GRAIN YIELD OF TRITICALE VARIETIES DEPENDING ON THE FOLIAR FERTILIZATION IN THE CONDITIONS OF INCREASING NORMS OF FERTILIZATION OF THE SOIL WITH NITROGEN

Stefka DOBREVA*, H. KIRCHEV, Angelina MUHOVA*****

Field Crops Institute-Chirpan, stefanovadobreva@gmail.com

2 G. Dimitrov bul., 6200 Chirpan, Bulgaria

****Agricultural University-Plovdiv , hristoforkirchev@abv.bg***

12 Mendeleev str., 4000 Plovdiv, Bulgaria

*****Field Crops Institute-Chirpan, muhova.angelina@gmail.com***

2 G. Dimitrov bul., 6200 Chirpan, Bulgaria

***Abstract**: In the period 2014-2017, a three-factor field experiment has been conducted in the field of Institute of field crops, Chirpan, Bulgaria. It has been studied both the independent influence of nitrogen fertilization and the combination of foliar fertilization on four triticale varieties: Kolorit (standard), Attila, Boomerang and Respect. The experiment is based on the fractional plot method in four replications with a plot size of 12 m^2. Grain yields of triticale varieties are determined directly from each plot using the Wintersteiger micro combine harvester. The results are calculated to standard grain moisture of 13%. A dispersion analysis (ANOVA) was applied to identify statistically significant differences between variants, and three-factor dispersion analysis (MANOVA) was used to establish the independent action of the factors. From the study, it was found out that the combination of mineral and foliar fertilization increases the grain yield in all varieties. On average, for the three years, the highest yield was the Boomerang variety - 568.1 kg/da, which is 78.5% higher than the standard, with fertilization with nitrogen N_{18} and in combination with leaf fertilization. The increase in yield for other varieties compared to the standard Kolorit is: for Atilla with 66.5% and for Respect with 31.5%.*

***Key words:** triticale, yield, fertilization.*

INTRODUCTION

Triticale (× *Triticosecale* Wittmack) is a manmade crop that is characterized by tolerance in terms of soil and climate conditions. A number of authors demonstrated the large potential of triticale, both in terms of productivity (LUKIPUDIS ET AL., 1986; TERZIEV, 1996; BOYADJIEVA ET AL., 1995; LOSERT ET AL., 2017) and in relation to grain yield (TERZIEV ET AL., 1999; ITTU ET AL., 2014). However, increasing the yield is a major task. The role of fertilization for increasing yields from agricultural crops is well known (GUSHEVILOV, 2001; LESTINGI ET AL., 2010; GERDZHIKOVA, 2014; JANUŠAUSKAITĖ, 2014; BIBERDZIC ET AL., 2017).

There is a relatively weak study of foliar fertilizers on crops, including triticale (DANE ET AL., 2012; WOJTKOWIAK ET AL., 2016).

MATERIAL AND METHODS

In the period 2014-2017, a three-factor field experiment has been conducted in the field of Research Institute of field crops, Chirpan, Bulgaria. It has been studied both the independent influence of nitrogen fertilization and the combination of foliar fertilization on four triticale varieties: Colorit (standard), Attila, Boomerang and Respect. The experiment is based on the fractional plot method in four replications with a plot size of 12 m^2.

The experiment is set after a predecessor sunflower. The soil tillage after harvesting the precursor is disking and cultivation, their number is consistent with condition of the soil. Sowing is done at the appropriate agro-technological time and depending on the weather conditions of the year. For the sowing, a seed drill and a seed rate of 550 germinating seeds per m^2 were used.

Foliar fertilizers Lactofol O were tested. The Lactofol complex suspension fertilizers for leaf application contain macro and micro elements, bio stimulants - vitamins and physiologically active substances (MILEV AND TODOROVA, 2014). The foliar fertilizer Lactofol is introduced twice in the tillering and spike emergence stages at a dose of 600 ml/da early in the morning by manually sprinkling the plants.

Grain yields of triticale varieties are determined directly from each plot using the Wintersteiger micro combine harvester. The results are calculated to standard grain moisture of 13%. A dispersion analysis (ANOVA) was applied to identify statistically significant differences between variants, and three-factor dispersion analysis (MANOVA) was used to establish the independent action of the factors.

