Scientific Papers. Series A. Agronomy, Vol. LXIII, No. 1, 2020
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

REACTION TO FERTILIZATION OF ROMANIAN VARIETIES OF WINTER TRITICALE, UNDER THE CONDITIONS OF TRANSYLVANIA PLAIN, BETWEEN THE YEARS 2012-2019

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Abstract

In the last decades, due to the genetic advances obtained in the plant breeding sector, a series of triticale varieties with high production potential and stability have been created, more productive than wheat varieties and even maize cultivated in the hilly areas with poorly fertile soils and low pH. This research aims to follow the behaviour of several winter triticale varieties created by INCDA Fundulea, namely: Plai, Titan, Stil, Haiduc, Negoiu and TF 2, on a period of 8 experimental years, in condition specific to Transylvania Plain. Research covered two levels of fertilization N_{50}:P_{50} and N_{100}:P_{50}. Results show different reaction of the winter triticale varieties to fertilization treatment. The older variety TF 2 delivered an average yield of 6954 kg ha^{-1} in the plots fertilized with 100 kg ha^{-1} N. The highest yields were recorded in the year 2014 by Haiduc variety, delivering a yield of 9203 kg ha^{-1}in treatments with 100 kg ha^{-1} N. Results pointed out that an important genetic progress was achieved in which concerns the potential yield of this species.

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

INTRODUCTION

Triticale is a new kind of wheat stubble, created by the hybridisation of wheat and rye (Lalević et al., 2012). According to the opinion of the most researchers, triticale is a plant species characterized by a high genetic potential for grain yield, as well as good nutritive properties of its grain, so it is regarded as a very promising crop (BorojEvić, 1981; Cvetkov, 1982; Đokić, 1988; Biberdžić et al., 2012). In their willing to create a species with great adaptability and stable yields, scientists combined the best properties of wheat (high and stable yield and early maturity) with the positive properties of rye (good resistance to diseases, pests, cold, drought, a large number of spikelet per spike etc.). The advantages of triticale are applied also in environments where conditions limit the productivity of other cereals; it canal so begrown on more marginal land (arid, acidic, etc.) and adapts to reduced tillage systems (Ciftci and Eleroglu, 2012). Triticale is suitable for cultivation even at high altitudes, in soils with poor physical and chemical properties, such as acidic and saline soils (Naeem et al, 2002; Lalević et al., 2012). Thanks to its valuable characteristics and agronomic advantages, the number of areas for triticale cultivation in the world increased great in the last decades, from 232631 ha in 1985 to 3809192 ha in 2018 (FAO, 2020). Yield also varied from 2575 kg/ha in 1985 to 3361 kg/ha in 2018 (FAO, 2020). Modern triticale cultivars show higher yields and superior adaptation to soil quality and environments than wheat (Ugarte et al., 2007; Janušauskaitė, 2014).

In Romania the area cultivated with triticale increased from 1214 ha in 1997 to 78887 ha in the year 2018 (FAO, 2020). The yield of triticale increased from 3012 kg/ha in 1997 to 4277 kg/ha in the year 2018. These increases could be explained by the increase of the cultivated area, by the evolution of scientific research in this field and also by improving the crop management techniques. One of the most important crop management techniques for spring triticale production is N fertilization (Janušauskaitė, 2008; Obuchowski et al., 2010; Janušauskaitė, 2013). Positive effects of N fertilization on grain yield have been reported by several researchers (Gibson et al., 2007;

Lestingi et al., 2010). The success of any treatment stands in adoption of optimum mineral fertilizer doses along with an optimum application moment. Nitrogen stress at critical growth stages may lead to irreversible yield loss (Janušauskaitė, 2013).

In Romania, an increase interest in triticale research programs has been showed by the agricultural research institute - R.I.C.I.C. Fundulea. Scientists from this institute conducted several amelioration programs in triticale since the year 1971 and they recorded so far 13 varieties (Ittu et al., 2006). Their achievements showed to be very competitive with other international programs, fact highlighted also thru recording the Titan variety in Canada, France and Hungary or Negoiu variety in Moldavia (www.incda-fundulea.ro/60ani/INCDA60.pdf). Between the years 1982-2003, the first intensive varieties of Romanian triticale were recorded (Table 1, after Ittu et al., 2007): Plai (1992), Colina (1993), Titan (1998) and Tril (2001) and later Stil (2003), varieties which showed to be a remarkable genetic progress compared to the first Romanian variety, TF2, both from production potential and its stability point of view (Ittu et al., 2004).

