Acta Agrophysica, 2002, 68, 115-122

OCCURRENCE OF DROUGHTS AND EXCESS OF RAIN WATER IN THE REGION OF THE WEST POLESIE AND THEIR EFFECT ON THE LOSSES IN PRODUCTION OF SPRING TRITICALE

L. Martyniak

Institute of Land Reclamation and Grasslands in Falenty, 05-090 Raszyn, Poland

A b s t r a c t. In the work are the results of the variety experiments with spring triticale, conducted in the years 1985-2000 in SDOO Uhnin, representing the area of the West Polesie. The distribution of precipitation in relation to the water need distribution during the periods of growth and development of plants was analysed. The studies showed a high variability in the level of precipitation during the particular years and, their different distribution and intensity during vegetation of plants. Water deficits in the defined figure intervals do not cause any decline in the yield of the spring triticale. As late as after exceeding of the "critical threshold", they lower the potential of yielding.

K e y w o r d s: drought, excessive precipitation, yield, spring triticale

INTRODUCTION

As with the territory of the whole country, a high variability of the level and distribution of atmospheric precipitation is found in the region of the West Polesie [3,4]. The periods of deficits and excess of precipitation during the plants vegetation are observed alternatively. However, not all states of excessive humidity of the soil that appear due to abundant rainfalls and over-drying as result of their lack inhibit the development of plants and restrict their yielding [2]. The studies indicate that the variability of the water factor is to a certain degree necessary for plants for their correct development. It causes the enhancement of activities of mechanisms that regulate metabolic processes, occurring in the plants [1]. There are, however, the critical levels of excess and deficit of water in the soil after exceeding of which the plants react by a distinct lowering of yields.

*The present work is a fragment of the studies, performed within the Project 6 P06B 05 720, financed by the Committee for Scientific Studies (KBN).

The results of the studies, based on the sixteen-years data on yielding and the conditions of spring triticale growth in the variety experiment of SDOO Uhnin are aimed at the presentation of the level and variability of water deficits (less so of excess) in relation to water needs of plants during the vegetation seasons, and at the determination of the relationships between the deficits of precipitation and yielding.

METHOD

The deficits and excess of precipitation in relation to water needs of spring triticale during the vegetation seasons: 1985-2000 were determined from:

$$N = P - k\,Eto \tag{1}$$

where: N – deficit or excess of atmospheric precipitation, P – precipitation, k – vegetal coefficient, determining the state and degree of plant development, ETo – potential (indicator) evapotranspiration, calculated by Penman-Monteith method in the decade intervals.

The calculations did not consider the soil retention, assuming it as relatively constant in relation to daily meteorological elements. During the vegetation cycle of the spring triticale, the basic stages of growth and development of plants have been distinguished; during these stages, the main processes of formation of yield structure elements, variable in respect of the needs and sensitivity in relation to the environment, take place.

In the work, the results of the variety of experiments with spring triticale, conducted in the years 1985-2000 in SDOO Uhnin representing the area of the West Polesie. The station is situated in the region of the Wieprz-Krzna river channel and represents the region of the West Polesie. The experiments were conducted on a very good rye complex, bonitation class III. The level of the ground water reached, as a rule, a depth below 1 m. The experiments were carried out under similar agrotechnical conditions during the particular years. The basic analytical unit was the mean crop of grain from all the examined varieties. The source material of the main meteorological elements derived from the regular climate observations, performed at the place of experimental studies. The analysis of the relationship between the spring triticale yield and meteorological conditions during the years of the studies was conducted, using the Pearson correlation matrix.

RESULTS

The growth and development of the spring triticale, as with other cultivated crops, is strongly modified by weather factors during the vegetation period. The run of the vegetation period of the spring triticale in the years 1985-2000 is presented in Table 1.