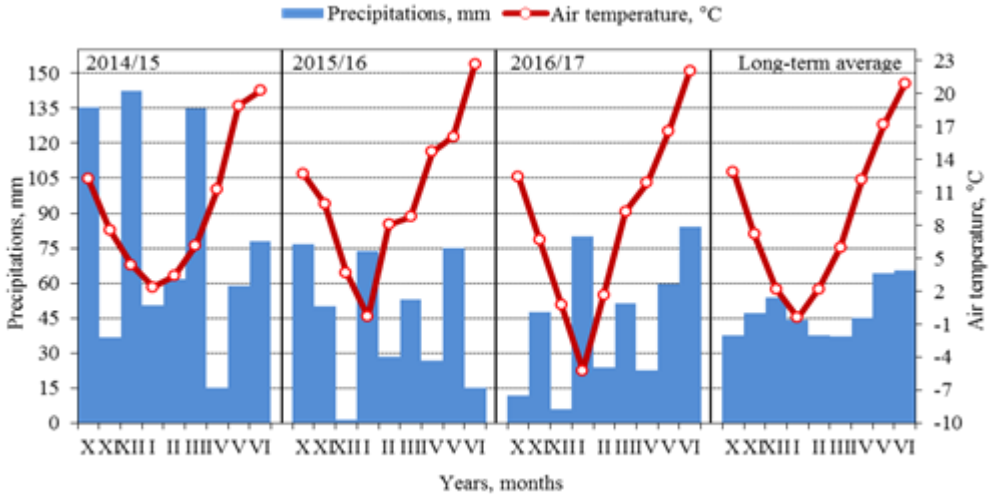

Figure 1. Precipitation and temperature during triticale vegetation.

The experimental fields of the institute are characterized by a deep humus horizon (80-115 cm). The heavy clay composition is due to the high moisture content of Pelic Vertisols. When moistened, they swell strongly, and when drought, reduce their volume. By reason of the high soil moisture, this type of soils are adequate for growing triticale, even after prolonged drought. In the years of study the meteorological conditions vary. In the years of study meteorological conditions vary. Figure 1 are marked differences between the survey years and years period.

RESULTS AND DISCUSSION

In 2015 grain yield ranged from 202,7 kg/da in variety Respect to 553,9 kg/da in Boomerang variety. In the second year, grain yields are the lowest and range from 193,1 kg/da to Colorit to 536,1 kg/da for Boomerang variety, and the third to the highest - from 356,7 kg/da for Respect to 614,4 kg/da in the Boomerang variety (Table 1).

These results are unambiguously the reason why, on average, for the three-year trial, the highest grain yield was obtained from the Boomerang variety – 568,1 kg/da, followed by Colorit varieties – 533,9 kg/da, Attila 530,0 kg/da and Respect – 418,6 kg/da.

When looking at the variants closely, there is one-sided increase in yield: increasing the fertilizer rate respectively increased yield, and all variants included foliar fertilizer exceed variants with self-nitrogen fertilization.

Table 1.

Grain yields per year and an average of three years, kg/da.

Varieties	Fertilization levels, kg/da	Years			Average
		2015	2016	2017	
Colorit	N_0P_0	283,6	193,1^{NS}	486,8	321,2
	N_0P_0 + lactofol	306,9^{NS}	218,6***	507,9^{NS}	344,5^{NS}
	N_6P_6	361,5^{NS}	382,5***	511,4^{NS}	418,5*
	N_6P_6 + lactofol	387,2*	397,2***	511,7^{NS}	432,0**
	$N_{12}P_6$	431,6***	415,8***	532,4*	459,9***
	$N_{12}P_6$ + lactofol	450,8***	418,1***	543,8**	470,9***
	$N_{18}P_6$	554,9***	438,3***	555,0**	511,9***
	$N_{18}P_6$ + lactofol	571,6***	455,6***	574,4***	533,9***
Attila	N_0P_0	277,8^{NS}	282,3***	442,1^{NS}	334,1^{NS}
	N_0P_0 + lactofol	293,4^{NS}	290,6***	462,6^{NS}	348,9^{NS}
	N_6P_6	402,8**	417,3***	476,4^{NS}	432,2**
	N_6P_6 + lactofol	419,6***	439,2***	498,9^{NS}	452,6**
	$N_{12}P_6$	476,4***	484,7***	508,9^{NS}	490,0***
	$N_{12}P_6$ + lactofol	495,0***	505,0***	528,6*	509,5***
	$N_{18}P_6$	504,1***	514,2***	531,9*	516,7***
	$N_{18}P_6$ + lactofol	519,3***	526,4***	544,4**	530,0***
Boomerang	N_0P_0	300,7^{NS}	216,2^{NS}	496,1^{NS}	337,7^{NS}
	N_0P_0 + lactofol	303,2^{NS}	226,4^{NS}	516,8^{NS}	348,8^{NS}
	N_6P_6	434,3***	409,5***	517,2^{NS}	453,7**
	N_6P_6 + lactofol	448,6***	438,9***	534,7*	474,1***
	$N_{12}P_6$	460,5***	464,7***	564,1**	490,4***
	$N_{12}P_6$ + lactofol	465,4***	489,7***	550,1**	501,7***
	$N_{18}P_6$	545,4***	511,4***	601,8***	552,9***
	$N_{18}P_6$ + lactofol	553,9***	536,1***	614,4***	568,1***
Respect	N_0P_0	202,7^{NS}	196,9^{NS}	356,7^{NS}	252,1^{NS}
	N_0P_0 + lactofol	327,1^{NS}	205,8^{NS}	357,5^{NS}	296,8^{NS}
	N_6P_6	336,7^{NS}	328,1***	377,1^{NS}	347,3^{NS}
	N_6P_6 + lactofol	345,4^{NS}	347,2***	389,9^{NS}	360,8^{NS}
	$N_{12}P_6$	349,6^{NS}	397,8***	399,7^{NS}	382,4^{NS}
	$N_{12}P_6$ + lactofol	359,8^{NS}	416,9***	402,1^{NS}	392,9^{NS}
	$N_{18}P_6$	377,5**	419,7***	407,2^{NS}	401,5*
	$N_{18}P_6$ + lactofol	394,0**	432,8***	429,0^{NS}	418,6*
LSD	*5 %*	*79,3*	*42,7*	*41,9*	*79,2*
	1%	*105,0*	*56,5*	*55,5*	*105,3*
	0,1 %	*135,7*	*73,0*	*71,5*	*136,9*