Table 1. Triticale varieties created by R.I.C.I.C. Fundulea between the years 1984-2007

No. crt.	Variety	Registration year	Authors
1	TF2	1984	Gh. Ittu, N.N. Săulescu, C. Ţapu, N. Ceapoiu
2	PLAI	1992	Gh. Ittu, N.N. Săulescu, Mariana Ittu, M. Verzea, P. Mustăţea
3	COLINA	1993	Gh. Ittu, N.N. Săulescu, Mariana Ittu, P. Mustăţea
4	TITAN	1998	Gh. Ittu, N.NSăulescu, Mariana Ittu, P. Mustăţea
5	TRIL	2001	Gh. Ittu, N.N. Săulescu, Mariana Ittu, P. Mustăţea
6	STIL	2003	Gh. Ittu, N.N. Săulescu, Mariana Ittu, P. Mustăţea
7	GORUN	2005	Gh. Ittu, N.N. Săulescu, Mariana Ittu, P. Mustăţea
8	HAIDUC	2006	Gh. Ittu, N.N. Săulescu, Mariana Ittu, P. Mustăţea

Ittu et al. (2001) pointed out that the triticale cultivars created by R.I.C.I.C. Fundulea proved to be more adapted than other small grain cultivars in areas with acid soils from hilly region, but the yield recorded with Titan variety, showed that this cultivar can be successfully cultivated, even in plain area with fertile soils.

The objective of this study is to follow the behaviour of several winter triticale varieties created by R.I.C.I.C. Fundulea, on a period of 8 experimental years and to elaborate a proper fertilizer management for conditions specific to Transylvania Plain.

MATERIALS AND METHODS

The field research was conducted over an eight-year period (2012-2019) at the Agricultural Research and Development Station Turda. The experiment area is located in Turda city, Cluj County, in Western Transylvania Plain, Romania.

The soil is a deep alluvial - clay soil with neutral reaction and a medium humus supply (3.5%). The climate is continental having 4 distinct seasons (after Koppen system).

Average annual rainfall is 540 mm from which 68% are recorded during the growing season (Deac et al., 2016).

The medium average rainfalls recorded in the experimental period is 599.51 mm (Figure 1). The highest monthly sum of rainfalls were recorded in May, September and October months while the highest sum of rainfalls were recorded in the year 2016 (816.8 mm).

The lowest sum of rainfalls were recorded in the year 2012 (504.4 mm). High variation in mean annual rainfall were registered between the eight study years, the difference in rainfall distribution over the growing season being very diverse, as well.

Monthly and annual mean temperatures recorded high variations among the experimental period (Figure 2).

The highest annual average temperature was recorded in the year 2019 (11.35^0C) while the smallest annual average temperature was recorded in the year 2016 (9.99^0C).

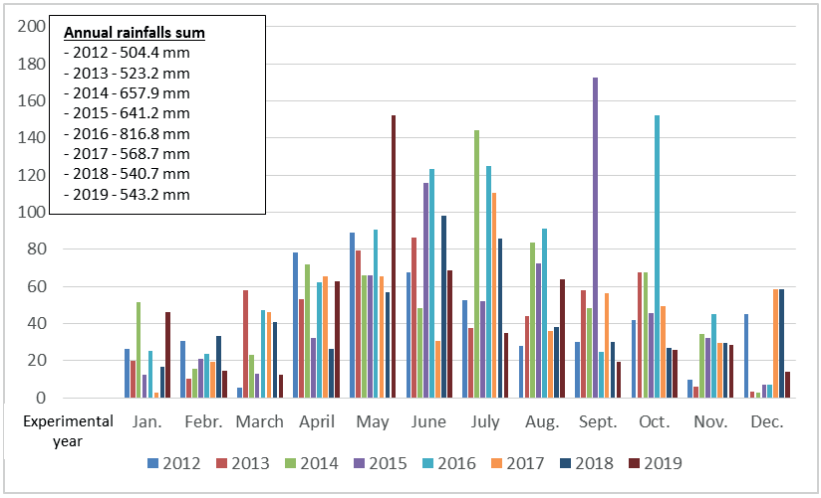

Figure 1. Monthly sum of rainfalls recorded over eight-year experimental trial
(Source of data: Weather station from Turda - longitudinal: $23^0 47'$; latitudinal $46^0 35'$; altitudinal 427 m)