Table 1. The run of the vegetation period of the spring triticale in the years 1985 2000, SDOO Uhnin

Vegetation season		Range of period
Growth stages	Date (mean of years)	
Sowing	16.04	$24.03_{[89]} - 25.4_{[96,97]}$
Emergence	29.04	$13.04_{[89]} - 6.05_{[87]}$
Tillering	14.05	$1.05_{[89]} - 20.05_{[94,95]}$
Shooting	27.05	$16.05_{[89]} - 5.06_{[87]}$
Heading	14.06	$31.05_{[00]} - 21.06_{[87]}$
Milk maturity	6.07	$22.06_{[89]} - 15.07_{[97]}$
Wax maturity	2.08	$17.07_{[89]} - 17.08_{[85]}$

In the vegetation cycle of the spring triticale, the basic stages, the main vital processes of the plants, differing in respect of sensitivity to the unfavourable water-temperature conditions take place. The mean date of seeding from 16 years took place on 16 of April. The real dates, approximating to the mean calendar date were, however, noted very rarely. The scattering of the seeding time during the years of the studies reached one month and resulted mainly from the differentiated meteorological conditions that took place during the years of the studies. Due to the same reason, and, in consequence of the date of seeding, the dates of developmental stages of the plants were differentiated.

In agricultural production, the quantity of precipitation is important as well as their distribution at time. The level and the distribution of precipitation during the vegetation seasons of the spring triticale in the period of 1985-2000, is given in Table 2.

During the analysed 16 years, the mean sum of precipitation in the vegetation season for the spring triticale for Uhnin was 227 mm. The extremely wet year was 1985 (more than 100% above the mean from many-years period). The vegetation season of this year was characterised by many-times repeated high rainfalls, of a heavy type. During the period from stalk shooting stage till the grain maturity, seven heavy rainfalls were observed, including 5, exceeding 30 mm of rainfall during 24 h. The abundant rainfalls, as described above, did not have any effect on

Table 2. The level and the distribution of precipitation during the vegetation seasons of the spring triticale in the period of 1985-2000, SDOO Uhnin

Years	Season sums of precipitation (mm)	Rainless periods > 15 days			Rain periods > 7 days			Maximum daily of precipitation			
		number	number of days	growth stages*	number	number of days	growth stages	21-30 mm	growth stages	>30 mm	growth stages
1985	501	-	-	-	1	11	IV	2	VI	5	III-VI
1986	224	1	19	I, II	-	-	-	2	VI	-	-
1987	152	1	15	III, IV	1	8	VI	1	IV	-	-
1988	200	1	27	I, II, III	-	-	-	2	III; V	1	VI
1989	168	1	15	III, IV	-	-	-	-	-	-	-
1990	175	-	-	-	-	-	-	-	-	-	-
1991	215	-	-	-	1	8	II, III	2	V; VI	-	-
1992	214	1	19	VI	-	-	-	-	-	2	VI
1993	170	2	21; 10	I, II, III	1	10	VI	1	IV	-	-
1994	131	3	18, 17, 19	IV, V, VI	1	8	III	1	V	-	-
1995	136	2	14; 16	III-VI	2	8; 7	IV; V	-	-	-	-
1996	232	2	16; 15	I; III-V	2	9, 8	II; III	1	VI	-	-
1997	416	1	19	I, II	2	11; 10	V; VI	3	II; V; VI	2	V-VI
1998	255	-	-	-	3	9; 9; 8	III; IV; VI	-	-	1	VI
1999	295	1	16	III, IV	3	7; 9; 14	I; II; V	-	-	2	I; V
2000	147	1	31	I-IV	1	8	VI	2	IV; VI	-	-

