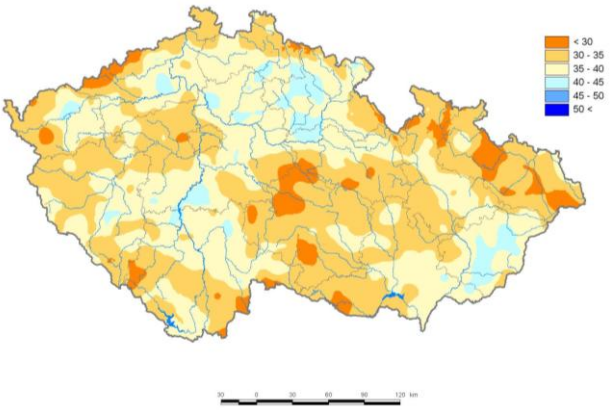

Fig. 4 Annual average amount of AVD, 1981–1990

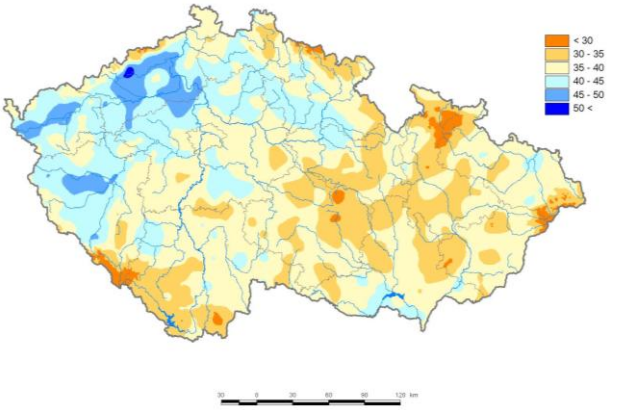

Fig. 5 Annual average amount of AVD, 2001–2010

CONCLUSION

Comparison of investigated period proved decreasing trend of number of days with risk of crops damage by frost and increasing trend of AVD towards present. Mapping results in connection with biological research could be useful tool for optimal spatial location of individual crops and their varieties regarding to probability of meteorological overwintering risk.

Acknowledgement

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