Productivity of common wheat (*Triticum aestivum* L.) depending on predecessor and the level of nitrogen fertilization.

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Abstract: In a field experiment during the period of 2005-2008 in south-east Bulgaria for estimation the influence of different predecessors (sunflower, stubble, coriander and sorghum) and the rate of nitrogen fertilization on productivity of the common winter wheat variety Prelom. The analysis of the results show that the predecessor and nitrogen rate in combination with meteorological conditions during the years of the study were decisive factors for the expression of the productivity of common winter wheat variety Prelom. The most suitable predecessor for the wheat under the conditions of south-east Bulgaria is the coriander, followed by sunflower and stubble. The sorghum was a unsuitable predecessor. The most effective fertilization rates are $N_{120}P_{80}$ with predecessor coriander and $N_{160}P_{80}$ with sunflower and stubble.

Key words: wheat, predecessor, nitrogen fertilization, elements of productivity, grain yield

Introduction

A prerequisite for the expression of the genetic potential of wheat is the use of suitable agronomy practices in combination with the specification meteorological

conditions for the region (Ivanova et al., 2009). Since meteorological conditions are not controllable, the main way for expression of varieties' biological possibility is improving the growing conditions. The choice of a suitable predecessor and optimal fertilization are some of the major agronomy factors (Ivanova et al., 2007; Gerdjikova et al., 2008; Gerdjikova et al., 2011; Penchev, et al., 2008; Yanchev & Popova, 2000). A number of researches have established the optimal parameters of these factors, which have effect on the productivity of wheat varieties grown in different agro-ecological and climatic conditions of Bulgaria (Delibaltova & Ivanova, 2006; Kirchev, 2001).

The investigation aim was to establish the effect of predecessor and the rates nitrogen fertilization on the elements of productivity and the grain yield of the common winter wheat variety Prelom in south-east Bulgaria.

Material and methods

The field experiment was held in the experimental of the selected area in Zhrebino village (South-east Bulgaria) in the period 2005 - 2008. The test was performed by means of a block method with four replications; experimental field area – 15 m^2. The sowing was made with 500 seeds/m^2 of common winter wheat variety Prelom after four predecessor – sunflower, stubble, coriander and sorghum and three rates of fertilization - $N_{80}P_{80}$, $N_{120}P_{80}$, $N_{160}P_{80}$ and control N_0P_0. All the stages of the established technology for wheat growing were followed. The grain yield is determined with standard grain moisture of 13%.

The indices; number of productive tillers (m^2), height of plants (cm), length of spike (cm), number of spikeletts per spike, number of the grains per spike, weight of the grains per spike (g) and grain yield (kg ha^{-1})were determined.

For the purpose of determining the quantity dependence between the studied indicators, the experimental data were processed according to the Anova Method of dispersion analysis, and the differences between the variants were determined by means of the Dunkan's Multiple Range Test (Dunkan, 1955)

The basic climatic factors, determining wheat growth, development and productivity were temperatures and precipitation, their combination and distribution during vegetative period.

The analysis of these factors showed that the values of the average monthly temperatures during the years of study did not differ significantly from those of the long-term period. Significant differences were observed in the quantity of precipitation during the individual agricultural years. The first experimental year (2005-2006) was the moistest one, followed by 2007/08 and least precipitation was reported in the second year of the experiment (2006-2007), which influenced the growth processes and productive capabilities of the wheat plants.

Results and discussion

The values of the elements of productivity were presented in Table 1 in average for the three years. The data showed that number of productive tillers varied depending on predecessor and nitrogen fertilization rate from 432 to 637number/m^2. Highest number of productive tillers Prelom variety was formed after $N_{160}P_{80}$ fertilization and predecessor coriander.

The lowest values of this index are reported after sorghum predecessor and non fertilized variants. Increasing the fertilizer rate increases the number of productive tillers after predecessor stubble up to 24%, then sorghum, coriander and sunflower respectively 11.1, 14.2 and 18.7% compared with untreated variants, suggesting a higher effect of nitrogen fertilization at stubble predecessor.

Height of plants without fertilization vary from 68.5 cm after sorghum predecessor up to 81.2 cm after predecessor coriander. Fertilization had a positive effect resulting in increasing stem from 3.7 to 7.4 cm after predecessor sunflower, from 4.4 to 6.9 cm after predecessor stubble, from 3.5 to 8.7 after coriander, and from 2.5 up to 6.3 after sorghum, which means that fertilization has had a stronger influence on the plant height than the predecessor.

