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Growth and development of spring oats cultivars and correlative relationship with basic agrometeorological parameters

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Abstract

The study was conducted between 2007-2009 years in educational and experimental base of the Agricultural University - Plovdiv. The observations were made in the field trial, which is set by the method of fractional plots in four replications.Considered entry into the main phenological phases of two Bulgarian variety (Obrazcov chiflik 4, Mina), one American (HiFi) and one Serbian (Novosadski naked). There have been specific correlation between the length of the period between the phases and the amount of precipitation in the period.

It was found that precipitation during different phases of development of spring oats strongly influence the duration of the inter-phase periods expressed by correlation coefficients (during the period between sowing to germination - R = 0,898; during the interphase period third leaf - tillering - R = 0,993 to R = 0,998; during the interphase period tillering– stem elongation - R = 0,547 to R = 0,698; during the interphase period stem elongation - flowering -R = 0,830 to R = 0,999). The relationship between the amount of precipitation after flowering till the end of the vegetation and the duration of interphase period flowering - full maturity is slightly negative in all tested varieties. A similar trend is in the period from germination to stage third leaf. Between varieties not reported significant differences. The total amount of precipitation during the growing period and the reported length of the growing period is in a strong negative correlation (R = -0,800 to R = -0,985).

Keywords: Oats, correlative relationship, agrometeorological parameters, spring cultivars

Introduction

The main climatic factors determining the growth, the development and the productivity of oats are the average night temperatures during the vegetation period, the absolute minimum temperatures in winter and maximum temperatures in summer as well as the quantity and the distribution of the rainfall (Kuzmova, 2009; Welch, 1995).

The oats are not very demanding regarding the temperature. Their seeds start germinating under temperatures of 1-2°C (Savova *et al., 2005*), for the formation of the vegetative organs the necessary temperature is 4-5°C and for the formation of the generative organs and the grain formation the favourable temperatures are between 16 and 20°C (Georgieva and Kostov, 1996). All this explains the reason why under our weather conditions the temperature does not act as a restrictive factor impeding the development of oats (Savova *et al.,* 2005).

The oats tend to be more demanding towards the quantity and the distribution of the registered rainfall during the vegetation period. They belong to the group of moisture-loving grain crops of the temperate climate. The quantity of water necessary for the germination of the seeds is 65% of their weight. The period proven to be particularly critical is 10-15 days before the panicle-formation (Savova et al., 2005). In Bulgaria there are not enough studies on the impact of the amount of precipitation in the different phases of development of the tested varieties expressed using correlative relationships (Antonova *et al.,* 1997; Georgieva, 1995, 1996; Georgieva and

Savova, 2005; Savova, 2002; Zorovski and Georgieva, 2010)

The purpose of the conducted observations and analyses is to establish some basic dependence between the duration of the interphase periods and the quantity of the registered rainfall under the conditions of Central Southern Bulgaria.

Materials and Methods

Within the period 2007-2009 in the experimental field of the Department of Plant Production at the Agricultural University – Plovdiv we conducted a field experiment on soil of the type Mollic Fluvisols based on FAO (Popova end Sevov, 2010).

We followed the development by comparing the duration of the interphase periods of two Bulgarian spring genotypes of oats – cultivar Obrazcov chiflik 4 (used as a reference for yield among the spring types of oats in Bulgaria) and cultivar Mina (naked), one American cultivar (HiFi) and one Serbian (Novosadski naked). We established the correlative dependence between them and also the dependence on the quantity of the rainfall during the respective periods of time.

The sowing was conducted on March based on the fractional lot method in four repetitions over an area of 10,5 m^2 and sowing rate of 500 g.s./m^2 after previously grown sunflower. The fertilization rate used was $N_6P_8K_8$. The statistical processing of the experimental data has been made using SPSS V.9.0 for Microsoft Windows (SAS Inst. Inc., 1999).

The combination of the meteorological factors within the period of the survey is very different and this determines the years of the yield as being specific with reference to the agro-meteorological conditions for the growth of the crop.

Generally speaking, the most favourable conditions for the winter oats were in the year 2008. The year 2009 ranks second and most unfavourable were the conditions in 2007.

Results and discussions

Cultivar Obrazcov chiflik 4

In all three years of study March is suitable month for rapid germination, regardless of when the sowing of seeds is carried out. In terms of rising temperatures towards the end of March in the year with the later sowing (31.03.2009) the period from sowing to germination is shorter - 10 days. In a timely sowing in 2007 and 2008, the duration of germination is 12-13 days. This period was negatively correlated depending on the length of the interphase period between germination phase to the third sheet (R = -0,992), but a strong positive correlation depending on the length of the interphase period between third leaf to tillering (R = 0.982).