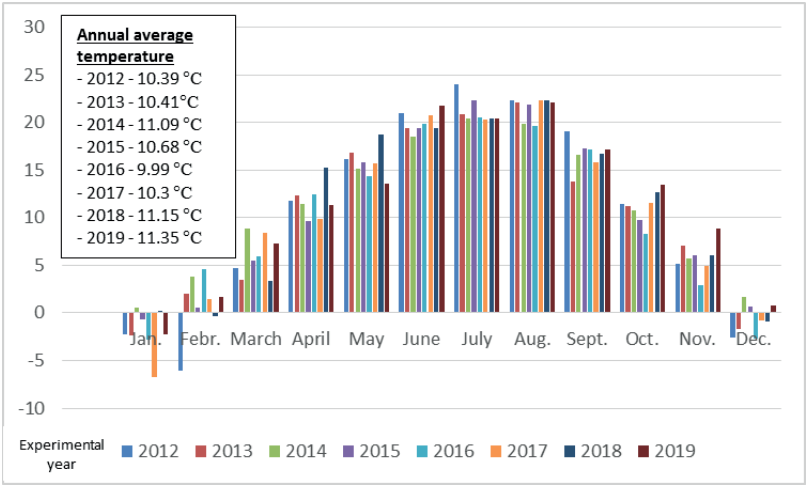

Figure 2. Monthly average temperatures recorded over eight-year experimental trial
(Source of data: Weather station from Turda - longitudinal: $23^0 47'$; latitudinal $46^0 35'$; altitudinal 427 m)

As plit plot design was used in each of the eight years, with six varieties of triticale in the main plots and two rates of N fertilization in the subplots, in 3 replications. The biological material consists in the following varieties of triticale (created at R.I.C.I.C. Fundulea): Plai, Titan, Stil, Haiduc, Negoiu and TF 2.The species were sown in the first decade of October month - each year. The two N fertilization rates were N_{50} and N_{100} (kg N ha^{-1}). The treatments were applied to the same plots in each crop season. Harvest of triticale was carried out during full ripeness. The experimental data obtained were statistical analysed using the program Statistica vs. 10.

RESULTS AND DISCUSSIONS

The experimental trial analysed in this study started in the year 2012 for a period of eight experimental years. The results recorded could be considered therefore representative for long-term trials. The importance of such studies is outstanding since during recent decades the global climate is changing, being recognized as

a serious environmental issue with high impact on crop production (Marton et al., 2007). The aim of our study was to follow grain yield behaviour of six triticale varieties in condition specific to Transylvania Plain. Conducting these trials over a period of eight experimental years validates the results recorded since the changes in weather patterns have been demonstrated through recent studies to have a greatest effect on crop yield (Barrow et al., 2000). The aim of every agricultural crop system is to achieve high and stable yields. These objectives can be fulfilled by adoption of a properin-field technology, proper choice of sowngenotypes and favourable agroclimatic conditions (Biberdžić et al., 2012). The significant differences ($p < 0.001$) found in grain yield of triticale was affected by variety, experimental year and nitrogen doses. The grain yield of Romanian varieties of winter triticale as affected by year are provided in Table 2. Results show high variations among the eight-year experimental trial. The average productions varied from 3942 kg ha^{-1} to 8572.83 kg ha^{-1}. The highest grain yields were recorded in the year 2014 on all triticale varieties tested in this trial. The best reaction was recorded on Haiduc variety which registered the highest trial mean (6933.14 kg ha^{-1}). In some experimental years Haiduc variety recorded yields higher than the average production (6950 kg ha^{-1}) reported by the producer (https://samanta.ro/triticale-haiduc-soi-toamna-romanesc/#).Comparing Haiduc variety with other five triticale varieties, Pochiscanu et al. (2013) concluded also that Haiduc recorded the highest yields. The smallest trial mean yields (average yields among the eight experimental years) were recorded on TF2 (6217.76 kg ha^{-1}). Results pointed out that the smallest yields were recorded in drought years, like the year 2012, on all triticale varieties studied. The average grain yield is comparable to that obtained by Villegas et al. (2010) and Pecio (2010). All the results were very significant from statistically point of view. Many reports showed the effect of weather conditions on nutrients utilization (Jelić, 1998; Biberdžić et al., 2012). Racz (2013) studied some varieties of triticale created at R.I.C.I.C. Fundulea in condition specific to Transylvania Plain. The experiment trial developed for a period of 3 experimental years, pointed out a good capacity for adaptation of the species analysed to different climate conditions. The author also highlighted a very significant influence of the experimental factor year on triticale production. Similar aspects were highlighted also by Voica (2011) who concluded that the variability of climatic conditions had significant influence on the behaviour of triticale.

