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STUDIES ON THE INFLUENCE OF FERTILIZATION DOSES ON RYE GENOTYPES IN NORTH BĂRĂGAN

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ABSTRACT

This paper aims at analysing the participation shares of the genotype and dose of fertilizer on the yield of winter rye during 2010-2013.

The aim of the experiment was to improve the cultivation technology of winter rye in non-irrigated conditions within the locality of Siliştea, Brăila County, Romania. Establishing the productive potential of certain rye varieties, one domestic and two of foreign origin, according to the fertilization formula was the main objective of the research.

A two factor AxB type experiment was conducted on split plots. Factor A, the variety, had three graduations: a_1 - Suceveana, a_2 - a_3 Amilo and - Ducato and factor B, the fertilization level, had three graduations: b_0 - unfertilized, b_1 - fertilized with 50 kg a.i. N and b_2 - fertilized with 100 kg a.i. N.

Highest yield was achieved by the Suceveana variety, which reacted positively to factor b, followed by Dukato and Amilo varieties.

All genotypes showed higher values of yield and significant yield increases in fertilized variants compared to the unfertilized control.

Key words: rye cereals, fertilization, genotype.

INTRODUCTION

Currently, rye is grown primarily for human food, being the second cereal used in bread making after wheat. Rye is a valuable food plant, which can grow in conditions that are adverse to wheat, capitalising acidic soils or sandy soils and succeeding in cold climates and wet or dry areas (Gaşpar et al., 1978).

Not being so pretentious to the conditions of growth, rye is widespread, occupying large areas, even reaching beyond the Arctic Circle to the 69th parallel (Bîlteanu et al., 1991; Bîlteanu, 2003).

The dynamics of cultivated areas at a global, European and national level shows a decrease in cultivated areas since 2001.

The smallest European area planted with rye was recorded in crop year 2009-2010 (2,263,199 ha) and largest area was recorded in 1999-2000 with a total area of 3,749,003 ha (Kessavalou et al., 1997; Clark, 2007).

In Romania, according to data provided by the Food and Agriculture Organization of the United Nations, in the last 13 years the area planted with rye fluctuated between 8667 ha and 21,792 ha (FAO.org).

In Brăila County, the area planted with rye in the last 7 years has varied between 6 and 365 ha. The only crop year in which the crop failed due to unfavourable climatic conditions during the vegetation period was 2009.

An important role in achieving satisfactory yields is the proper application of each technological link and also the climatic conditions during the growing season (Marton, 2002).

The requirements of the crop in nutrition elements change in relation to the two main processes occurring during the life cycle, growth and development (Rusu et al., 2005). Rye, having a well-developed root system and a high capacity to absorb nutrients from the soil, responds well to the application of

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organic and mineral fertilizers (Gîngioveanu et al., 1999). However, in recent decades the values of chemical indices of the soil decreased as a result of long term use of large amounts of ammonium N fertilizers (Zang et al., 2006; Biermacher et al., 2006).

The provision of the necessary nutrients for growing rye should be based on planned production and agrochemical mapping values (Oancea, 2005).

MATERIAL AND METHODS

To achieve satisfactory yields the crop management applied to the rye culture has to be clear and flexible depending on weather conditions.

The experiment was set in the crop years of 2010-2011, 2011-2012 and 2012-2013, in an agricultural society (SC FERMANDY SRL), which is located in Siliştea, Brăila.

The preceding crop was rape and the seeding density was 500 seeds/m^2.

This was a polyfactorial experiment of the type A x B, placed according to the split plot method, each plot having 1715 m².

The two factors studied were:

A = rye variety, with three graduations, namely:

a_1 – Suceveana;
a_2 – Amilo;
a_3 – Ducato.

B = dose of fertilizer used in kg a.i./ha, with three graduations:

b_1 – unfertilized;
b_2 – fertilized with 50 kg ha^{-1};
b_3 – fertilized with 100 kg ha^{-1}.

The main purpose of the studies was to establish which genotype can provide the highest yields under the agro-pedological conditions of Siliştea.

In the field, during the growing season, observations and determinations were made regarding the following aspects: the number of emerged plants/m^2; the number of plants at the beginning of winter/m^2; the number of plants at the end of winter (indicating winter hardiness)/m^2; plant size - average of 10 plants from three sampling points; number of ears/m^2; the average yield harvested from an area of 1 m^2.

The number of grains per ear; length of ear and mass of 1000 grains were determined in the lab.