Early intervention in stem elongation and duration of this phase is very important for the productivity of oats in connection with the formation of reproductive organs in panicle at this period. Our data show that as earlier sowing (2008), the stem elongation is longer (24 days in 2008) and occurs in relatively favorable conditions in late April and May. Extension of this period undoubtedly influenced and precipitation (R = 0,952).

The length of the growing season depends heavily especially on the length of some interphase periods. For example, the extension of the period from sowing to germination in established specific agrometeorological factors shortens the duration of the growing season (R = -0,993), reporting from germination until maturity. Same relationship is reported between the vegetation period and interphase period of the third leaf to tillering (R = -0,997).

The period from germination to stage third leaf is positively correlated with the length of the growing season. This means that any delay in the entering of third leaf phase and extending the corresponding interphase period due to adverse conditions, certainly extended growing season (R = 0,998). In spring varieties excessive prolongation of the growing season is unfavorable because the course of the period of grain maturation passes in the negative to this process months of June and especially July.

Amount of precipitation in each of interphase periods has a concrete and specific impact on their duration. It is particularly in the period after sowing to germination (R = 0,898), from third leaf to tillering (R = 0,993), from tillering to stem elongation (R = 0,698) and from stem elongation to flowering (R = 0,952). At the same time the duration of the interphase period between flowering to full maturity is not significantly influenced by the amount of precipitation in the period (R = -0,101).

Cultivar HiFi

Cultivar HiFi (Table 2) develop relatively parallel to Bulgarian standard Obrazcov chiflik 4 till tillering stage. There are differences in the duration of interphase from tillering to starting of phase stem elongation. During the three years, this period is two days longer. This difference is reflected in the extension of the growing season only in 2009. In the other two years it is offset in next phases – stem elongation, flowering and maturation.

Established in cultivar Obrazcov chiflik 4 relationships between the length of some interphase periods are the same at this cultivar. Rainfall in the growing season ranged 152 mm/m^2 (2009) to 315 mm/m^2 (2007). In 2008 rainfall with average (165 mm/m2) compared to the other two, but they are evenly distributed, which explains the highest yield this year (Zorovski and Georgieva, 2010).

Cultivar Mina and cultivar Novosadski naked

Cultivars Mina (Table 3) and Novosadski naked (Table 4) are oriented towards the production of food for humans. Ensuring conditions for the most formed panicle productive elements and most fully filling the grain is closely related to the agro-meteorological conditions, in particular rainfall. Cultivar Novosadski naked comes later in the flowering phase compare to cultivar Mina during tested three years. It shifts the whole ripening phase in the adverse conditions of June and July. As a result, inter-phase period flowering to full maturity is shortened by 2 to 10 days in three years.

However, the general trends of the strongest positive correlation dependence of precipitation duration of inter-phase periods 3rd leaf - tillering and stem elongation- flowering remains (R = 0,830 to R = 0,999). Pronounced is positive according to the period of tillering to stem elongation (R = 0,547 to R = 0,698).

Conclusion

It is found a strong negative correlation between the length of the interphase period from stem elongation to flowering and flowering to full maturity at tested oat varieties.

The length of the growing period of spring varieties of oats Obrazcov chiflik 4, HiFi, Mina and Novosadski naked is in a strong negative correlation with the length of inter-phase periods of sowing to germination and third leaf to tillering, but in a strong positive correlation with the period from germination to third leaf.

The length of the growing season in tested spring oat varieties is in medium (R = 0,541 for Mina; R = 0,674 for Obrazcov chiflik 4; R = 0,629 for HiFi) up to strong (R = 0,952 for Novosadski naked) positive correlation with the duration of the interphase period flowering to full maturity.

Precipitation during different phases of development of spring oats strongly influence the duration of the inter-phase periods expressed by correlation coefficients as follows:

- During the period between sowing to germination - R = 0,898;
- During the interphase period third leaf - tillering - R = 0,993 to R = 0,998;
- During the interphase period tillering–stem elongation - R = 0,547 to R = 0,698;
- During the interphase period stem elongation - flowering -R = 0,830 to R = 0,999;

The relationship between the amount of precipitation after flowering till the end of the vegetation and the duration of interphase period flowering - full maturity is slightly negative in all tested varieties. A similar trend is in the period from germination to stage third leaf. Between varieties not reported significant differences.