*Growth stages: I sowing – emergence, II emergence-tillering, III tillering – shooting, IV shooting-heading, V heading – milk maturity, VI milk maturity – wax maturity

the level of yielding of the spring triticale in this year. Also, very high precipitation (more than 80% above the mean from many-years period) was found in 1997. As compared to 1985, the distribution of precipitation during the period of plant vegetation was, however, different. The first period of plants growth ran under the semi-arid conditions (the 19-day period without precipitation) while in the generative period of plant growth, since the stage of earing till the complete grain maturity, the precipitation courses lasted for longer than one week (it happened twice) and the rain-shower precipitation occurred five times. The long-lasting precipitation courses and sudden storm rains, occurring in a final period of vegetation, caused the lodging of plants that made the process of photosynthesis and assimilation difficult; in consequence, it caused a lowering of the grain crop. The semi-arid years (33-42%) below the mean value from the many-years period) in this region included: 1987, 1994, 1995 and 2000. In all the mentioned semi-arid years, the decrease of the yield of triticale grain, was observed.

The deficits and excess of precipitation during the vegetation seasons of the studied many-years period are given in Fig. 1. From the studies, it results that during the period of cereals vegetation the evapotranspiration at the territory of the West Polesie exceeded often the level of precipitation. It has a big influence on exhaustion of water retention of the soils and the state of water resources in the country. However, the water deficits, expressed as a difference in precipitation and evapotranspiration as a incoming and expenditure factors of water balance, respectively, do not completely explain the variability of spring triticale yielding. The coefficients of linear correlation between the yield of the grain and water deficits were low and statistically unconfirmed. In the case of cereals that possess a deep root system, enabling them to take water from the deeper layers of the soil, water deficits in the defined figure intervals do not cause a decline in the yield. As late as after exceeding the "critical threshold", they inhibit the development of plants and lower their yield-producing potential.

Figure 2 shows the variability of yielding of the spring triticale during the analysed years. Below the confidence interval, marked on the figure, we may find the years during which due to weather anomalies, the low yield was obtained

The studies demonstrated a quite high stability of yielding of the spring triticale during the studies' many-years' period. In most of the studied years, the deviations of the grain yield in relation to the mean from the total period, were found in the confidence interval, characterising a natural variability of yielding. The exception concerned the catastrophically low yields of the grain (16.7 dt ha^{-1}), obtained in the experiment of 1994, with the extremely low precipitation. A significant