The application of differential doses of nitrogen was done as follows: at the time of sowing, using the GASPARDO GIGANTE 400 fertilizer drill, the gross amount applied was 340 kg ha^{-1} resulting in N = 27 kg ha^{-1}, P_2O_5= 82 kg ha^{-1} and K_2O = 82 kg ha^{-1}, this amount only being applied to the fertilized variants (V_2, V_3, V_5, V_6, V_8, V_9).

At the end of winter in the variants V_2, V_5 and V_8 a quantity of 25 kg N ha^{-1} and a further amount of 25 kg of N was applied at the straw lengthening phase was applied in each experimental year.

In variants fertilized with 100 kg a.i. N (V_3, V_6 and V_9) in all years of study, the first fertilization of 50 kg of N was performed after winter ended and the difference of 50 kg was applied during the straw lengthening phase.

RESULTS AND DISCUSSION

During the three experimental years, the climate conditions were monitored throughout the growing season because, alongside genotype and level of fertilization, they have an essential role in determining the yield. From the data shown in charts 2 and 3 it can be seen that the total contribution of rainfall, in all the analysed years, exceeded the annual average, crop-year 2012-2013 being the one who stood out with the highest amounts of precipitation.

During the whole agricultural year from 2012 to 2013 the total rainfall of 536 mm exceeded the annual average (447 mm) by 89 mm, confirming a year with above average values. In the agricultural year 2011-2012 the total rainfall of 527 mm exceeded the multi-year average by 80 mm.

The agricultural year 2010-2011 was characterized by low rainfall compared to other years. Nevertheless, the contribution of rainfall exceeded the multi-year average by 49 mm.

In terms of temperatures, all experimental crop years showed higher mean values with around 1°C above the long term average.