Table 2. Grain yield of Romanian varieties of winter triticale as affected by year

Experimental year	Grain yield [kg ha^{-1}]					
	Triticale varieties					
	Plai	Titan	Stil	Haiduc	Negoiu	TF2 (control)
2012	4733.66***	4795.33***	4747.83***	5382.00***	5399.66***	3942.00
2013	6405.66***	6343.55***	6288.00***	6786.66***	6111.66***	5734.16
2014	8523.00***	8568.00***	8572.83***	8321.16**	7861.33	7772.50
2015	7872.83***	6507.16***	7109.83	7473.83	7672.83**	7150.00
2016	6599.00^{00}	6830.00	7250.33	7356.00	7322.00	7093.00
2017	5315.16	5243.66	5874.33***	5646.66**	5905.50***	5033.50
2018	7995.83***	7571.33**	7845.00***	7975.83***	7798.66***	6985.33
2019	6490.83*	6749.16***	7099.83***	6523.00**	6610.00**	6031.66
Mean of variety (Y)	6741.99	6576.02	6848.49	6933.14	6835.20	6217.76

Notes: ** - $p < 0.01$ - significant; *** - $p < 0.001$ - highly significant (HS, confidence 99.9%)

The effect of N fertilization on yield and qualitative characters of cereal grain has been reported in various studies (Lestingi et al., 2010; Delogu et al., 1998; Riley). The amount of nitrogen needed by triticale crop to reach high yields and quality depends greatly on the seasonal conditions, soil type, and rotational history of the soil as well as the potential yield of the cultivars. Nitrogen is the key nutrient input for achieving higher yield of triticale (Alazmani, 2015). The grain yield of Romanian varieties of winter triticale as affected by

fertilization are provided in Table 3. Results show high variation among the eight-year experimental trial, showing variations very significant from statistical point of view. The results increased in parallel with dose increase for all triticale varieties studied. The average productions varied from 6217.77 kg ha^{-1} to 6933.14 kg ha^{-1}.

The highest yields were recorded on fertilization with N_{100} on all triticale varieties.
The highest production on both fertilization doses were recorded by Haiduc variety while the smallest production were recorded on TF2 (the oldest variety created at NARDI Fundulea, and was considered control variant).

Table 3. Grain yield of Romanian varieties of winter triticale as affected by fertilization

Source	Grain yield [kg ha^{-1}]					
	Plai	Titan	Stil	Haiduc	Negoiu	TF2
N_{50} (control)	6115.95	5999.08	6187.29	6323.87	6163.87	5481.33
N_{100}	7368.04***	7152.95***	7509.70***	7543.29***	7506.54***	6954.20***
Trial mean	6742.00	6576.02	6848.50	6933.14	6835.20	6217.77

Notes: ***: $p < 0.001$ - highly significant (HS, confidence 99.9)

Our results subscribe to previous studies which revealed increases in yield of triticale grain at increased N fertilizer levels. Lewandowski and Kauter (2003) reported that fertilization with 70 kg N ha^{-1}significantly increased triticale crop yields. The highest reaction to fertilization (production increase from N_{50} to N_{100}) was reported by TF2 (1473 kg ha^{-1}) followed by Negoiu (1343 kg ha^{-1}), Stil (1322 kg ha^{-1}), Plai (1253 kg ha^{-1}) and Haiduc (1220 kg ha^{-1}). The smallest reaction to fertilization was observed on Titan variety (1153 kg ha^{-1}). Moreno et al. (2003), which proceeds that the N fertilizer highly depends on growing season's variations conditioned by environmental factors. Biberdžić et al. (2012) conducted a study meant to follow the reaction of some triticale varieties in different agroclimatic conditions and concluded that application of fertilizers had a positive effect on triticale grain yield increase. Oral (2018)pointed out that the best grain yield and majority components results were obtained on the experimental plots fertilized with 120 kg N ha^{-1}. Moreover, the author recommended that the application of higher doses of nitrogen should be considered taking into account several factors like the climatic data of seasons.

CONCLUSIONS

Results show a positive reaction to the conditions of Transylvania plain of Romanian varieties of winter triticale tested in this trial. Despite high variations in the climatic condition specific to the eight-year experimental period, the varieties tested recorded high yields in all experimental years. The significant differences ($p < 0.001$) found in grain yield of triticale was affected by variety, experimental year and nitrogen doses. Nitrogen (N) fertilization gave grain yield increase, the best results being achieved on treatment with 100 kg N ha^{-1}. The most productive variety for the agroclimatic condition tested in this trial is Haiduc.
Considering the results recorded in this experimental trial we recommend Haiduc variety for condition specific to those experimented in this study- in order to achieve maximum yields. Monthly and annual mean temperatures recorded high variations among the experimental period. Because the aim of this manuscript was to follow the reaction of several triticale varieties to fertilization within a specific experimental period we tracked only the influence of the experimental factor year into consideration reason why we didn't provide a deeper analyse of the correlation between climatic variations and triticale yield achievements. Yet we consider that this should be a further study objective since during recent decades the global climate is changing, being recognized as a serious environmental issue with high impact on crop production.

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