The length of spike varied within 6.8 to 8.9 cm. depending on the predecessor and applied nitrogen rates. The highest values of that characteristic were reported at coriander predecessor and the fertilization rate $N_{120}P_{80,}$ and the lowest one – at sorghum predecessor and without fertilization.

Number of spikeletts per spike is influenced both by the predecessor and the rate of fertilizations. After sorghum predecessor, the values of this index are the lowest and ranged from 14.2 in the absence of fertilization up to 19 of fertilization rate $N_{160}P_{80}$. The highest values of that characteristic were reported at coriander predecessor $N_{120}P_{80}$ fertilization, while at sunflower and stubble – at $N_{160}P_{80}$.

In non fertilized variants the number of the grains per spike depending on the predecessor is from 24.5 (after sorghum) up to 39.5 (after coriander). The fertilization increases the grain number up to 16.2% after predecessor coriander and up to 22.4% after predecessor stubble, compared to the untreated ones.

Table 1. Structural elements of the yield (mean 2005-2008)

Elements of productivity	Rates of fertilization (kg ha $^{-1}$)	Predecessor			
		Sunflower	Stubble	Coriander	Sorghum
Number of productive tillers (m^2)	N_0P_0	530	475	558	432
	$N_{80}P_{80}$	582	560	606	460
	$N_{120}P_{80}$	600	585	628	465
	$N_{160}P_{80}$	629	591	637	480
Height of plants (cm)	N_0P_0	69.4	71.2	72.5	68.5
	$N_{80}P_{80}$	73.1	75.6	76.0	71.0
	$N_{120}P_{80}$	75.3	76.9	79.0	73.0
	$N_{160}P_{80}$	76.8	78.1	81.2	74.8
Length of spike (cm)	N_0P_0	7.3	7.2	7.7	6.8
	$N_{80}P_{80}$	7.7	7.8	8.3	7.0
	$N_{120}P_{80}$	8.2	8.0	8.9	7.1
	$N_{160}P_{80}$	8.4	8.2	8.6	7.2
Number of spikeletts per spike	N_0P_0	19.0	17.6	20.5	14.2
	$N_{80}P_{80}$	22.8	19.8	22.3	16.7
	$N_{120}P_{80}$	23.4	21.6	25.7	18.2
	$N_{160}P_{80}$	24.0	22.0	24.6	19.0
Number of the grains per spike	N_0P_0	30.2	28.6	34.0	24.5
	$N_{80}P_{80}$	33.7	30.5	37.1	25.0
	$N_{120}P_{80}$	36.1	34.4	39.5	30.1
	$N_{160}P_{80}$	35.2	35.0	38.3	31.0
Weight of the grains per spike (g)	N_0P_0	1.25	1.15	1.56	0.95
	$N_{80}P_{80}$	1.38	1.19	1.61	1.10
	$N_{120}P_{80}$	1.47	1.43	1.73	1.27
	$N_{160}P_{80}$	1.53	1.47	1.67	1.33

Weight of the grains per spike has highest values after predecessor coriander and fertilization rate $N_{120}P_{80}$– 1.73g and lowest values after predecessor sorghum and absence of fertilization – 0.95g. At rate of fertilization $N_{160}P_{80}$ the weight of the

grains per strike after sunflower and stubble increases with 22.5 and 27.8% compared to the non fertilized one.

Grain yield varied depending on the climatic conditions throughout the years and under the effect of predecessor and fertilization (Table 2).

More favorable combination of the major meteorological factors (air temperature, soil and air humidity) during wheat vegetation led to obtaining higher yields in the first year of the study compared to the second and the third.

The highest yield of grain (6755 kg ha^{-1}) was carried out after predecessor coriander and fertilization level $N_{120}P_{80}$ and the lowest (3180 kg ha^{-1}) after sorghum and variants without fertilization.

High temperatures and lack of moisture during pouring and maturation of the grain during the year 2007 reflects adversely on the yields obtained. Fertilization increases the yield of grain. Makes impression that this year and in the four predecessors the yield is higher at level of fertilization $N_{80}P_{80}$ in comparison to the higher rates. Differences between the variants $N_{120}P_{80}$ and $N_{160}P_{80}$ are small and unproven.