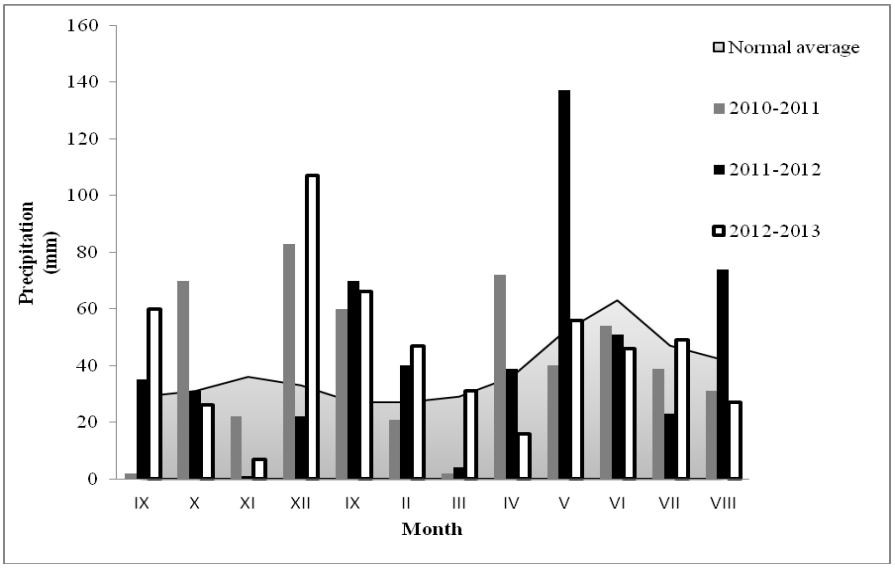

Figure 1. The rainfall recorded during the years of trials

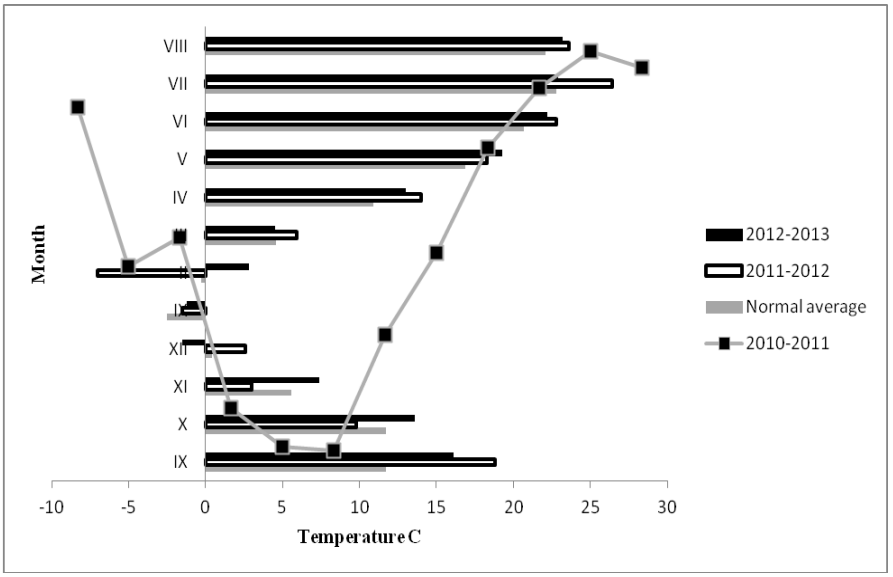

Figure 2. Temperatures recorded during the experimental period

It should be noted that in March 2013 temperatures fell sharply on 26.03.2013, when there was a temperature of -2°C and a 10 cm snow layer that persisted for 2 days.

The pedological study revealed that in field T65, where the experiment was placed, the soil is typical chernozem belonging to the chernozem class (according to SRTS 2003), with three pedogenetical horizons (A, A/C and C), glomerular structure and the texture of clay. The soil showed a high and very high effervescence, confirming the presence of calcium carbonates, starting in the superficial accumulation horizon.

Following measurements in the laboratory, the samples taken in the three agricultural years analysed at the profile depth of 0-40 cm revealed that the soil has high fertility, a clay texture throughout the profile and an apparent density of between 1.26 and 1.38 g/cm$^{3.}$

The total porosity varied between 47 and 52%, while the water supply in the soil was between 284.9 and 343.7 m^3/ha, the largest water reserve recorded in the agricultural year 2011-2012.

The soil was characterized by an alkaline pH, low humus content, large amounts of P and K and small amounts of nitrogen and

carbonates and the total humus content varied between 2.11 and 2.32%.

In the experiment, the rye genotypes took a variable number of days from sowing to emerging, the Dukato genotype being the first to emerge 9 days after sowing, Amilo showed a uniform 12 days from sowing to emerging, while the Suceveana variety emerged after 10 days (Table 1).

The emergence percentage of rye plants of the 9 variants (Table 2) ranged between 72.6% and 98% in the three years of study. From the data obtained and shown in Table 3 it can be seen that the highest percentage of emerged plants was recorded by the Suceveana genotype.

Table 1. Time from sowing to emergence during the experiment period

Genotype	Crop year	No. days sowing-emergence	Average (days)
Suceveana	2010-2011	11	10
	2011-2012	10	
	2012-2013	9	
Amilo	2010-2011	10	12
	2011-2012	12	
	2012-2013	14	
Dukato	2010-2011	7	9
	2011-2012	9	
	2012-2013	11	

Table 2. Percentage of plants emerged during the experiment

Variant	Crop year	Seeds planted	No. of emerged plants	% of emerged plants	Difference (plants/m^2)	Significance
a_1b_1	2010-2011	500	488	97.6	-	
	2011-2012		497	99.4	+ 9	-
	2012-2013		473	94.6	- 15	-
a_1b_2	2010-2011		497	99.4	+ 9	-
	2011-2012		481	96.2	- 7	-
	2012-2013		492	98.4	+ 4	-
a_1b_3	2010-2011		490	98	+ 2	-
	2011-2012		478	95.6	- 10	-
	2012-2013		451	90.2	- 37	-
Average Suceveana genotype			483	96.6	--	-
a_2b_1	2010-2011		390	78	- 98	-
	2011-2012		361	72.2	- 127	°
	2012-2013		416	83.2	- 72	-
a_2b_2	2010-2011		381	76.2	- 107	-
	2011-2012		377	75.4	- 111	-
	2012-2013		433	86.6	- 55	-
a_2b_3	2010-2011		349	69.8	- 139	°
	2011-2012		390	78	- 98	-
	2012-2013		350	70	- 138	°
Average Amilo genotype			383	76.6	--	-
a_3b_1	2010-2011		469	93.8	-19	-
	2011-2012		486	97.2	- 2	-
	2012-2013		464	92.8	- 24	-
a_3b_2	2010-2011		473	94.6	- 15	-
	2011-2012		466	93.2	- 22	-
	2012-2013		468	93.6	- 20	-
a_3b_3	2010-2011		475	95	- 13	-
	2011-2012		461	92.2	- 27	-
	2012-2013		477	95.4	- 11	-
Average Dukato genotype			471	94.2	--	-
Average of the trial			445.66	89.13	--	-

LSD (P 5%) = 117.29 plants/m^2 LSD (P 1%) = 177.64 plants/m^2 LSD (P 0.1%) = 291.04 plants/m^2

The Amilo genotype recorded an average of emerged plants of 76.6% in the three agricultural years analysed, while Dukato recorded a 94.2% of emerged plants.