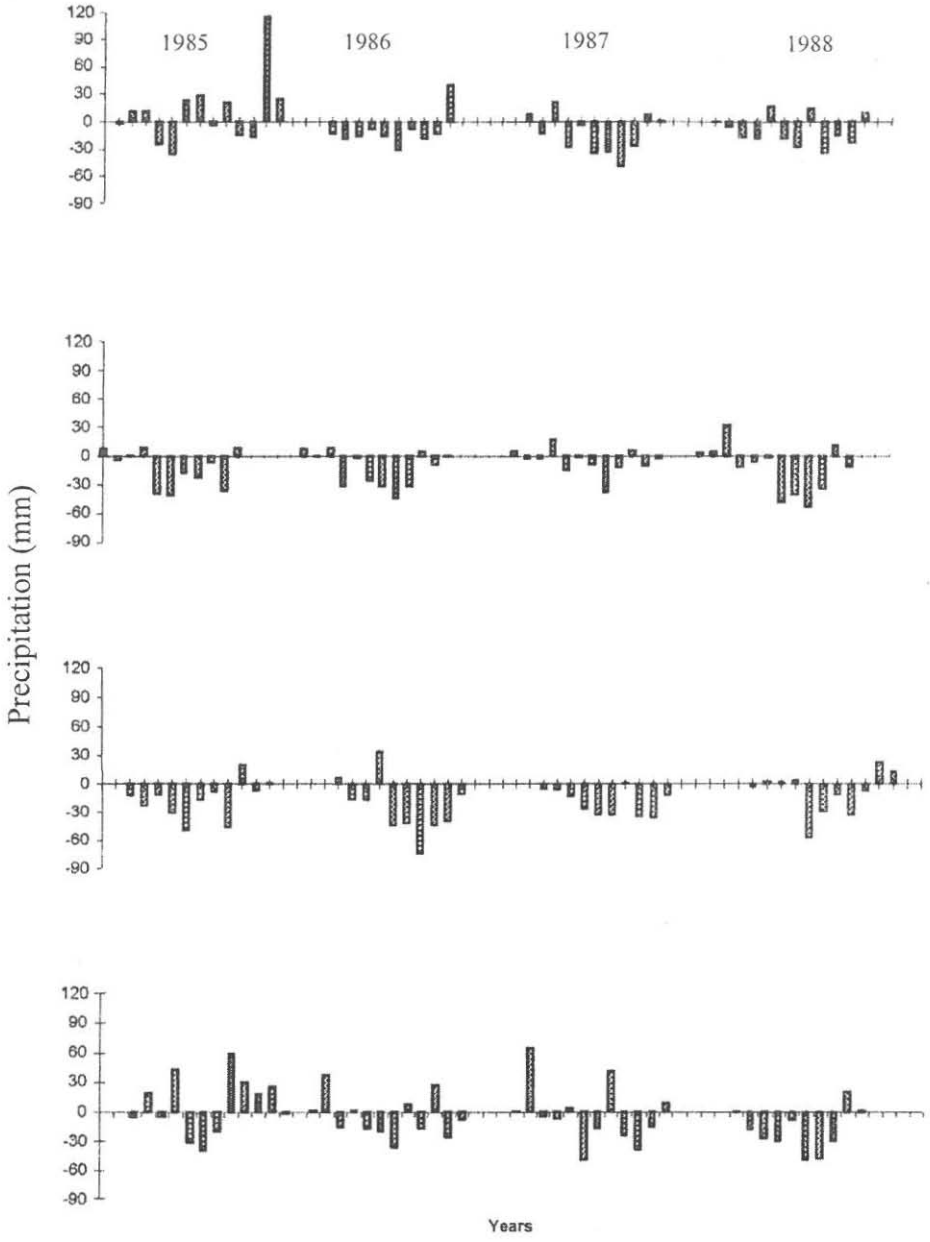

Fig. 1. Deficits and excess of precipitation in mm according towater requirements of the spring triticale in the years 1985-2000, SDOO Uhnin

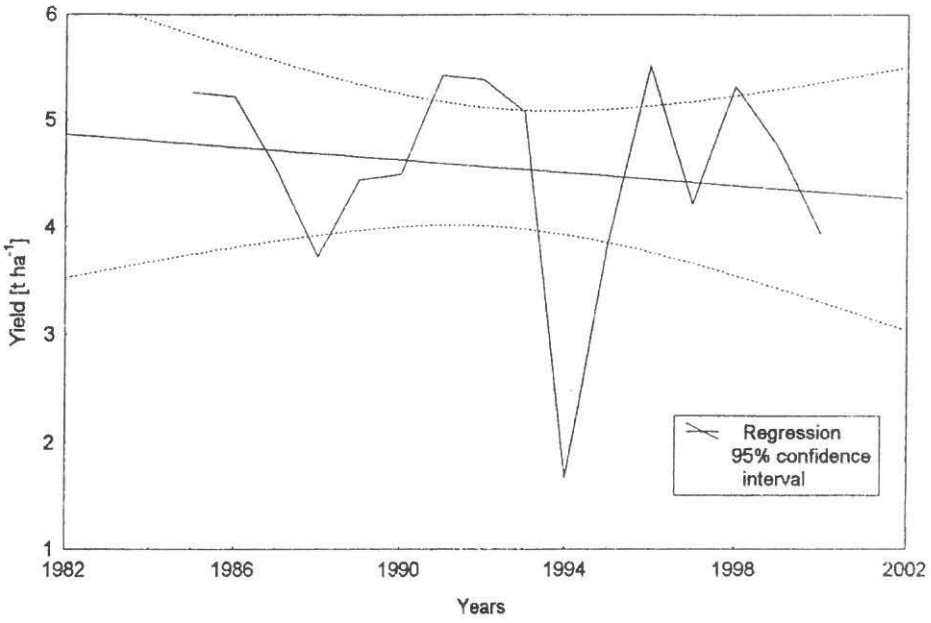

Fig. 2. Variability of yielding of the spring triticale in the years 1985-2000, SDOO Uhnin

lowering of the grain's yield (about 20%) as compared to the mean from the many-years' period was also obtained in the years1988 and 1995, with the periodical deficits of precipitation during the stages of stalk shooting till the milk maturity stage.