The total amount of precipitation during the growing period and the reported length of the growing period is in a strong negative correlation (R = -0,800 to R = -0,985).

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Table 1. Correlation between the length of inter-phase periods and the amount of precipitations, cultivar Obrazcov chivlik 4

	Sowing Emerg ence	Emergence -Third leaf	Third leaf -Tillering	Tillering-Stem elongation	Stem elongation-Flowering	Flowering-Full maturity	Vegetation period	Precipitations Sowing-Emergence	Precipitations Emergence-Third leaf	Precipitations Third leaf - Tillering	Precipitations Tillering-Stem elongation	Precipitations Stem elongation-Flowering	Precipitations Flowering-Full maturity	Amount of railfall Vegetation period
Sowing-Emergence	1,000	-0,992	0,982	-0,327	0,454	-0,756	-0,993	0,898	0,327	0,952	-0,905	0,705	0,728	0,800
Emergence-Third leaf		1,000	-0,998*	0,444	-0,338	0,668	0,998	-0,946	-0,444	-0,983	0,952	-0,610	-0,808	-0,869
Third leaf –Tillering			1,000	-0,500	0,277	-0,619	-0,997	0,965	0,500	0,993	-0,969	0,558	0,844	0,899
Tillering-Stem elongation				1,000	0,693	-0,371	0,436	-0,710	-0,998	-0,601	0,698	0,440	-0,886	-0,829
Stem elongation-Flowering					1,000	-0,926	-0,346	0,015	-0,693	0,159	-0,032	0,952	-0,281	-0,172
Flowering-Full maturity						1,000	0,674	-0,390	0,371	-0,519	0,406	-0.997*	-0,101	-0,211
Vegetation period							1,000	-0,943	-0,436	-0,981	0,949	-0,616	-0,803	-0,865
Precipitations Sowing-Emergence								1,000	0,710	0,990	-0,998	0,320	0,955	0,982
Precipitations Emergence-Third leaf									1,000	0,601	-0,698	-0,440	0,886	0,829
Precipitations Third leaf – Tillering										1,000	-0,992	0,454	0,903	0,945
Precipitations Tillering-Stem elongation											1,000	-0,337	-0,950	-0,979
Precipitations Stem elongation-Flowering												1,000	0,026	0,138
Precipitations Flowering-Full maturity													1,000	0,994
Amount of railfall Vegetation period														1,000

Table 2. Correlation between the length of inter-phase periods and the precipitation, cultivar HiFi

	Sowing Emergence	Emergence -Third leaf	Third leaf -Tillering	Tillering-Stem elongation	Stem elongation-Flowering	Flowering-Full maturity	Vegetation period	Precipitations Sowing-Emergence	Precipitations Emergence-Third leaf	Precipitations Third leaf - Tillering	Precipitations Tillering-Stem elongation	Precipitations Stem elongation-Flowering	Precipitations Flowering-Full maturity	Amount of railfall Vegetation period
Sowing-Emergence	1,000	-0,992	0,982	-0,327	0,189	-0,629	-0,998	0,898	0,327	0,952	-0,905	0,705	0,728	0,800
Emergence-Third leaf		1,000	0,998	0,444	-0,064	0,526	0,992	-0,946	-0,444	-0,983	0,952	-0,610	-0,808	0,869
Third leaf –Tillering			1,000	-0,500	0,127	-0,470	-0,982	0,965	0,500	0,993	-0,969	0,558	0,844	0,899
Tillering-Stem elongation				1,000	0,866	-0,529	0,327	-0,710	-0,998	-0,601	0,698	0,440	-0,886	-0,829
Stem elongation-Flowering					1,000	-0,882	-0,189	-0,263	-0,866	-0,121	0,246	0,830	-0,536	-0,438
Flowering-Full maturity						1,000	0,629	-0,222	0,529	-0,360	0,239	0,995	-0,076	-0,036
Vegetation period							1,000	-0,898	-0,327	-0,952	0,905	-0,705	-0,728	-0,800
Precipitations Sowing-Emergence								1,000	0,710	0,990	-0,998	0,320	0,955	0,982
Precipitations Emergence-Third leaf									1,000	0,601	-0,698	-0,440	0,886	0,829
Precipitations Third leaf – Tillering										1,000	-0,947	0,454	0,903	0,945
Precipitations Tillering-Stem elongation											1,000	-0,337	-0,950	-0,979
Precipitations Stem elongation-Flowering												1,000	0,026	0,138
Precipitations Flowering-Full maturity													1,000	0,994
Amount of railfall Vegetation period														1,000