Statistically speaking, only the Amilo genotype registered significant negative, in a_2b_1 and a_2b_3 versions.

According to the plant vegetation status and their resistance to the action of climatic conditions during winter, the best resistance was recorded by the local genotype, Suceveana (Table 3), followed by the Amilo and Dukato genotypes.

Thus, Suceveana behaved best to the climatic conditions of the crop years studied, with an average loss of 28 plants/m^2.

At maturity, plant height ranged on average in the three experimental years, between 93 and 154 cm, the Amilo genotype, the variant fertilized with 100 kg N, recording a maximum value in all experimental years.

In the Suceveana and Amilo genotypes, the plant height was directly proportional to the dose of fertilizer.

It should be noted that the genotype Dukato at a fertilizer dose of 100 kg recorded a smaller height compared with the variant fertilized with 50 kg a.i. N, in all the years analysed.

In variants fertilized with 100 kg of N of genotypes Suceveana and Amilo the number of plants decreased in all experimental years.

Table 3. Status of vegetation at the end of winter of rye genotypes (average of the values in the three agricultural years)

Variant	No of plants/sq. metre		
	At beginning of winter	At end of winter	Plants lost after winter
a_1b_1	486	432	54
a_1b_2	490	471	19
a_1b_3	473	463	10
Average Suceveana	483	455.3	27.66
a_2b_1	389	357	29
a_2b_2	397	376	21
a_2b_3	363	329	34
Average Amilo	383	354	28
a_3b_1	473	423	50
a_3b_2	469	421	48
a_3b_3	471	459	12
Average Dukato	471	434.3	36.7
Trial average	445.66	414.5	30.8

The average number of ears varied between 203 and 370 ears/m^2, the lowest number of ears was recorded in a_3b_1 (Dukato - unfertilized), while the maximum number of ears was recorded in Suceveana fertilized with 50 kg a.i. N.

The average number of grains per ear ranged from 26 to 48 grains/ear, the highest number recorded in unfertilized variant genotype Dukato, in all the years analysed.

In the Amilo variety, the dose of fertilizer of 100 kg N showed a positive effect on the number of grains per ear in all experimental years.

In the Dukato variety, the lowest number of grains was obtained in the variant fertilized with 100 kg a.i. N (V_9), the number of grains per ear being inversely proportional to the dose of fertilizer (Figure 3).

In the Dukato variety, although the number of grains per ear in the unfertilized variant (V_7) was higher compared with the others, grains were smaller and almost shrivelled in crop years 2010-2011 and 2011-2012. In the crop-year 2012-2013 the number of grains per ear in the Dukato genotype, the control variant, was lower than the other two genotypes unfertilized variants.

The average weight of a thousand grains (TKW) recorded values between 25.3 and 36.8 g, the lowest being recorded in the unfertilized Suceveana genotype.

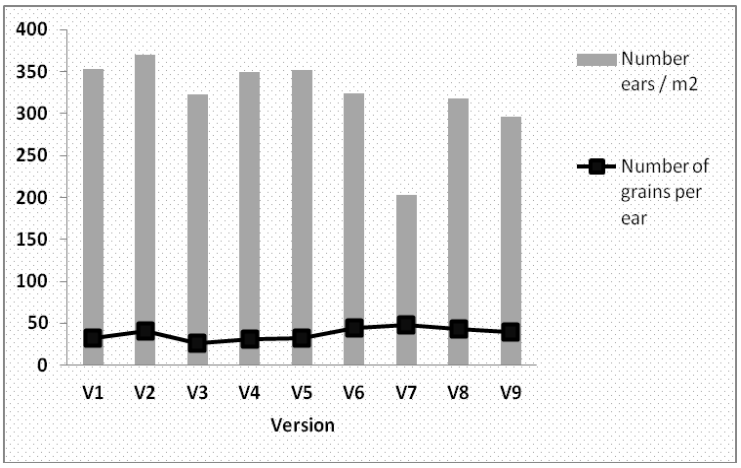

Figure 3. Average productivity elements in 2010-2013

Data in Table 4 show that the TKW followed the same upward curve as the dose of fertilizer only for the Dukato and Suceveana genotypes, which also recorded the highest averages in the three experimental years.

