PHENOLOGICAL DEVELOPMENT OF TRITICALE VARIETIES DEPENDING ON THE WEATHER CONDITIONS

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Abstract: A field experiment was set in the period 2014-2017 on the experimental field of the Research Institute of Field Crops of the Agricultural Academy, Chirpan. Three triticale varieties were used: Colorit, Boomerang and Respect. With the aim of establishing the effect of the temperature and precipitation conditions of the year on the phenological development of triticale varieties, the sum of the active temperatures, the average temperature for the period and the sum of precipitation were calculated for each stage period. From a tillering to a maturity stage within the different varieties, a different duration of the growth stage periods is observed. These differences contribute to a better clarification of the biological requirements of the studied varieties.

Key words: triticale, meteorology, phenology

Introduction

Genetically triticale (× *Triticosecale* Wittmack) is an amphiploid produced by crossing the genomes of two different species - wheat and rye. The first hybrids were fertile progenies, which arose from an inter-generic hybridization and followed by chromosome doubling between a female parent from the genus *Triticum* and the male parent from the genus *Secale*. The majority of the today's varieties are descendants of a primary hybrids, which involve either common (*Triticum aestivum* L., 2n=42=AABBDD) or durum (*Triticum durum*, 2n=28=AABB) wheat as a female parent and cultivated diploid rye (*Secale cereale* L., 2n=14=RR) as a male parent (Knezevic et al., 2010; Knezevic et al., 2016; Lalevic et al., 2012; Madic et al., 2013; Madic et al., 2015; Sucu and Cifci, 2016).

The main factors which determine the time and quality of sowing and on which depend the germination, the growth and the development are heat, soil moisture and length of the day. As a reason for the great diversity in the time of occurrence and the passage of the main phenological phases in crop development can be mentioned genotype, sowing date, accessible nutrients, soil moisture, daytime, air and soil temperatures and others (Bassu et al., 2013; Giunta et al., 2015; Mager et al., 2016; Santiveri et al., 2001).

Triticale goes through the same growth stages as the other cereal crops and occupies an intermediate position between wheat and rye in terms of its development (Akhlaq et al., 2015; Estrada-Campuzano et al., 2008; Kirchev et al., 2010; Royo and Blanco, 1999).

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The objectives of the present study are to clarify both the peculiarities of the phenological development of triticale varieties under the influence of the specific weather conditions and the genotypic differences between them.

Material and methods

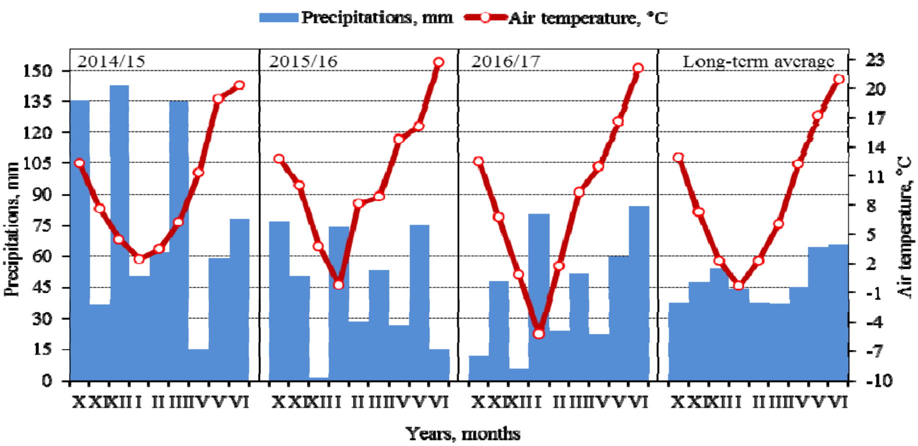
Field trial: A field experiment was set in the period 2014-2017 on the experimental field of the Research Institute of Field Crops of the Agricultural Academy, Chirpan. Three triticale varieties were used – the standard Colorit, and other two varieties created at Dobrudja Agricultural Institute – Gen. Toshevo, Bulgaria: Boomerang and Respect.