CONCLUSIONS

1. Based on the sixteen-year data from Uhnin, representing the area of the West Polesie, a high variability of the level of precipitation during the particular years and, their different distribution and intensity during vegetation of plants, has been found.

2. The studies showed a quite high stability of yielding of the spring triticale during the studies many-years' period. In most of the studied years, the grain yields were found in the confidence interval, characterising the natural variability of yielding.

3. Water deficits in the defined figure intervals do not cause any decline in the yield of the spring triticale. As late as after exceeding the "critical threshold", they inhibit the development of plants and lower the potential of yielding.

REFERENCES

1. **Dzieżyc J:** Yield – producting factors – Yielding of the plants (in Polish). PWN Warszawa-Wrocław, 1993.
2. **Martyniak L., Kaczyński T., Kamasa J.:** Evaluation of yielding of the cereals and potatoes in the year of drought 1992 as perfomed in the grounds of the results of yield experiments. Proc. Int. Workshop on "Drought in the Carpatians Region". Budapest-Alsogod, 249-258, 1995.
3. **Szajda J., Gajda J.:** Climatic conditions of the central part of the region of Wieprz-Krzna Channel (in Polish). Ann. UMCS, Lublin, XLVIII, 11, 76-91, 1993.
4. **Zawora T.:** Insufficient and excessive precipitations at the territory of Poland (in Polish). Zesz. Nauk ATR Bydgoszcz, 148 Rol. 27; 109-115, 1988.

WYSTĘPOWANIE SUSZ I NADMIARU WODY OPADOWEJ W REJONIE POLESIA ZACHODNIEGO ORAZ ICH WPŁYW NA STRATY W PRODUKCJI PSZENŻYTA JAREGO

L. Martyniak

Instytut Melioracji i Użytków Zielonych w Falentach, 05-090 Raszyn, Polska

S t r e s z c z e n i e. W pracy przedstawiono wpływ niedoboru i nadmiaru opadów w sezonach wegetacyjnych 1985-2000 na zmienność plonowania pszenżyta jarego w rejonie Polesia Zachodniego. W tym celu wykorzystano szesnastoletnie wyniki doświadczenia odmianowego COBORU z pszenżytem jarym, przeprowadzonego w Stacji Doświadczalnej Oceny Odmian w Uhninie (szerokość geograficzna = 51° 34' , długość geograficzna = 23° 02').

Analizowano rozkład opadów względem rozkładu potrzeb wodnych w okresach wzrostu i rozwoju roślin. Potrzeby wodne pszenżyta jarego określano wielkością ewapotranspiracji, obliczoną metodą Penmana- Monteitha.

Badania wykazały dużą stabilność plonowania pszenżyta jarego w badanym wieloleciu. W poszczególnych latach odchylenia plonów ziarna względem średniej z wielolecia, mieściły się w przedziale ufności, charakteryzującym naturalną zmienność plonowania .Wyjątkiem były bardzo niskie plony ziarna (1,67 t ha^{-1}) uzyskane w doświadczeniu w 1994 roku, o ekstremalnie niskich opadach. Istotną zniżkę (około 20%) plonu ziarna w porównaniu do średniej z wielolecia uzyskano również w latach 1988 i 1995, o okresowych niedoborach opadu w fazach strzelania w źdźbło do dojrzałości mlecznej.

S ł o w a k l u c z o w e: susza, nadmiar opadów, plon, pszenżyto jare