Table 3. Correlation between the length of inter-phase periods and the precipitation, cultivar Mina

	Sowing Emergence	Emergence -Third leaf	Third leaf -Tillering	Tillering-Stem elongation	Stem elongation-Flowering	Flowering-Full maturity	Vegetation period	Precipitations Sowing-Emergence	Precipitations Emergence-Third leaf	Precipitations Third leaf - Tillering	Precipitations Tillering-Stem elongation	Precipitations Stem elongation-Flowering	Precipitations Flowering-Full maturity	Amount of railfall Vegetation period
Sowing Emergence	1,000	-0,992	0,982	-0,327	0,189	-0,564	-0,998	0,898	0,327	0,952	-0,905	0,705	0,927	0,980
Emergence-Third leaf		1,000	-0,998	0,444	-0,064	0,455	0,995	-0,946	-0,444	-0,983	0,952	-0,610	-0,967	-0,997
Third leaf - Tillering			1,000	-0,500	0,100	-0,397	-0,987	0,965	0,500	0,993	-0,969	0,558	0,981	0,998
Tillering-Stem elongation				1,000	0,866	-0,596	0,352	-0,710	-0,998	-0,601	0,698	0,440	-0,657	-0,507
Stem elongation-Flowering					1,000	-0,918	-0,163	-0,263	-0,866	-0,121	0,246	0,830	-0,192	-0,008
Flowering-Full maturity						1,000	0,541	-0,142	0,596	-0,284	0,159	-0.983	-0,214	-0,390
Vegetation period							1,000	-0,909	-0,352	-0,960	0,916	-0,686	-0,937	-0,985
Precipitations Sowing-Emergence								1,000	0,710	0,990	-0,996	0,320	0,997	0,967
Precipitations Emergence-Third leaf									1,000	0,601	-0,698	-0,440	0,657	0,507
Precipitations Third leaf - Tillering										1,000	-0,992	0,454	0,997	0,994
Precipitations Tillering-Stem elongation											1,000	-0,337	-0,998	-0,971
Precipitations Stem elongation-Flowering												1,000	0,388	0,551
Precipitations Flowering-Full maturity													1,000	0,983
Amount of railfall Vegetation period														1,000

Table 4. Correlation between the length of inter-phase periods and the precipitation, cultivar Novosadski naked

	Sowing Emergence	Emergence -Third leaf	Third leaf - Tillering	Tillering-Stem elongation	Stem elongation-Flowering	Flowering - Full maturity	Vegetation period	Precipitations Sowing-Emergence	Precipitations Emergence -Third leaf	Precipitations Third leaf -Tillering	Precipitations Tillering-Stem elongation	Precipitations Stem elongation-Flowering	Precipitations Flowering-Full maturity	Amount of railfall Vegetation period
Sowing-Emergence	1,000	-0,992	0,982	-0,327	0,954	-0,965	-0,999	0,898	0,327	0,992	-0,970	0,938	0,364	0,810
Emergence-Third leaf		1,000	-0,998	0,444	-0,984	0,925	0,997	-0,946	-0,444	-0,998	0,993	-0,974	-0,478	-0,877
Third leaf –Tillering			1,000	-0,500	0,993	-0,899	-0,990	0,965	0,500	0,998	-0,998	0,986	0,533	0,906
Tillering-Stem elongation				1,000	-0,596	0,069	0,371	-0,710	-0,998	-0,447	0,547	-0,635	-0,999	-0,819
Stem elongation-Flowering					1,000	-0,842	-0,967	0,989	0,596	0,985	-0,998	0,959	0,627	0,949
Flowering-Full maturity						1,000	0,952	-0,752	-0,069	-0,923	0,873	-0.814	-0,108	-0,629
Vegetation period							1,000	-0,917	-0,371	-0,997	0,980	-0,953	-0,407	-0,837
Precipitations Sowing-Emergence								1,000	0,710	0,947	-0,978	0,995	0,737	0,985
Precipitations Emergence-Third leaf									1,000	0,447	-0,547	0,635	0,999	0,819
Precipitations Third leaf – Tillering										1,000	-0,993	0,975	0,481	0,879
Precipitations Tillering-Stem elongation											1,000	-0,994	-0,579	-0,928
Precipitations Stem elongation-Flowering												1,000	0,665	0,963
Precipitations Flowering-Full maturity													1,000	0,841
Amount of railfall Vegetation period														1,000