*Positive * or negative ^{0} significance at P=5, 1 and 0,1%; ^{NS} – non significance*

On average, for three years, the three-way dispersion analysis confirmed the greatest impact of nitrogen fertilization (Table 2). All fertilizer norms used in the study lead to increase of the grain yield. The low nitrogen rate of 6 kg/da increased the yield by 28,9%, the rate of N_{12} increased the yield by 41,4% and the highest rate by 54,2% of N_0P_0. All three fertilization rates are shown positive acting relative to the control with the highest level of statistically significant differences of LSD = 0.1%.

Average absolute yield of standard variety Colorit in off the influence of other factors is 436,2 kg/da. The next two varieties, Attila and Boomerang, outperformed the standard variety in terms of productivity, have

not been proven even at the lowest level of LSD. By the factor "variety" significance is observed only for the Respect variety. This variety has 17.2% significant less productivity, compared to standard Colorit.

Single action of the factor "foliar fertilization" on grain yield of triticale is not statistically confirmed. Lactofol treatment increases yields by 3.7%, but this difference remains beyond statistical reliability, which confirms that foliar fertilizers can not be used alone and replace mineral fertilization.

Table 2.

Three-way MANOVA analysis of variance

Soil fertilization		Yield, kg/da	% of N_0P_0
N_0P_0		327,0	100,0
N_6P_6		421,4***	128,9
$N_{12}P_6$		462,2***	141,4
N_{18} P_6		504,2***	154,2
LSD	*5 %*	*41,8*	*12,8*
	1 %	*55,6*	*17,0*
	0,1 %	*72,2*	*22,1*
Variety			% of Colorit
Colorit		436,2	100,0
Attila		$451,8^{NS}$	103,6
Boomerang		$465,9^{NS}$	106,8
Respect		$361,0^{000}$	82,8
LSD	*5 %*	*41,8*	*9,6*
	1 %	*55,6*	*12,8*
	0,1 %	*72,2*	*16,5*
Foliar fertilization			% of Without foliar fertilization
Without foliar fertilization		420,9	100,0
With Lactofol		$436,5^{NS}$	103,7
LSD	*5 %*	*29,6*	*7,0*
	1 %	*39,3*	*9,3*
	0,1 %	*51,1*	*12,1*

*Positive * or negative ^{0} significance at P=5, 1 and 0,1%; ^{NS} – non significance*

CONCLUSIONS

The triticale varieties, used in this study can be ranked in the following order of grain yield – Boomerang > Attila > Colorit > Respect. On average, the three-way dispersion analysis confirmed the greatest impact of nitrogen fertilization. All fertilizer norms lead to increase of the grain yield. Lactofol treatment increases grain yields, but this difference remains beyond statistical reliability, which confirms that foliar fertilizers cannot be used alone and cannot replace mineral fertilization.

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