INFLUENCE OF SNOW COVER ON FIELD CROPS' DEVELOPMENT

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Phenology is the study of the seasonal timing of recurrent biological events (such as flowering, migration of birds, and emergence of insects), the causes of their timing with regard to biotic and abiotic forces, and the interrelations among phenophases (developmental stage) of the same or different species. Drivers of phenological responses range from macroclimatic circulation patterns to local environmental factors such as temperature, precipitation and snow cover, photoperiod and edaphic factors. Czech Hydrometeorological Institute has been operating network of phenological stations. In this paper, we have analyzed spring barley phenological stages within period 1985–2011 from selected CHMI stations at different altitudes using statictical software. Phenological data were also evaluated in dependence on local climatological factors such as temperature and snow cover.

Keywords: phenology, spring barley, snow cover, Czech Hydrometeorological Institute, Czech Republic

INTRODUCTION

Phenology is the study of periodically repeating stages in the life cycle of animals and plants as influenced by environmental conditions.

Understanding and predicting crop development is fundamental to many aspects of agronomy including optimizing crop management practices such as herbicide, fertilizer and irrigation applications. Phenology submodels are also critical components of crop simulation models, and crop models are increasingly being utilized as part of decision aids to assess specific strategic and tactical crop cultural practice alternatives (McMaster and Wilhelm, 2003). It is frequently argued that intensive farming systems in Western and Central Europe have a comparatively lower sensitivity to climatic changes, which are modest in temperature or precipitation (e.g. Chloupek et al. 2004).

The paper aims to study influence of snow cover and air temperature on spring barley development.

MATERIALS AND METHODS

The CHMI has operated with a phenological network of field crops since 1984 to 2012. Volunteer observers followed the methodology for phenological stations – field crops (ANONYMUS, 2009) and Phenological Atlas (COUFAL et al., 2004), where patterns of phenophases are illustrated. In total, there were 80 stations with MASL (mean above sea level) ranging from 155 m (Doksany) to 725 m (Nedvězí).

Into this paper were chosen phenological stations Strážnice (177 m asl, 017°19' E, 48°54' N), Pusté Jakartice (275 m asl, 017°57' E, 49°58' N) and Tis u Chotěboře (455 m asl, 015°30' E, 49°42' N) with spring barley phenological data (sowing; emergence and tillering phenological stages).

Climatic data was used from the following stations: Strážnice (176 m asl, 017°20' E, 48°53' N), Opava (270 m asl, 017°52' E, 49°55' N) and Havlíčkův Brod (452 m asl, 015°34' E, 49°36' N). Both data – phenological and climatological – was exported from CHMI database (PHENODATA and CLIDATA).

Data were evaluated in the period 1985–2011. Statistical calculations were done by tools of Excel. Pearson's correlation coefficient was used to determine the relationship between the two variables (maximum snow cover and phenophase onset; monthly mean temperature and phenophase onset).

RESULTS

The mean date of sowing, emergence and tillering of spring barley in the period from 1985 to 2011 was 24th March, 6th April and 25th April (Strážnice); 31st March, 16th April and 30th April (Pusté Jakartice) and 7th April, 23rd April and 10th May (Tis u Chotěboře). The annual variation (1985–2011) in sowing, emergence and tillering at all stations represents Figures 1-3).

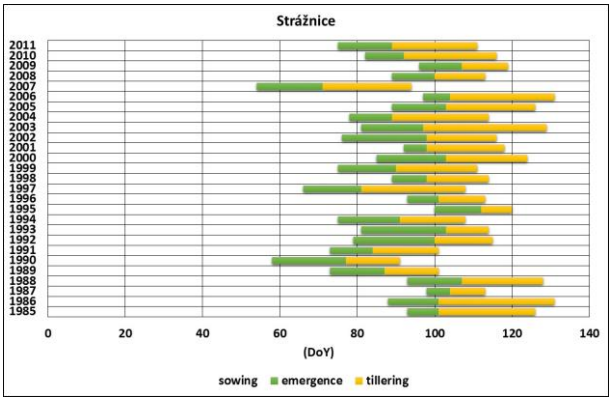

Figure 1. Annual variation in sowing, emergence and tillering of spring barley, Strážnice station, period 1985–2001.

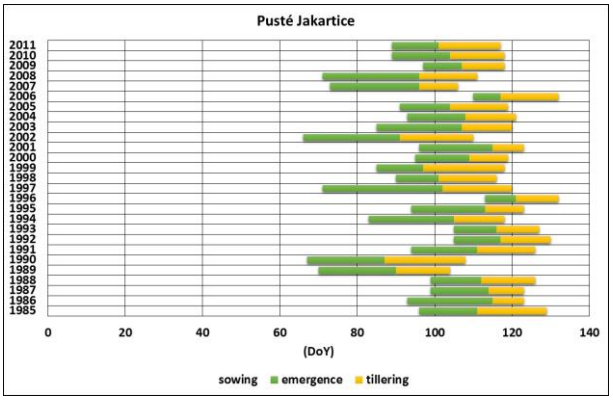

Figure 2. Annual variation in sowing, emergence and tillering of spring barley, Pusté Jakartice, period 1985–2001.