During the period of study (2005 – 2008) the highest yield after predecessor coriander is obtained at rate of fertilization $N_{120}P_{80}$ – 5472 kg ha^{-1}, while after sunflower and stubble at rate $N_{160}P_{80}$ respectively – 5391 and 5226 kg ha^{-1}. The lowest yields were reported with non fertilization after predecessors: sunflower – 3252 kg ha^{-1}, stubble – 3025 kg ha^{-1} in coriander 3534 kg ha^{-1} and in sorghum 2512 kg ha^{-1}

The tested rates of fertilization increased grain yield up to 2139 kg ha-1 after sunflower, up to 2201 kg ha-1 after stubble, up to 1938 kg ha-1 after coriander, and up to 1624 kg ha-1 after sorghum.

Table 2. Grain yield, kg ha $^{-1}$

Predecessor	Rates of fertilization (kg ha $^{-1}$)	Years of study			Average for the period (kg ha $^{-1}$)
		2005 - 2006	2006 - 2007	2007 - 2008	
Sunflower	N_0P_0	4213 ^{a}	2624 ^{a}	2920 ^{a}	3252
	$N_{80}P_{80}$	5435 ^{b}	3516 ^{c}	4852 ^{b}	4601
	$N_{120}P_{80}$	6533 ^{c}	3400 ^{b}	5907 ^{c}	5280
	$N_{160}P_{80}$	6671 ^{d}	3381 ^{b}	6120 ^{d}	5391
	$LSD_{5\%}$	*132*	*106*	*187*	
Stubble	N_0P_0	3701 ^{a}	2505 ^{a}	2869 ^{a}	3025
	$N_{80}P_{80}$	5324 ^{b}	3400 ^{c}	4802 ^{b}	4509
	$N_{120}P_{80}$	6470 ^{c}	3183 ^{b}	5720 ^{c}	5124
	$N_{160}P_{80}$	6622 ^{d}	3151 ^{b}	5906 ^{d}	5226
	$LSD_{5\%}$	*146*	*216*	*174*	
Coriander	N_0P_0	4350 ^{a}	2800 ^{a}	3451 ^{a}	3534
	$N_{80}P_{80}$	5566 ^{b}	3612 ^{c}	5080 ^{b}	4753
	$N_{120}P_{80}$	6755 ^{c}	3460 ^{b}	6202 ^{c}	5472
	$N_{160}P_{80}$	6720 ^{c}	3425 ^{b}	6130 ^{c}	5425
	$LSD_{5\%}$	*314*	*148*	*253*	
Sorghum	N_0P_0	3180 ^{a}	2055 ^{a}	2300 ^{a}	2512
	$N_{80}P_{80}$	4532 ^{b}	2806 ^{b}	3550 ^{b}	3629
	$N_{120}P_{80}$	5360 ^{c}	2760 ^{b}	4118 ^{c}	4079
	$N_{160}P_{80}$	5440 ^{c}	2757 ^{b}	4210 ^{c}	4136
	$LSD_{5\%}$	*328*	*202*	*264*	

*Values with the same letters do not differ significantly

On analysing the data Table 3 it was ascertained that lake the years (Y) with their climatic conditions had statistic influence on the yield grain – η 99, as well as fertilization (F) – η 98.

The predecessor (P) influence of the grain yield was significant-η 95. Interaction - F x Y - η 92 and P x Y - η 73 was also significant for grain yield, while between predecessor and fertilization - η 36.

Table 3. Analysis of variance for grain yield for the period 2005 - 2008

Source of Variation	Sum of Square SS	DF	Mean Square MS	Sig of F	Partial ETA, Sqd η
Predecessor - P	39666293,52	3	13222098	, 000	95
Fertilization - F	122355456,20	3	40785152	, 000	98
Years - Y	179773437,10	2	89886719	, 000	99
P x F	1212250,88	9	134694,54	, 000	36
P x Y	5935113,97	6	989185,66	, 000	73
F x Y	25904820,05	6	4317470,00	, 000	92
P x F x Y	2411937,07	18	133996,50	, 000	53
Residual	2154917,75	144	14964,71		

Conclusions

The predecessor and nitrogen rate in combination with meteorological conditions during the years of the study were decisive factors for the expression of the productivity of common winter wheat variety Prelom.

The most suitable predecessor for the wheat under the conditions of south-east Bulgaria is the coriander, followed by sunflower and stubble. The sorghum was a unsuitable predecessor.

The most effective fertilization rates are $N_{120}P_{80}$ with predecessor coriander and $N_{160}P_{80}$ with sunflower and stubble.

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