The hectolitre mass (test weight) varied between 66 and 73 kg hl^{-1}, the highest mean being recorded in genotype Dukato, fertilized with 100 kg $N_{(a_3b_{3)}}$.

Table 4. Weight of 1000 grains in the two-factor experiment at SC Fermandy, during 2010-2013

Variant average	TKW (g)	Test weight (kg hl^{-1})
a_1b_1	25.3	70
a_1b_2	27.3	68
a_1b_3	36.8	72
a_2b_1	26.9	68
a_2b_2	27.2	67
a_2b_3	27.1	70
a_3b_1	27.1	66
a_3b_2	29.4	71
a_3b_3	31.8	73

The average results recorded in the three experimental years, summarized in Table 5 show a fluctuating trend of the yields in the experimental variants, with low values being recorded for variants fertilized with 50 kg a.i. N for the Suceveana and Amilo genotypes and the unfertilized variant of the Dukato genotype.

Average yields obtained in experimental years fluctuated between 2857 and 4147 kg ha^{-1} for the Suceveana genotype, between 2915 and 3089 kg ha^{-1} for the Amilo variety and between 2831 and 4013 kg ha^{-1} for the Dukato genotype (Table 5).

From the analysis of variance table, in the three years of experimentation, one can see significant differences between the studied variants. The climatic conditions during the growing season significantly influenced production, the lowest yield being obtained in crop year 2012-2013.

The best results were obtained in the agricultural year 2010-2011 for the Suceveana and Dukato genotypes fertilized with 100 kg a.i. N.

The Amilo genotype recorded the best yields in the 2011-2012 crop year, regardless of the level of fertilization.

The Dukato genotype recorded maximum values of yield during the agricultural year of 2011-2012 in the unfertilised variants and the variants fertilized with 50 kg a.i. N, while the variant fertilised with 100 kg a.i. N recorded maximum values in the crop-year 2010-2011.

There were very significant yield increases in variants a_1b_2, a_2a_2, a_3b_2 and a_3b_3 compared to the local genotype (Suceveana) in the unfertilised variant, averaged over the three crop-year years.

Table 5. Grain yield of winter rye in the trial performed at the SC Fermandy, Brăila during 2010-2013

Variant	Average yield (kg ha^{-1})			Average (kg ha^{-1})	Difference (kg ha^{-1})	Significance
	2010-2011	2011-2012	2012-2013			
a_1b_1	2924	2916	2731	2857	-	-
a_1b_2	4638	4474	3329	4147	+1290	***
a_1b_3	3407	3217	2643	3089	+232	-
a_2b_1	3002	3057	2686	2915	+58	-
a_2b_2	3126	3355	2711	3064	+207	-
a_2b_3	4015	4018	3694	3909	+1052	***
a_3b_1	2980	2991	2522	2831	-246	°
a_3b_2	4034	4237	3768	4013	+1156	***
a_3b_3	3985	3747	3296	3676	+819	***

LSD (P 5%) = 238.07 kg ha^{-1}; LSD (P 1%) = 327.20 kg ha^{-1}; LSD (P 0.1%) = 447.93 kg ha^{-1}

The analysis of variance for the yields obtained by the rye varieties reveals that the Dukato genotype achieved very significant positive yield differences at both fertilization doses compared to the control.

Variant a_3b_1 registered significant negative values while variants a_1b_3, a_2b_1 and a_2b_2 were not statistically different.

CONCLUSIONS

The studied genotypes registered yields ranging between 2831 and 4147 kg /ha^{-1}.

Significant positive differences compared to the control were recorded for the a_1b_2 and a_2b_3, a_3b_2 and a_3b_3 variants, while the a_3b_1 variant displayed significant negative differences.

The interactions between variety and dose of fertilizer were high and significant, indicating that the yield ranking of varieties was influenced by fertilization.

In the agropedological conditions of the area in which the experiment took place in the crop-years 2010-2013, the best yield results were obtained in the local variety Suceveana, fertilized with 50 kg a.i. N, followed by the Dukato genotype fertilized with the same dose.

The average yields of the analysed varieties put the Suceveana variety, which is adapted to the conditions of Romania, in the spotlight.

In terms of the agropedological conditions specific to the area in which the experiment took place, the Suceveana genotype is the only one which achieved consistent yield in the three experimental years.

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