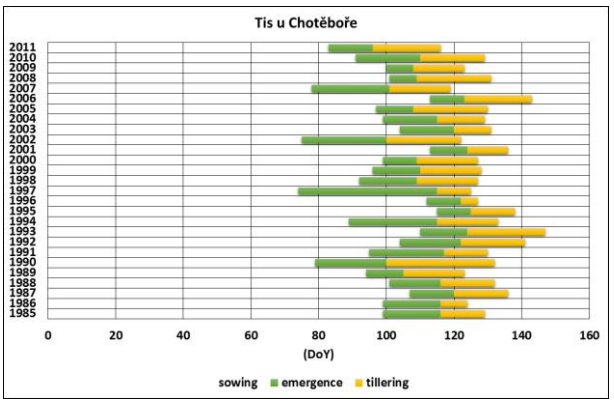

Figure 3. Annual variation in sowing, emergence and tillering of spring barley, Tis u Chotěboře, period 1985–2001.

The earliest onset of emergence was on 12th March 2007 (Strážnice), 28th March 1990 (Pusté Jakartice) and 6th April 2011 (Tis u Chotěboře). The earliest onset of tillering was on 1st April 1990 (Strážnice), 14th April 1989 (Pusté Jakartice) and 26th April 2011 (Tis u Chotěboře). The earlist term of sowing was on 23rd 2007 at Strážnice station. The latest onset of emergence was on 22th April 1995 (Strážnice), 23rd April 1996 (Pusté Jakartice) and 5th May 1995 (Tis u Chotěboře). The latest onset of tillering was on 11th May 1986 (Strážnice), 12th May 1996 (Pusté Jakartice) and 27th May 1993 (Tis u Chotěboře).

Pearson's correlation coefficients between maximum new and total snow cover and phenophase onset are mentioned in Tables 1–4, monthly mean air temperature during 1985–2011 period is presented in Table 5. The highest correlation coefficients are shown at Pusté Jakartice station and the correlation is stronger between snow cover and tillering at all stations. Kolář et al. (2014) investigated influence of climatic factors on the low yields of spring barley in Southern Moravia and their study indicates a clear connection between phenophases and yield anomalies. They have also documented a higher occurrence of negative climatic factors as dominant causes of climate change.

Table 1. Pearson's correlation coefficient between maximum snow cover and emergence at Strážnice, Pusté Jakartice and Tis u Chotěboře stations.

	SNOmax	SCEmax
Strážnice	0.126	0.046
Pusté Jakartice	0.379	0.456
Tis u Chotěboře	0.111	0.024

SNOmax = maximum new snow cover
SCEmax = maximum total snow cover

Table 2. Pearson's correlation coefficient between maximum snow cover and tillering at Strážnice, Pusté Jakartice and Tis u Chotěboře stations.

	SNOmax	SCEmax
Strážnice	0.171	0.165
Pusté Jakartice	0.362	0.517
Tis u Chotěboře	0.227	0.131

SNOmax = maximum new snow cover
SCEmax = maximum total snow cover

Table 3. Pearson's correlation coefficient between mean air temperature (February, March, April) and emergence at Strážnice, Pusté Jakartice and Tis u Chotěboře stations.

	February	March	April
Strážnice	-0.216	-0.584	0.269
Pusté Jakartice	-0.548	-0.686	-0.046
Tis u Chotěboře	0.146	-0.197	-0.027

Table 4. Pearson's correlation coefficient between mean air temperature (March, April, May) and tillering at Strážnice, Pusté Jakartice and Tis u Chotěboře stations.

	March	April	May
Strážnice	-0.571	0.183	0.218
Pusté Jakartice	-0.636	-0.163	-0.128
Tis u Chotěboře	-0.429	-0.291	-0.125

Table 5. Monthly mean air temperature (1985–2011).

	February	March	April	May
Strážnice	0.4	4.2	9.9	14.7
Opava	-0.2	3.2	8.6	13.6
Havlíčkův Brod	-1.0	2.7	8.1	13.3

CONCLUSION

The mean date of sowing, emergence and tillering of spring barley in the period from 1985 to 2011 was 24th March, 6th April and 25th April (Strážnice); 31st March, 16th April and 30th April (Pusté Jakartice) and 7th April, 23rd April and 10th May (Tis u Chotěboře). There is nearly a month difference in phenophase onsets between stations. The highest PCC between maximum new and total snow cover and phenophase onset are shown at Pusté Jakartice station. The correlation is stronger between snow cover and tillering at all stations, so it means stronger influence of snow cover on this part of barley development.

Acknowledgement

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