The experiment consisted of a randomized complete block design after predecessor sunflower with four replication and plots of 10 m^2 planted at a sowing rate of 550 viable seeds m^{-2}.

Estimation methods: The beginning of the major phenological stages was identified according to Zadoks scale (1974): sowing (00 – dry seed); Sprung (10 – first leaf through coleoptile); 3 leaf (13 – 3 leaves unfolded); tillering (21 – main shoot and 1 tiller); stem elongation (31 – 1st node detectable); spike emergence (59 – Emergence of inflorescence completed); Maturity (95 – Seed dormant).

With the aim of establishing the effect of the temperature and the precipitation conditions of the year, the sum of the active temperatures (above 5^0C), Σ Tact ^{0}C, the average temperature for the period (T aver. ^{0}C) and the sum of precipitation (mm) were calculated for each growth stage period.

Soil and climate conditions:



Graph. 1. Temperature and precipitation during triticale vegetation.

The experimental station of the Research Institute of Field Crops - Chirpan has a field with a powerful humus horizon (80 - 115 cm) with a thrush - grained, passing to a slightly pronounced prismatic structure at its lower part. The high moisture content of the Pelic Vertisols is determined by their heavy loamy mechanical composition. They swell strongly when moistened and reduce their volume when they dry out. Because of their high moisture, these soils are suitable for growing triticale, especially in years of lasting droughts (Panayotova, 2007).

Meteorological conditions are different during the three years of the study. Figure 1 shows the three-year differences over the long-term average (Fig. 1).

Results and discussion

During the three years of the study no differences were found in the growth stage periods from sowing to germination, moreover all varieties entering at the same time due to the same temperature and precipitation conditions (Table 1).

The sprung of triticale in 2014 occurs 22 days after sowing, in 2015 after 18 days, and the third year - after 27 days. The duration of this growth stage period depends on the amount of precipitation but is limited by the air temperature and more higher the average daily air temperature, so faster the germination occurs. The growth stage period sprung-third leaf lasts between 13 and 22 days during the three years of the study. Although in 2016 the sum of the active temperatures is higher - 135.5 ˚C than in 2014 (110.1 ˚C), the amount of rainfall in 2014 is 21.5 mm more than in 2015, which also determines the shorter growth stage period. The growth stage period sprung-third leaf is the longest in 2017. Although compared with 2016 the rainfall was 92.6 mm more and the sum of the active temperatures was almost the same, the average daily temperature was 6.4 °C, which is 3.3 ˚C lower than the previous stage.

In the first year of the study, the growth stage period of the third leaf - tillering was 19 days, in the second 21 days, and in the third 15 days. The accumulated sum of active temperatures is as follows: 144.0, 171.4 and 124.7˚C, and the amount of rainfall is 185.4, 97.7 and 32.3 mm respectively. Meteorological conditions are most favorable in 2015, given the higher rainfall of 87.8 mm more than in 2016 and 153.1 mm compared to 2017, which is the reason for the shorter growth stage period.

Table 1. Characteristics of the growth stage period to tillering stage.

Years	Growth stage period	Nr. of days with active t˚C	Σ Tact ˚C	T aver. ˚C	Sum of precipitation, (mm)
2014/15	sowing-sprung	22	180.5	8.2	157.4
	sprung-3th leaf	13	110.1	8.5	71.8
	3th leaf-tillering	19	144.0	7.6	185.4
2015/16	sowing-sprung	18	183.7	10.2	-
	sprung-3th leaf	14	135.5	9.7	50.3
	3th leaf-tillering	22	171.4	7.8	97.7
2016/17	sowing-sprung	27	281.6	10.5	48.3
	sprung-3th leaf	22	140.5	6.4	142.9
	3th leaf-tillering	15	124.7	8.3	32.3

From a tillering phase to a maturity phase, different periods of different varieties are recorded (Table 2).

Table 2. Characteristics of the growth stage periods tillering - maturity.

A. Colorit

Years	Growth stage period	Nr. of days with act. t°C	Σ Tact °C	T aver. °C	Sum of precipitation, (mm)
2014/15	tillering-stem elongation	30	296.9	9.9	40.0
	st. elongation-sp. emergence	26	422.3	16.2	54.7
	sp. emergence-maturity	42	1054.6	25.1	93.5
2015/16	tillering-stem elongation	26	246.7	9.5	48.1
	st. elongation-sp. emergence	30	405.6	13.5	22.5
	sp. emergence-maturity	72	1320.0	18.3	106.9
2016/17	tillering-stem elongation	32	358.4	11.2	30.0
	st. elongation-sp. emergence	17	260.5	15.3	29.7
	sp. emergence-maturity	61	1256.6	20.6	117.4

B. Boomerang

Years	Growth stage period	Nr. of days with act. t°C	Σ Tact °C	T aver. °C	Sum of precipitation, (mm)
2014/15	tillering-stem elongation	38	397.8	10.5	40.2
	st. elongation-sp. emergence	18	321.4	17.9	54.5
	sp. emergence-maturity	42	1054.6	25.1	93.5
2015/16	tillering-stem elongation	38	370.4	9.7	60.9
	st. elongation-sp. emergence	27	396.3	14.7	25.8
	sp. emergence-maturity	63	1205.6	19.1	90.8
2016/17	tillering-stem elongation	34	377.3	11.1	34.2
	st. elongation-sp. emergence	15	241.6	16.1	29.7
	sp. emergence-maturity	61	1256.6	20.6	117.4

C. Respect

Years	Growth stage period	Nr. of days with act. t°C	Σ Tact °C	T aver. °C	Sum of precipitation, (mm)
2014/15	tillering-stem elongation	38	397.8	10.5	40.2
	st. elongation-sp. emergence	18	321.4	17.9	54.5
	sp. emergence-maturity	42	1054.6	25.1	93.5
2015/16	tillering-stem elongation	38	370.4	9.7	60.9
	st. elongation-sp. emergence	27	396.3	14.7	25.8
	sp. emergence-maturity	63	1205.6	19.1	90.8
2016/17	tillering-stem elongation	34	377.3	11.1	34.2
	st. elongation-sp. emergence	20	328.6	16.4	42.8
	sp. emergence-maturity	56	1154.3	20.6	101.3

In 2015, the growth stage tillering-stem elongation of the Colorit variety (30 days) was shortest and there were no differences in average daily temperatures (9.9 and 10.5 °C) and the amount of rainfall (40.0 and 40.2 mm). Similar observations are noted in the next years of the study. In 2016, the period is shortest for the Colorit variety (26 days), the average temperature for the Boomerang and Respect varieties is close to 9.5 and 9.7

°C, but the rainfall is less – 12.8 mm. In 2017, Colorit entered to the stage earliest (32 days), the average daily temperatures were almost the same, and the rainfall was less – 4.2 mm.

The growth stage period stem elongation-spike emergence is shorter in 2015 for the Boomerang and Respect varieties (18 days). In 2016, no difference in the duration of the growth stage period between varieties was observed. However, the duration of the Boomerang and Respect varieties was 3 days shorter, which can be explained by the higher average temperature (14.7 °C) than that of the Colorit variety (13.5 °C). In 2017, the Boomerang and Colorit varieties pass in the shortest time during the growth stage period (15 and 17 days), unlike Respect (20 days). Although the average daily temperatures are close (16.1 and 15.3 ˚C), it is necessary that the Respect variety accumulates a heat sum to bring its average daily temperature to that of the other varieties.

The maturity period is shortest for Boomerang and Respect varieties (63 days). This is due to the higher average day temperature (19.1 ˚C) in contast to that of Colorit (18.3 ˚C) and the shorter previous stage stem elongation-spike emergence (27 days) than that of Colorit (30 days).

Conclusion

During the growth stage sowing-germination period, differences between varieties have not been established, all varieties entering at the same time due to the same values of temperature and precipitation conditions. In the conditions of insufficient rainfall, determining the duration of germination is the average daily temperature.

From a tillering to a maturity phase in different varieties, a different duration of the growth stage periods is observed. These differences contribute to a better clarification of the biological requirements of the studied varieties.

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